FOI 180411
Document 2

| | |
|---|---|
| **From:** | Barker, James |
| **To:** | s22 |
| **Cc:** | de Brouwer, Gordon; Knudson, Dean; Cahill, Matt; Papps, David; Taylor, Mark; s22 Codina, Martin; Richardson, Geoff; Oxley, Stephen |
| **Subject:** | Toondah harbour, further brief [DLM=Sensitive:Legal] |
| **Date:** | Wednesday, 5 April 2017 5:31:18 PM |
| **Attachments:** | s47C |

---

Hi s22

As flagged earlier, enclosed is briefing on the Toondah Harbour proposal, as well as associated TPs which are also enclosed. This has also been put through pdms (including an attachment of an earlier brief on this proposal, which isn't enclosed with this email because of size).

Happy to discuss further.

Regards
James

FOI 180411
Document 6

# THE HON STEVEN CIOBO MP

Minister for Trade, Tourism and Investment

Link:
3/5 Date: MS

RECEIVED 0 2 MAY 2017

The Hon Josh Frydenberg MP
Minister for the Environment and Energy
Parliament House
CANBERRA ACT 2600

Dear ~~Minister~~ Josh

I recently received a letter from Cr Karen Williams, Mayor Redland City Council, regarding the Australian Government's environmental assessment process for the Toondah Harbour development in Cleveland, Queensland. As you are aware, the project has been referred to you for consideration under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).*

Cr Williams wrote to me as I granted Tourism Major Project Facilitation (TMPF) service status to the Toondah Harbour project in late 2016 following an assessment against certain selection criteria. The TMPF service provides approved significant tourism infrastructure projects with a case manager in Austrade to help guide project proponents through the Australian Government's approval processes.

Please find enclosed a copy of Cr Williams' letter which I am forwarding to you as many of the issues raised are a matter for your consideration.

I look forward to receiving notification of the outcome of the project's referral under the EPBC Act in due course.

Yours sincerely

**Steven Ciobo**

30 APR 2017

Parliament House Canberra ACT 2600 Australia
Telephone (02) 6277 7420 E-mail Trade.Minister@dfat.gov.au

MC17-00[illegible]

From the Mayor's Office
Karen Williams
Mayor of Redland City

[1]

30 March 2017

KW:DS:fm
Contact: Mayor's Office
Ph: 3829 8235

The Honourable Steven Ciobo MP
Minister for Trade, Tourism and Investment
PO Box 6022
House of Representatives
Parliament House
Canberra ACT 2600

Email: steven.ciobo.MP@aph.gov.au

Dear Minister

I write to commend you for granting Tourism Major Project Facilitation status to the Toondah Harbour Priority Development Area project in Redland City.

The declaration indicates that you, as Minister for Trade, Tourism and Investment, acknowledge the immense economic value of this $1.4 billion project to our city and South East Queensland.

The project – a partnership between the Queensland Government, Redland City Council and Walker Group Holdings – was referred to the Federal Government more than 15 months ago for environmental assessment.

I have been quite concerned about the referral process and the six suspensions of the referral decision since December 2015.

Under federal environmental legislation, actions that are likely to have a significant impact on the environment require approval from the Federal Environment Minister, your colleague the Honourable Josh Frydenberg.

My understanding is that identifying the likelihood of significant impacts is generally undertaken on a case-by-case basis, guided by scientific analysis as part of an environmental impact assessment process.

I am advised that Walker Group has not had an opportunity to provide this evidence base as the Government says it is willing to work to find a solution, yet to date has not identified a suitable assessment pathway.

I lobbied the former Queensland Government to have Toondah Harbour declared a priority development area to fast-track the area's redevelopment. I also lobbied the current Government to support the project, which they have done.

Redland City Council
ABN 86 058 929 428

Cnr Bloomfield & Middle Sts.
Cleveland Qld 4163

PO Box 21,
Cleveland Qld 4163

Telephone 07 3829 8623
Facsimile 07 3829 8781

Mobile 0416 123 588

Email mayor@redland.qld.gov.au
www.redland.qld.gov.au

A project of this nature will be transformational for the Redlands, both in establishing a destination identity for the area and providing critical infrastructure for tourism in the Cleveland-Moreton Bay region.

There is no suggestion that the project should not meet all environmental requirements and be subject to detailed testing. We have always supported such scrutiny. However, it is our firm view that it should be up to the proponent to demonstrate the acceptability of the proposal through an EIS. On the surface of it, there does not appear to be scientific basis for the department to reach an alternative conclusion.

This project has been 50 years in the making. I am concerned about the impact of the continued stymieing by the Australian Government of the momentum of the PDA process and the implications for this regional community if the project is sidelined without proceeding to the assessment phase.

I trust the Federal agencies can work cooperatively with us, the State and Walkers to facilitate an outcome than enables the scientific assessment of the project to commence in the near future.

Yours sincerely

Mayor Karen Williams
**Redland City Council**

From the Mayor's Office
**Karen Williams**
**Mayor of Redland City**

FOI 180411
Document 7

30 March 2017

KW:DS:fm
Contact: Mayor's Office
Ph: 3829 8235

The Honourable Josh Frydenberg MP
Minister for the Environment and Energy
Member for Kooyong
PO Box 6022
House of Representatives
Parliament House
CANBERRA ACT 2600

Dear Minister

I write to thank you for meeting with me on 22 March during my visit to Canberra as part of the annual Council of Mayors South East Queensland delegation.

As you are aware, your colleague, Tourism Minister Steven Ciobo, recently granted Tourism Major Project Facilitation status to the Toondah Harbour Priority Development Area project in Redland City.

The declaration indicates that Minister Ciobo and his Department acknowledge the economic potential of this $1.4 billion project for our city and South East Queensland.

As we discussed during our meeting the project was referred to your department by Walker Group more than 15 months ago for environmental assessment.

As I indicated to you I have been quite concerned about the referral process and the six suspensions of the referral decision since December 2015.

Under federal environmental legislation, actions that are likely to have a significant impact on the environment require approval from the Federal Environment Minister.

My understanding is that identifying the likelihood of significant impacts is generally undertaken on a case-by-case basis, guided by scientific analysis as part of an environmental impact assessment process.

I am advised that Walker Group has not had an opportunity to provide this evidence base as the Government says it is willing to work to find a solution, yet to date has not identified a suitable assessment pathway.

I lobbied the former Queensland Government to have Toondah Harbour declared a priority development area to fast-track the area's redevelopment. I also lobbied the current State Government to support the project, which they have done.

A project of this nature will be transformational for the Redlands, both in establishing a destination identity for the area and providing critical infrastructure for tourism in the Cleveland-Moreton Bay region.

Redland City Council
ABN 86 058 929 428
Cnr Bloomfield & Middle Sts.
Cleveland Qld 4163
PO Box 21,
Cleveland Qld 4163
**Telephone 07 3829 8623**
Facsimile 07 3829 8781
Mobile 0416 123 588
Email mayor@redland.qld.gov.au
www.redland.qld.gov.au

There is broad support for the project across our city, with around 80 per cent indicating they wanted to see Toondah Harbour redeveloped. As you are aware, there is also a vocal group of project opponents.

There is no suggestion that the project should not meet all environmental requirements and be subject to detailed testing. We have always supported such scrutiny.

This project has been 50 years in the making. I am concerned about the implications for this regional community if the project is sidelined without proceeding to the assessment phase.

We are not asking for you to approve the project, but merely to allow Walkers to take the project to the next stage of assessment, an EIS, to provide the opportunity for them to prove their environmental credentials.

It is our firm view that the proponent should have the opportunity to demonstrate the acceptability of the proposal through an EIS. On the surface of it, there does not appear to be scientific basis for your department to reach an alternative conclusion.

Under the current use of Toondah as a ferry and barge terminal, no-one takes responsibility for the daily impacts of marine traffic and regular dredging in a RAMSAR site, nor does any agency expect companies to cease their operations.

I trust the Federal agencies can work cooperatively with us, the State and Walkers to facilitate an outcome that enables the scientific assessment of the project to commence in the near future.

Yours sincerely

KWilliams

Mayor Karen Williams
**Redland City Council**

FOI 180411
Document 8

30 March 2017

KW:DS:fm
Contact: Mayor's Office
Ph: 3829 8235

The Honourable Josh Frydenberg MP
Minister for the Environment and Energy
Member for Kooyong
PO Box 6022
House of Representatives
Parliament House
CANBERRA ACT 2600

Dear Minister

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The declaration indicates that Minister Ciobo and his Department acknowledge the economic potential of this $1.4 billion project for our city and South East Queensland.

As we discussed during our meeting the project was referred to your department by Walker Group more than 15 months ago for environmental assessment.

As I indicated to you I have been quite concerned about the referral process and the six suspensions of the referral decision since December 2015.

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My understanding is that identifying the likelihood of significant impacts is generally undertaken on a case-by-case basis, guided by scientific analysis as part of an environmental impact assessment process.

I am advised that Walker Group has not had an opportunity to provide this evidence base as the Government says it is willing to work to find a solution, yet to date has not identified a suitable assessment pathway.

I lobbied the former Queensland Government to have Toondah Harbour declared a priority development area to fast-track the area's redevelopment. I also lobbied the current State Government to support the project, which they have done.

A project of this nature will be transformational for the Redlands, both in establishing a destination identity for the area and providing critical infrastructure for tourism in the Cleveland-Moreton Bay region.

There is broad support for the project across our city, with around 80 per cent indicating they wanted to see Toondah Harbour redeveloped. As you are aware, there is also a vocal group of project opponents.

There is no suggestion that the project should not meet all environmental requirements and be subject to detailed testing. We have always supported such scrutiny.

This project has been 50 years in the making. I am concerned about the implications for this regional community if the project is sidelined without proceeding to the assessment phase.

We are not asking for you to approve the project, but merely to allow Walkers to take the project to the next stage of assessment, an EIS, to provide the opportunity for them to prove their environmental credentials.

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Under the current use of Toondah as a ferry and barge terminal, no-one takes responsibility for the daily impacts of marine traffic and regular dredging in a RAMSAR site, nor does any agency expect companies to cease their operations.

I trust the Federal agencies can work cooperatively with us, the State and Walkers to facilitate an outcome that enables the scientific assessment of the project to commence in the near future.

Yours sincerely

Mayor Karen Williams
**Redland City Council**

FOI 180411
Document 9

**From:** Barker, James
**To:** s22
**Subject:** RE: Toondah Harbour Withdrawal of EPBC 2015/7612 [SEC=UNCLASSIFIED]
**Date:** Friday, 5 May 2017 11:29:45 AM

---

No, not yet.

**From:** s22
**Sent:** Friday, 5 May 2017 11:27 AM
**To:** Barker, James <James.Barker@environment.gov.au>
**Subject:** RE: Toondah Harbour Withdrawal of EPBC 2015/7612 [SEC=UNCLASSIFIED]

James

We are responding to a query on Toondah. To confirm, we haven't received the new application yet?

Thanks

**From:** Barker, James
**Sent:** Thursday, 4 May 2017 6:38 PM
**To:** s22 @environment.gov.au>
**Cc:** de Brouwer, Gordon <Gordon.deBrouwer@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; Cahill, Matt <Matt.Cahill@environment.gov.au>; Tregurtha, James <James.Tregurtha@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; Papps, David <David.Papps@environment.gov.au>; Taylor, Mark <Mark.Taylor@environment.gov.au>; s22 @environment.gov.au>
**Subject:** FW: Toondah Harbour Withdrawal of EPBC 2015/7612 [SEC=UNCLASSIFIED]

Hi s22

Fyi too. This withdrawl will be reflected on the Department's website shortly (I expect tomorrow). We have not yet received a further referral.

If you are asked about it in the meantime, you could indicate that:

- The proponent has withdrawn its proposed development for Toondah Harbour in Moreton Bay, under the EPBC Act.
- The proponent has written to the Department, stating its intention to submit an alternative referral.
- When the Department gets that referral, it will be published for 2 weeks public comment, as required by the EPBC Act.
- After that comment period, unless further information is required or an extension is requested by the proponent, a decision will be made by the Minister or his delegate about whether the proposal requires further detailed assessment and approval under the EPBC Act.

**From:** Peter Saba [mailto:Peter.Saba@walkercorp.com.au]
**Sent:** Thursday, 4 May 2017 3:15 PM
**To:** Barker, James <James.Barker@environment.gov.au>
**Cc:** Cahill, Matt <Matt.Cahill@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; Stephen Davis <stephen.davis@davisadvisory.com.au>
**Subject:** Toondah Harbour Withdrawal of EPBC 2015/7612

James,

Further to our recent discussion, please find attached our formal notification to withdraw our referral (2015/7612).

Please let me know if you have any queries.

Regards,

Peter.

**Peter Saba**
General Manager - Queensland Development

Walker Corporation
Level 18, 150 Charlotte St Brisbane QLD 4000
T +61 7 3007 7402
M +61s47F
www.walkercorp.com.au

**From:** s22
**To:**
**Cc:** de Brouwer, Gordon; Knudson, Dean; Cahill, Matt; Taylor, Mark; Papps, David; s22
**Subject:** FYI, Toondah Harbour referral now published for public comment [SEC=UNCLASSIFIED]
**Date:** Thursday, 11 May 2017 4:13:58 PM

s22

Fyi, we have now published the referral on the Department's website at http://epbcnotices.environment.gov.au/publicnoticesreferrals/

This means that the referral decision will be due on 8 June. I've made a minor update to the points below accordingly.

Thanks
James

---

**From:** Barker, James
**Sent:** Tuesday, 9 May 2017 11:30 AM
**To:** s22 @environment.gov.au>
**Cc:** de Brouwer, Gordon <Gordon.deBrouwer@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; Cahill, Matt <Matt.Cahill@environment.gov.au>; Tregurtha, James <James.Tregurtha@environment.gov.au>; Taylor, Mark <Mark.Taylor@environment.gov.au>; Papps, David <David.Papps@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>
**Subject:** FYI, Toondah Harbour referral received [SEC=UNCLASSIFIED]

Hi s22

Fyi, we have this morning received the new referral for Toondah harbour (EPBC 2017/2939).

Once we have confirmed with Walker that EPBC Regulation requirements have been met, and the proponent pays the referral fee, it will be published on the Department's website for the 10 business day public comment period. This is likely to happen in the next few days. I'll let you know once it is made public.

In anticipation of the referral being made public, the following are some updated points if needed:

- Walker Group has submitted a referral for the development of Toondah Harbour, in Moreton Bay, Queensland.
- The referral has been published on the website of the Department of Environment and Energy for 2 weeks public comment until 8 June, as required under national environment law.
- After the comment period, unless further information is required or an extension is requested by the proponent, a decision will be made by the Minister or his delegate

about whether the proposal requires further detailed assessment and approval under the EPBC Act.

- Walker Group has withdrawn a previous referral for the proposed development.

If asked – what is the difference between the new proposal and the old one?

- The new referral includes changes to the project's footprint.
- The Department is further assessing the detail of the new proposal.

Emails contained in Document 9

s22

[redacted]

s22

MC17-013137

**brisbane**
australia's new world city

FOI 180411
Document 11

3 0 MAY 2017

+61 7 3006 6200
+61 7 3006 6250
brisbanemarketing.com.au
Level 8, Roy Harvey House,
157 Ann Street,
Brisbane Qld 4000
PO Box 12260, George Street
Brisbane Qld 4003 Australia
ABN 86 094 633 262

Min No: MC
Division: ESD
Link:
DLO: 1/5
Date: 30/5
RECEIVED 3 0 MAY 2017
Environment and Energy Minister
☐ Covering Brief
☑ Minister Reply
☐ CoS/Adviser Reply
☐ Refer to:......
☐ Departmental Reply
☐ Appropriate Action
☐ For Information
☐ Campaign ☐ Advice/Min

24 May 2017

The Hon Josh Frydenberg MP
Referrals Gateway
Environment Assessment Branch
Department of the Environment
GPO Box 787
Canberra ACT 2601

Copy sent via email: epbc.referrals@environment.gov.au

Dear Hon Josh Frydenberg MP,

**2017/7939 - Walker Group Holdings Pty Limited Toondah Harbour Development**

Brisbane Marketing is the city's economic development board, a wholly-owned subsidiary of Brisbane City Council, playing a key role in the ongoing evolution and success of the city. Brisbane Marketing is responsible for major events, foreign direct investment, Brisbane's Convention Bureau, profiling Brisbane as an international education destination and serving as the Regional Tourism Organisation (RTO) for Brisbane, Logan, Ipswich, Scenic Rim, Lockyer Valley, Moreton Bay, Redlands and Somerset Local Government Areas.

I am writing to advise of Brisbane Marketing's support for the Toondah Harbour Project (reference number 2017/7939), a joint initiative of Walker Group Holdings Pty Ltd, Redland City Council and Economic Development Queensland (EDQ). I encourage the Federal Government to allow this important project to progress to scientific investigations that will enable an EIS to be prepared.

Brisbane Marketing has engaged with the project proponents in our role as the RTO, and considering the agencies' core responsibilities, we understand that the project has the ability to be a major catalyst for further tourism investment, job creation and economic value for the region.

Specifically, the following benefits and opportunities that could be realised should this important project progress include:

1. **Catalyst for further tourism investment**
   Tourism plays a significant role in the Brisbane economy. With over $9 billion of private capital currently being invested or mooted in tourism related infrastructure and major projects, the sector is contributing strong economic growth. The $1.3 billion Toondah Harbour revitalization project, will provide an important catalyst that can deliver more demand generating tourism product, leading to opportunities for increased tourism visitation.

2. **Stronger connectivity to Moreton Bay & Redlands region**
   An opportunity exists to provide more strategic and direct access to the natural tourism assets including Moreton Bay Island and North Stradbroke Island. An improved and environmentally sustainable connection between Brisbane CBD and the Moreton Bay and Redlands region will deliver enhanced products and experiences to national and international visitors. The Toondah Harbour revitalisation will significantly elevate the current infrastructure, from a baron industrial facility to a cosmopolitan and activated precinct.

3. **Access to the region's natural assets**
   In 2016, Brisbane realised over 7 million visitors, with international visitors increasing by 9.4% since 2015. This growth has been generated by the strong increase in leisure visitation from China. Tourism Australia research clearly articulates that this significant inbound growth market is largely motivated to visit Australia for the aquatic and coastal environment, natural beauty and wildlife. The delivery of the Toondah Harbour development will enable Brisbane and the region to showcase our world-class natural assets and improves the visitor experience.

4. **Significant economic value driver**
   Tourism is a significant driver of Brisbane region's economy, contributing $6.3 billion to GDP and employing a total 64,700 people, or 5.5% of total jobs in the region. Beyond the tourism sector's existing value, the visitor economy has significant growth potential with current forecasts to 2020 indicating that the sector is capable of realising total visitor expenditure growth of 104% and an increased work force of over 80,000 people by 2020. Coupled with significant private investment in the pipeline, the Toondah Harbour development enables this sector's growth and visibility, and will be a major driver of new employment.

Brisbane Marketing is highly encouraged by Walker Group Holdings Pty Ltd proposal to develop Toondah Harbour and the potential for it to unlock further private investment in the tourism sector, improve connectivity to the region's existing natural assets and be a major catalyst for job creation and economic prosperity.

We strongly encourage the Federal Government to view this development on its favourable merits and allow the project to progress to the next stage of environmental investigations.

Should you have any questions please do not hesitate to contact Oriana Wyrozebska, Senior Manager Investment Attraction (Tourism Infrastructure) from my team on +61 7 3006 6266 or owyrozebska@brisbanemarketing.com.au.

Kind regards,

John Aitken (1)
**CHIEF EXECUTIVE OFFICER**

*CC: Peter Saba, General Manager Development, Walker Corporation*
*CC: Mayor Karen Williams, Redland City Council*

FOI 180411
Document 12

**From:** Barker, James
**To:** s22
**Cc:** de Brouwer, Gordon; Knudson, Dean; Cahill, Matt; Gowland, Kynan; s22 Papps, David; Taylor, Mark; Taylor, Hilton; Richardson, Geoff; Oxley, Stephen; s22
**Subject:** RE: Toondah Harbour, TPs [SEC=UNCLASSIFIED]
**Date:** Thursday, 8 June 2017 1:04:56 PM
**Attachments:** 2017-7939 Comms-referral decision-talking points.docx

---

Hi s22

As discussed, enclosed are some talking points, contingent on the Minister making a controlled action decision (in MS17-000774).

Happy to discuss of course.

Thanks
James

---

**From:** Barker, James
**Sent:** Tuesday, 6 June 2017 4:06 PM
**To:** s22 @environment.gov.au>
**Cc:** de Brouwer, Gordon <Gordon.deBrouwer@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; Cahill, Matt <Matt.Cahill@environment.gov.au>; s22 @environment.gov.au>; s22 @environment.gov.au>; Papps, David <David.Papps@environment.gov.au>; Taylor, Mark <Mark.Taylor@environment.gov.au>; Taylor, Hilton <Hilton.Taylor@environment.gov.au>; Richardson, Geoff <Geoff.Richardson@environment.gov.au>; Oxley, Stephen <Stephen.Oxley@environment.gov.au>; s22 @environment.gov.au>
**Subject:** RE: 3rd Toondah Brief [SEC=UNCLASSIFIED]

Hi s22

I've now put through a 3rd brief for Toondah Harbour (also enclosed). This brief is not time critical. This brief is contingent on the Minister's making a decision on MS17-000774 (the 'controlled action' decision brief).

Thanks
James

s22

s22

s22

**TALKING POINTS**

**TOONDAH HARBOUR DEVELOPMENT**

- I have decided that the proposed Toondah Harbour Development needs to undergo a comprehensive environmental assessment under national environment law.
  - I made this decision because I consider the proposal is likely to have a significant impact on the Moreton Bay wetland, and nationally listed threatened and migratory species.
- The proponent, the Walker Group, will now be required to undertake the detailed environmental assessment, before I decide whether or not the proposal can go ahead.
  - There will be an opportunity for public comment during the assessment of the project.
  - The environmental assessment will allow for a detailed examination of the likely environmental impacts, measures to avoid, mitigate and offset those impacts, and the economic and social benefits.
- Further information about the assessment process will be published on the Department of Environment and Energy's website, as the assessment proceeds.

***If asked why the original 2015 referral was withdrawn***

- Walker Group originally referred this proposal in 2015.
- In May 2017, Walker withdrew their original referral and submitted a new proposal.
- The main change in the new proposal is to reduce the size of the development to increase a buffer between the development and the shorebird roost site at the adjacent Cassim Island.

***If asked how the development will impact the wetland***

- Walker Group's referral nominated the proposal as likely to have significant impacts on the wetland and habitat for migratory birds.
- These impacts will now be further examined through the more detailed assessment that Walker Group must now undertake.

Contact Officer: James Barker
Phone: s22

Last updated: 8 June 2017

### *If asked about the __Ramsar Convention__*

- Australia is required by the Ramsar Convention to protect internationally listed wetlands, which include the Moreton Bay Ramsar site.
- The environmental impact assessment will consider likely impacts on the Ramsar site.

**BACKGROUND**

- Walker Group is proposing to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, sourth of Brisbane.
- The proposal was referred on 11 May 2017 and replaces their earlier referral for substantively the same project.
- The main change to the new proposal is to reduce the size of the development which will increase the buffer between the development and the shorebird high tide roost site at Cassim Island.
- The proposed development area is 73 hectares, approximately 50 hectares of this is within the Moreton Bay Ramsar wetland. The proposal includes approximately 40 hectares of land reclamation within the wetland.
- In June 2013, at the request of Redland City Council, the Queensland State Government declared Toondah Harbour a Priority Development Area (PDA) under the Queensland *Economic Development Act 2012*. As a result, the PDA is excempt from the standard planning and development assessment processes and will be assessed by Economic Development Queensland against the PDA Development Scheme.

*Community Response*

- 180 public submissions and 1,238 campaign were received during the public comment period on the referral. Four of these submissions supported the proposed development.

Contact Officer: James Barker
Phone: s22

Last updated: 8 June 2017

FOI 180411
Document 14

DEPARTMENT OF THE ENVIRONMENT AND ENERGY

PDR: MS17-000774

Copy to:
Secretary
Mr Knudson
Mr Cahill
Mr Papps
Mr Oxley
Mr Taylor
s22 [redacted]

Chief of Staff
s22 [redacted]

**To:** Minister for the Environment and Energy (For Decision)

**REFFERAL DECISION - TOONDAH HARBOUR DEVELOPMENT, QUEENSLAND (EPBC 2017/7939)**

Through: Matt Cahill, First Assistant Secretary, Environment Standards Division.

**Timing:** 8 June 2017 - statutory timeframe.

Office of the Minister for the Environment and Energy
06 JUN 2017

| | | | |
|---|---|---|---|
| **Recommendation:**<br>s47C [redacted] that you decide that the Toondah Harbour Development Queensland (EPBC 2017/7939) referral is a controlled action and that you sign the brief at **Appendix A**.<br><br>RECEIVED 09 JUN 2017 MaPS<br><br>**Minister:**<br><br>**Comments:** | | | **Signed / Not signed**<br><br>Date:<br>8/6/17 |
| **Clearing Officer:**<br>Sent: 5/06/17 | James Barker | Assistant Secretary, Assessments and Governance Branch | Ph: 02 6274 2694<br>Mob: s22 [redacted] |
| Contact Officer: | s22 [redacted] | Director, Queensland Assessments North | Ph: 6274 s22 [redacted] |

**Key Points:**

1. This brief is provided for you to consider whether or not further assessment of the Toondah Harbour Development (EPBC 2017/7939) is required under the *Environment Protection and Biodiversity Conservation Act 1999*.

2. The project proposes to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 km south of Brisbane. The proposal will involve the excavation of a new marina and land reclamation within Moreton Bay Ramsar wetland.

3. The Department recommends that you decide that the proposed action is likely to have a significant impact on: a Ramsar wetland of international importance, listed threatened species and communities and listed migratory species for the reasons outlined in the brief at **Appendix A**.

**Appendix**

**A:** Referral Decision Brief and Attachments

## DEPARTMENT OF THE ENVIRONMENT AND ENERGY

MS17-000774

**To:** Minister (for decision)

**Referral Decision Brief – Toondah Harbour Development, Queensland (EPBC 2017/7939)**

Through: Matt Cahill, First Assistant Secretary, Environment Standards Division.

**Timing:** 8 June 2017 - statutory timeframe.

| | | |
|---|---|---|
| **Recommended Decision** | **NCA** ☐ **NCA(pm)** ☐ **CA** ☒ | |
| **Designated Proponent** | Walker Group Holdings Pty Ltd<br>81 001 215 069 | |
| **Controlling Provisions triggered or matters protected by particular manner** | World Heritage (s12 & s15A)<br>Yes ☐ No ☒ No if PM ☐ | National Heritage (s15B & s15C)<br>Yes ☐ No ☒ No if PM ☐ |
| | Wetlands (Ramsar)(s16 & s17B)<br>Yes ☒ No ☐ No if PM ☐ | Threatened Species & Communities (s18 & s18A)<br>Yes ☒ No ☐ No if PM ☐ |
| | Migratory Species (s20 & s20A)<br>Yes ☒ No ☐ No if PM ☐ | C'wealth marine (s23 & s24A)<br>Yes ☐ No ☒ No if PM ☐ |
| | Nuclear actions (s21 & s22A)<br>Yes ☐ No ☒ No if PM ☐ | C'wealth land (s26 & s27A)<br>Yes ☐ No ☒ No if PM ☐ |
| | C'wealth actions (s28)<br>Yes ☐ No ☒ No if PM ☐ | GBRMP (s24B & s24C)<br>Yes ☐ No ☒ No if PM ☐ |
| | A water resource – large coal mines and CSG (s24D & s24E)<br>Yes ☐ No ☒ No if PM ☐ | C'wealth heritage o/s (s27B & s27C)<br>Yes ☐ No ☒ No if PM ☐ |
| **Public Comments** | Yes ☒ No ☐ Number: 180 individual and 1238 campaign. See Attachment N. | |
| **Ministerial Comments** | Yes ☒ No ☐ Who: Queensland Department of Environment and Heritage Protection. See Attachment I. | |
| **Assessment Approach Decision** | Yes ☐ No ☒<br>Bilateral Applies ☐ | |

**Recommendations:**

1. Consider the information in this brief, the referral (Attachment A) and other the information in the attachments.

**Considered / Please discuss**

2. Agree with the recommended decision.

**Agreed / Not agreed**

3. If you agree to 2, indicate that you accept the reasoning in the departmental briefing package as the basis for your decision.

**Accepted/Please discuss**

4. Agree to the designated proponent.

**Agreed / Not agreed**

5. Agree to stop the clock on the assessment approach decision to allow time for the Queensland Government to confirm whether the project can be assessed under the bilateral agreement with the Commonwealth.

**Agreed / Not agreed**

6. Sign the notice at Attachment B (which will be published if you make the recommended decision).

**Signed / Not signed**

7. Sign the letters at Attachment C advising the proponent and relevant parties of your decision.

**Signed / Not signed**

8. Sign the draft statement of reasons at Attachment D having made any modification you consider necessary to ensure that the statement reflects your reasoning (we have provided this in anticipation of requests for it from third parties).

**Signed / Not signed**

Date: 8/6/7

**Minister for the Environment and Energy,**
**The Hon Josh Frydenberg MP**

**Comments:**

**BACKGROUND:**

**Description of the referral**

1. Toondah Harbour is an existing marine area that serves as the base for water taxi, passenger and ferry services between the mainland and North Stradbroke Island. Walker Group Holdings Pty Ltd (the proponent) is proposing to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 kilometres (km) south of Brisbane. The proposal will involve the excavation of a new marina and reclaiming land within the adjoining Moreton Bay Ramsar wetland. The Toondah Harbour project is proposed to be delivered in stages over a 15 to 20 year period.

2. The key components of the proposal are:

- project area of 73 hectares, of which approximately 50 hectares is within the Moreton Bay Ramsar wetland;
- approximately 40 hectares of reclamation within Moreton Bay Ramsar wetland;
- new ferry terminals to improve access to North Stradbroke Island;
- mixed use development including residential, retail, commercial and tourism uses;
- a marina;
- public open space and boardwalks providing foreshore access; and
- dredging of the existing Toondah Harbour marine access channel to allow for safe navigation for all vessels.

3. A referral for the project (Attachment A) was submitted under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 May 2017. The statutory timeframe for a decision under the EPBC Act is 8 June 2017.

4. In its referral, the proponent stated its belief that the proposal is a controlled action for the purposes of the EPBC Act and will likely have a significant impact on the ecological character of the Moreton Bay Ramsar wetland, listed threatened species and ecological communities, and listed migratory species. The proponent has stated in the referral that there are no alternatives to the location and footprint of the action.

*State approval process*

5. In June 2013, at the request of Redland City Council, the Queensland State Government declared Toondah Harbour a Priority Development Area (PDA) under the *Economic Development Act 2012* (Qld). As a result, the PDA is exempt from the standard planning and development assessment processes and will be assessed by Economic Development Queensland against the PDA Development Scheme. The proponent has stated that it intends to seek a declaration of the project as a 'coordinated project' under the *State Development and Public Works Organisation Act 1971* (Qld).

6. If you agree to the recommended decision, the Department will seek further information from the Queensland State Government regarding the state assessment process for the project. Subject to that advice, it may be that the project can be assessed under the bilateral agreement or, if not, your delegate will make a decision on the assessment approach.

**RECOMMENDED DECISION:**

7. Under section 75 of the EPBC Act you must decide whether the action that is the subject of the referral is a controlled action, and which provisions of Part 3 (if any) are controlling provisions for the action. In making your decision you must consider all adverse impacts the action has, will have, or is likely to have, on the matter protected by each provision of Part 3. You must not consider any beneficial impacts the action has, will have or is likely to have on the matter protected by each provision of Part 3.

8. The Department recommends that you decide that the proposed action is likely to have a significant impact on:

- the ecological character of the Moreton Bay Ramsar site (sections 16 and 17B);
- listed threatened species, including marine turtles and the critically endangered Eastern Curlew (sections 18 and 18A); and
- listed migratory species, including the dugong (sections 20 and 20A).

**Ramsar wetlands**

9. The Moreton Bay Ramsar site is located in and around Moreton Bay, east of Brisbane in Queensland (Attachment E). The Ramsar wetland supports extensive intertidal areas of sand and mud flat habitats, seagrass, mangroves and saltmarsh that provide vital habitat for dugongs, turtles and waterbirds including significant populations of migratory shorebirds. The wetland supports more than 50,000 migratory waders. At least 43 species of wading birds use the intertidal habitats, including 30 migratory species listed on international conservation agreements.

10. In addition, Moreton Bay is one of only two Ramsar sites in Australia that supports the critically endangered Eastern Curlew throughout the year, with juvenile birds not migrating until they are 2-3 years old. The ecological character of the Moreton Bay Ramsar wetland is described in *Ecological Character Description – Moreton Bay Ramsar Site* (Attachment F) and *Information sheet on Moreton Bay Ramsar Site* (Attachment G).

11. The proposed development area is immediately adjacent to and within the Moreton Bay Ramsar site.

12. The referral states that it is likely that the proposed action will result in significant impacts on the ecological character of a portion of the Moreton Bay Ramsar wetland. In particular, the proposed action will permanently remove an area of the Ramsar wetland through approximately 40 hectares of land reclamation and is likely to negatively impact the ecological character of the wetland.

13. Advice from the Department's Wetland Section (Attachment H) considers that direct impacts to the ecological character of the wetland will occur as the proposed action will result in:

- areas of the wetland within the referral area being removed or substantially modified through dredging, excavation and/or land reclamation activities;
- impacts on habitat values through the removal of seagrass, mangroves and intertidal mudflats;
- impacts on the lifecycle of an ecologically significant proportion of the population of the Eastern Curlew and Bar-Tailed Godwit, as well as other listed migratory species, such as Whimbrels and Grey-Tailed Tattler, through the removal of, or disturbance to, foraging and roosting habitat in or near the referral area; and
- changes in the hydrological regime of the wetland and consequent changes to water quality and aquatic habitats from sedimentation.

14. The referral lacks detail on the proposed development, such as the size of the marina, the number of apartments, the height of buildings and the extent of dredging required to upgrade the channel. The referral has not considered indirect impacts from the proposed action such as light pollution, the potential for increased weeds and domestic animals, and human traffic. In addition, advice from the Department's Wetland Section concludes that the impacts on the ecological character of the site will be difficult to mitigate and offset.

15. Although the referral states that a buffer zone will be included between the development and the mangroves and high tide roosting site at Cassim Island, it does not provide sufficient information for the Department to be confident that this will reduce the impacts on migratory shorebirds.

16. The Department therefore concludes that the proposed action is likely to have a significant impact on the ecological character of the Moreton Bay Ramsar wetland.

**Listed migratory species**

17. The Department's Environment Reporting Tool (ERT) indicates that a total of 72 listed migratory species may occur within two kilometres of the proposed action (Attachment J). Based on the location of the action and likely habitat present in the area of the proposed action, the Department considers that significant impacts are likely in relation to the following matters:

Listed migratory shorebirds

18. The referral notes that habitat used by migratory shorebirds for foraging or roosting within Toondah Harbour and roosting habitat adjoining the project area are characterised as 'important habitat' for migratory shorebirds under the *EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*.

19. Eleven migratory shorebirds were recorded within or immediately adjacent to the project area during the proponent's field surveys. These include:

    - Grey-tailed Tattler (*Tringa brevipes*);
    - Ruddy Turnstone (*Arenaria interpres*);
    - Great Knot (*Calidris tenuirostris*) (also listed as critically endangered);
    - Red-necked Stint (*Calidris ruficollis*);
    - Bar-tailed Godwit (*Limosa lapponica baueri*) (also listed as vulnerable)
    - Whimbrel (*Numenius phaeopus*);
    - Eastern Curlew (*Numenius madagascariensis*) (also listed as critically endangered);
    - Terek Sandpiper (*Xenus cinereus*); and
    - Curlew Sandpiper (*Calidris ferruginea*) (also listed as critically endangered).

20. Migratory shorebirds use two different habitat types within or adjacent to the project area, namely intertidal mudflats that provide feeding habitat when exposed at low tide, and stands of mangrove trees, offshore sandbars and shoreline saltmarsh and claypan areas that provide high tide roost sites.

21. The referral states that the proposed action is likely to have both direct and indirect impacts on migratory shorebirds through clearing of approximately 40 hectares of foraging

habitat for dredging and land reclamation, and disturbance during construction including changes to water quality during dredging and reclamation works. However, the referral also states that the project area is not considered to be a major foraging site in terms of diversity or numbers of migratory shorebirds as similar habitat is found throughout Moreton Bay, and the project site provides less than 0.001% of feeding habitat within the Ramsar wetland. As outlined below, the Department considers that the loss of this foraging habitat, combined with the indirect impacts of the proposal, is likely to have a significant impact on migratory shorebirds.

22. Surveys undertaken by the proponent mapped large areas of intertidal foraging habitats in the project area, comprising areas of mudflat, sandflat, seagrass and areas of surface coral rubble, and two high tide roost sites directly adjacent to the project area (Figure 2, Attachment 3 of Attachment A).

23. Important roosting sites - Cassim Island and Nandeebie Claypan - are in close proximity to the proposed action. It is likely that the proposed action will have indirect impacts on these roosting sites, including noise and visual disturbance as a result of increased human use of the area.

24. Survey results provided in the referral (Attachment A) confirmed that Cassim Island, located approximately 100 meters east of the project boundary, and the Nandeebie Claypan, immediately south of the project area, are important roosting habitat for migratory shorebirds based on the relatively large total numbers of migratory shorebirds using these roost sites. Up to 920 migratory shorebirds of four species known to roost in mangrove trees were recorded at Cassim Island, while up to 1,060 migratory shorebirds were recorded roosting at the Nandeebie Claypan.

25. The *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (2013) and the *EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (2017) provide that a proposed action will be likely to have a significant impact on migratory species where the proposal will substantially modify, destroy or isolate an area of important habitat for migratory species.

26. The proposed action will reduce the area of occupancy for migratory shorebird species by removing approximately 40 hectares of foraging habitat; adversely affecting important roosting habitat and modifying, destroying, isolating and decreasing the availability and quality of habitat through indirect impacts such as light, noise and human interaction.

27. In addition to the above, advice received from the Department's Migratory Species Section (Attachment H) concluded that the proposed action will seriously disrupt the lifecycle (feeding, migration and resting behaviour) of an ecologically significant population of the Eastern Curlew and Bar-tailed Godwit, as well as other listed migratory species, such as Whimbrels and Grey-tailed Tattlers, through the removal of, or disturbance to, foraging and roosting habitat in or near the referral area. Additional impacts will result from linking important offshore roosting sites with the mainland as it will interfere with the recovery of the Eastern Curlew by removing important habitat and causing an increase in ongoing disturbance.

Other Migratory species

28. Moreton Bay supports important foraging populations of Green, Hawksbill and Loggerhead Turtles and is close to the southern-most extent of their range. The *Marine*

*Bioregional Plan for the Temperate East Marine Region* (2012) (Attachment K) considered Moreton Bay a significant feeding ground for the Green Turtle.

29. Advice from the Department's Migratory Species Section (Attachment H) considers that light pollution, vessel disturbance and habitat modification (though dredging and infrastructure/coastal development) are known threats to migratory marine species. The Department considers it likely that the proposed action will increase these threats to migratory marine species and reduce the area of occupancy of the species.

30. Based on this advice and other information available to the Department, such as the Species Profile and Threats database and information from the referral documentation, the Department considers that the proposed action is likely to have significant impacts on other migratory species such as:

- Loggerhead Turtle *(Caretta caretta)*;
- Green Turtle *(Chelonia mydas)*;
- Hawksbill Turtle *(Eretmochelys imbricata);*
- Indo-pacific Humpback Dolphin (*Sousa chinensis*); and
- Dugong (*Dugong dugon*).

**Listed threatened species and communities**

31. The Department's Environment Reporting Tool (ERT) identifies 57 threatened species and one ecological community may occur within two kilometres of the proposed action (see the ERT report at Attachment J). Based on the location of the action and likely habitat present in the area of the proposed action, the Department considers a number of these species will be impacted by loss of marine, intertidal and terrestrial habitat as well as light and noise disturbance during construction and operation of the project. The Department considers that significant impacts are likely in relation to the following matters:

Eastern Curlew (*Numenius madagascariensis*) – critically endangered

32. The Department has considered the likelihood of direct and indirect impacts, the importance of habitat in, and immediately adjacent to, the project area and the lack of adequate mitigation and management measures to minimise these impacts and concluded that the proposed action is likely to have a significant impact on the critically endangered Eastern Curlew.

33. The critically endangered Eastern Curlew occurs seasonally around the Australian coastline, with up to 3500 birds estimated to visit Moreton Bay (9% of the flyway population). The Eastern Curlew habitat in the Moreton Bay wetland is internationally important as it supports more than 1% of the individuals in a population of the migratory Eastern Curlew (*EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (2017)).

34. The project site contains intertidal foraging habitat for the Eastern Curlew with seven individuals recorded during 2015 surveys (Attachment A). Important roosting sites, the Nandeebie Claypan and Cassim Island, are also immediately adjacent to the project area with up to 180 Eastern Curlew having been recorded at the Nandeebie Claypan roosting site (Attachment 6 of Attachment A). Although there are a number of available roost sites

for the Eastern Curlew within the region, the Nandeebie Claypan is considered by the Department to be an important site within Moreton Bay (Attachment 6 of Attachment A).

35. The referral proposes a buffer zone of 100 to 200 metres between the development and the mangroves and high tide roosting site at Cassim Island. However, the referral does not provide adequate information on whether they would be sufficient to manage the impacts to the Eastern Curlew. The *Conservation Advice for Numenius madagascariensis (Eastern Curlew)* (2015) states that the species is easily disturbed by human interaction within 250m.

36. The Department considers that as the proposed action will substantially modify, destroy and isolate an area of habitat for the Eastern Curlew it is likely to have a significant impact on the species.

*Other listed species*

37. The Department's ERT identifies the potential presence of additional threatened species or communities within two kilometres of the proposed action area. Based on information available to the Department and the nature of the proposed action that includes removal of onshore vegetation, intertidal mudflats and seagrass bed that provide habitat for threatened species, the Department considers that the proposed action is likely to have significant impacts on other threatened species such as:

   - Great Knot (*Calidris tenuirosris*) – critically endangered
   - Curlew Sandpiper (*Calidris ferruginea*) – critically endangered
   - Bar-tailed Godwit (*Limosa lapponica baueri*) – vulnerable;
   - Koala (*Phascolarctos cinereus*) (combined populations of Qld, NSW and the ACT) – vulnerable;
   - Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable;
   - Loggerhead turtle *(Caretta caretta)* – endangered;
   - Green Turtle *(Chelonia mydas)* – vulnerable; and
   - Hawksbill Turtle *(Eretmochelys imbricate)* – vulnerable.

## PROTECTED MATTERS THAT ARE NOT CONTROLLING PROVISIONS:

| | |
|---|---|
| **World Heritage properties** | The ERT did not identify any World Heritage properties located within or adjacent to the proposed action area, therefore this controlling provision does not apply. |
| **National Heritage places** | The ERT did not identify any National Heritage places located within or adjacent to the proposed action area, therefore this controlling provision does not apply. |
| **Commonwealth marine environment** | The proposed action does not occur in the vicinity of a Commonwealth marine environment therefore this controlling provision does not apply. |
| **Commonwealth action** | The referring party is not a Commonwealth agency, therefore this controlling provision does not apply. |
| **Commonwealth land** | The proposed action is not being undertaken on Commonwealth land therefore this controlling provision does not apply. |
| **Nuclear action** | The proposed action does not meet the definition of a nuclear action as defined in the EPBC Act therefore this controlling provision does not apply. |
| **Great Barrier Reef Marine Park** | The proposed action is not located in the vicinity of the Great Barrier Reef Marine Park, therefore this controlling provision does not apply. |
| **Commonwealth Heritage places overseas** | The proposed action is not located overseas, therefore this controlling provision does not apply. |
| **A water resource, in relation to coal seam gas development and large coal mining development** | The proposed action is not a coal seam gas or a large coal mining development, therefore this controlling provision does not apply. |

## SUBMISSIONS:

### Public submissions

38. The proposal was published on the Department's website on 11 May 2017 and public comments were invited until 25 May 2017. 180 public submissions, including from the Ramsar Secretariat, and a further 1,238 campaign submissions were received during the public consultation period. Attachment N provides a summary of the public submissions.

39. The submissions raised issues including the following:

- unacceptable impacts of 40 ha of land reclamation within a Ramsar wetland;
- impacts to migratory shorebirds, seagrass, koalas, turtles and Dugongs;
- Australia's need to meet its obligations as a party to international agreements to protect migratory birds and Ramsar wetlands;
- impacts related to pollution from dredge spoil;

- the proposed development is not critical infrastructure – the local community would like to see an upgrade to the ferry terminal but do not support the construction of a marina and housing development; and
- the Ramsar Secretariat advised that the Moreton Bay Ramsar site will be placed under Article 3.2 notification. Under Article 3.2 of the Ramsar Convention "Each Contracting Party shall arrange to inform the Ramsar Secretariat…at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference".

**Comments from Commonwealth Ministers**

40. By letter dated 11 May 2017, the following ministers were invited to comment on the referral:

    - Senator The Hon Nigel Scullion, Minister for Indigenous Affairs
    - The Hon Darren Chester MP, Minister for Infrastructure and Transport

41. No comments were received in response to that invitation.

**Comments from State Ministers**

42. By letter dated 11 May 2017, the delegate for the Queensland Minister for Environment and Heritage Protection, the Hon Dr Steven Miles MP, was invited to comment on the referral. The response stated that the proposal will not be assessed using the EIS process in Chapter 3 of Queensland's *Environmental Protection Act 1994*. The response also stated that the Queensland Department of State Development reviewed the referral documentation and advised that the Coordinator-General has not received a request for declaration of this proposal as a coordinated project under Part 4 of the *State Development and Public Works Organisation Act 1971*.

## ASSESSMENT APPROACH:

43. If you agree that the action is a controlled action, you must decide on the approach for assessment in accordance with section 87 of the EPBC Act. Noting that the proponent intends to lodge a formal application for declaration of the proposal as a coordinated project under Part 4 of the *State Development and Public Works Organisation Act 1971* (Qld) and the potential for assessment under the bilateral agreement, the Department recommends that this decision is postponed and made by your delegate, once the Queensland government confirms the state assessment approach.

## OTHER MATTERS FOR DECISION-MAKING:

**Precautionary principle**

44. In making your decision under section 75, you are required to take account of the precautionary principle (section 391). The precautionary principle is that a lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage. A controlled action decision will require any uncertainties in the referral (e.g. around the potential effectiveness of mitigation measure and availability of offsets) to be clarified through further detailed assessment.

**Bioregional Plans**

45. In accordance with section 176(5), you are required to have regard to a bioregional plan in making any decision under the Act to which the plan is relevant. The *Marine Bioregional Plan for the Temperate East Marine Region (2012)* (Attachment J) is relevant to the proposed action.

**Consultation and handling**

46. The Wildlife, Heritage and Marine Division, Wetlands, Policy and Northern Water Branch, General Counsel Branch were consulted and provided advice in the preparation of this brief.

James Barker
Assessments and Governance Branch
Ph: 02 6274 2694
Mob: s22

**Attachments**

A: Referral

B: Decision notice FOR SIGNATURE

C: Letter to Walker Group Holdings FOR SIGNATURE

Letter to Queensland Minister for Environment and Heritage FOR SIGNATURE

Letter to Queensland Deputy Premier FOR SIGNATURE

Letter to Minister for Infrastructure and Development FOR SIGNATURE

Letter to Minister for Indigenous Affairs FOR SIGNATURE

Letter to Minister for Trade, Tourism and Investment FOR SIGNATURE

D: Statement of Reasons FOR SIGNATURE

E: Maps of project area, regional context, Ramsar site boundary.

F: Ecological Character Description – Moreton Bay Ramsar Site (Final Report)

G: Information sheet on Moreton Bay Ramsar Site (June 1999)
http://www.environment.gov.au/water/topics/wetlands/database/pubs/41-ris.pdf

H: Line Area Advice:

Wetlands Section Advice

Migratory Species Section Advice

I: Submission from EHP

J: Department's Environmental Reporting Tool

K: Marine Bioregional Plan for the Temperate East Marine Region (2012)

L: Summary of public submissions

FOI 180411
Document 14a

**Notification of**
**REFERRAL DECISION AND DESIGNATED PROPONENT – controlled action**

**Toondah Harbour Development, Queensland (EPBC 2017/7939)**

This decision is made under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

| | |
|---|---|
| **proposed action** | The development of a mixed use residential, commercial, retail and tourism precinct, including new ferry terminals and a marina at Toondah Harbour south of Brisbane, Queensland, as described in the referral received by the Department on 11 May 2017 [see EPBC Act referral 2017/7939]. |
| **decision on proposed action** | The proposed action is a controlled action. |
| **relevant controlling provisions** | • Wetlands of international importance (sections 16 & 17B)<br>• Listed threatened species and communities (sections 18 & 18A)<br>• Listed migratory species (sections 20 & 20A) |
| **designated proponent** | Walker Group Holdings Pty Limited<br>ABN: 8100 121 5069 |
| **Person authorised to make decision** | |
| **Name and position** | The Hon Josh Frydenberg MP<br>Minister for the Environment and Energy |
| **Signature** | |
| **date of decision** | 8 June 2017 |

**Statement of Reasons for a Decision that an Action is a Controlled Action under the *Environment Protection and Biodiversity Conservation Act 1999***

I, Josh Frydenberg MP, Minister for the Environment and Energy, provide the following statement of reasons for my decision of 8 June 2017, under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), that the proposed action by Walker Group Holdings Pty Ltd to redevelop the existing facilities, including construction of a marina, new ferry terminals and residential development at Toondah Harbour, south of Brisbane, Queensland (EPBC 2017/7939)[1], is a controlled action under Part 7 of Division 2 of the EPBC Act and the controlling provisions for the action are sections 16 and 17B (wetlands of international importance), sections 18 and 18A (listed threatened species and communities) and sections 20 and 20A (migratory species).

**Legislation**

1. Relevant legislation is at Annexure A.[2]

**Background**

2. Toondah Harbour is an existing marine area that serves as the base for water taxi, passenger and ferry services between the mainland and North Stradbroke Island. Walker Group Holdings Pty Ltd (the proponent) is proposing to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 kilometres (km) south of Brisbane. The proposal will involve the excavation of a new marina and reclaiming land within the adjoining Moreton Bay Ramsar wetland. The Toondah Harbour project is proposed to be delivered in stages over a 15 to 20 year period.

3. The key components of the proposal are:
   - A project area of 73 hectares, of which approximately 50 hectares is within the Moreton Bay Ramsar wetland;
   - approximately 40 hectares of reclamation within Moreton Bay Ramsar wetland
   - new ferry terminals to improve access to North Stradbroke Island;
   - mixed use development including residential, retail, commercial and tourism uses;
   - a marina;
   - public open space and boardwalks providing foreshore access; and
   - dredging of the existing Toondah Harbour marine access channel to allow for safe navigation for all vessels.

[1] The proposed action is described in further detail in the referral received by the Department on 11 May 2017.
[2] This legislation is provided as background and context and does not form part of my reasons.

4. A referral for the project was submitted under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 11 May 2017.

5. In its referral, the proponent stated its belief that the proposal is a controlled action for the purposes of the EPBC Act and will likely have a significant impact on the ecological character of the Moreton Bay Ramsar wetland, listed threatened species and ecological communities, and listed migratory species. The proponent has stated in the referral that there are no alternatives to the location and footprint of the action.

6. Under section 75 of the EPBC Act, I determined that the proposed action is a controlled action, due to likely significant impacts on the ecological character of the Moreton Bay Ramsar wetland, listed threatened species and communities and migratory species, and that the controlling provisions for the action are sections 16 and 17B, sections 18 and 18A and sections 20 and 20A.

**Evidence or other material on which my findings were based**

7. My decision under section 75 was informed by a recommendation brief prepared by officers of the Department of the Environment and Energy, which had the following attachments:

A: Referral

B: Decision notice FOR SIGNATURE

C: Letter to Walker Group Holdings FOR SIGNATURE

Letter to Queensland Minister for Environment and Heritage FOR SIGNATURE

Letter to Minister for Infrastructure and Development FOR SIGNATURE

Letter to Minister for Indigenous Affairs FOR SIGNATURE

Letter to Minister for Trade, Tourism and Investment FOR SIGNATURE

D: Statement of Reasons FOR SIGNATURE

E: Maps of project area, regional context, Ramsar site boundary.

F: Ecological Character Description – Moreton Bay Ramsar Site (Final Report)

G: Information sheet on Moreton Bay Ramsar Site (June 1999) http://www.environment.gov.au/water/topics/wetlands/database/pubs/41-ris.pdf

H: Line Area Advice:

Wetlands Section Advice

Migratory Species Section Advice

I: Submission from EHP

J: Department's Environmental Reporting Tool

K: Marine Bioregional Plan for the Temperate East Marine Region (2012)

L: Summary of public submissions

**Public submissions**

8. The proposal was published on the Department's website on 11 May 2017 and public comments were invited until 25 May 2017, in accordance with section 74(3) of the EPBC Act. 180 public submissions were received on the referral during the public comment period and a further 1,238 campaign submissions were received during the consultation period concluded

9. The issues raised in the public submissions including the following:

- unacceptable impacts of 40 ha of land reclamation within a Ramsar wetland;
- impacts to migratory shorebirds, seagrass, koalas, turtles and Dugongs;
- Australia's need to meet its obligations as a party to international agreements to protect migratory birds and Ramsar wetlands;
- impacts related to pollution from dredge spoil;
- the proposed development is not critical infrastructure – the local community would like to see an upgrade to the ferry terminal but do not support the construction of a marina and housing development; and
- the Ramsar Secretariat advised that the Moreton Bay Ramsar site will be placed under Article 3.2 notification. Under Article 3.2 of the Ramsar Convention "Each Contracting Party shall arrange to inform the Ramsar Secretariat... at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference".

**Ministerial comments**

10. By letter dated 11 May 2017, the following Ministers were invited to comment on the referral in accordance with section 74(1) of the EPBC Act:

- Senator, The Hon Nigel Scullion, Minister for Indigenous Affairs
- The Hon Darren Chester MP, Minister for Infrastructure and Transport

No comments were received in response to that invitation.

11. By letter dated 11 May 2017, the delegate of the Queensland Minister for Environment and Heritage Protection, the Hon Dr Steven Miles MP, was invited to comment on the referral in accordance with section 74(2) of the EPBC Act.

12. The delegate responsed stating that the proposal would not be assessed using the EIS process in Chapter 3 of Queensland's *Environmental Protection Act 1994*. The response also stated that the Queensland Department of State Development reviewed the referral documentation and advised that the Coordinator-General has not received a request for declaration of this proposal as a coordinated project under Part 4 of the *State Development and Public Works Organisation Act 1971*.

## Findings on material questions of fact

13. In deciding whether the proposed action is a controlled action, and which provision of Part 3 of the EPBC Act are controlling provisions for the action (if any), I considered all adverse impacts the action has or will have or is likely to have on each matter protected by a provision of Part 3 of the EPBC Act. I did not consider any beneficial impacts that the proposed action has or will have, or is likely to have on each matter protected by a provision of Part 3 of the EPBC Act.

14. I considered that I had sufficient information to determine whether the proposed action is a controlled action and, if so, what provisions of Part 3 are controlling provisions for the action.

### *Ecological character of the Moreton Bay Ramsar wetland*

15. The Moreton Bay Ramsar site is located in and around Moreton Bay, east of Brisbane in Queensland. The Ramsar wetland supports extensive intertidal areas of sand and mud flat habitats, seagrass, mangroves and saltmarsh that provide vital habitat for dugongs, turtles and waterbirds including significant populations of migratory shorebirds. The wetland supports more than 50,000 migratory waders. At least 43 species of wading birds use the intertidal habitats, including 30 migratory species listed on international conservation agreements.

16. In addition, Moreton Bay is one of only two Ramsar sites in Australia that supports the critically endangered eastern curlew throughout the year, with juvenile birds not migrating until they are 2-3 years old. I noted that the Eastern Curlew is a species recently identified for priority conservation in Australia's Threatened Species Strategy Action Plan 2015-16.

17. The referral stated that it is likely that the proposed action will result in significant impacts on the ecological character of a portion of the Moreton Bay Ramsar wetland. In particular, the proposed action will permanently remove an area of the Ramsar wetland through approximately 40 hectares of land reclamation which is likely to negatively impact the ecological character of the wetland.

18. The Department's Wetland Section advised that direct impacts to the ecological character of the wetland will occur as the proposed action will result in:

    - areas of the wetland within the referral area being removed or substantially modified through dredging, excavation and/or land reclamation activities;

    - impacts on habitat values through the removal of seagrass, mangroves and intertidal mudflats;

    - impacts on the lifecycle of an ecologically significant proportion of the population of the eastern curlew and bar-tailed godwit, as well as other listed migratory species, such as whimbrels and grey-tailed tattler, through the removal of, or disturbance to, foraging and roosting habitat in or near the referral area; and

    - changes in the hydrological regime of the wetland and consequent changes to water quality and aquatic habitats from sedimentation.

19. The referral lacks detail on the proposed development, such as the size of the marina, the number of apartments, the height of buildings and the extent of dredging required to upgrade the channel. The referral has not considered indirect impacts from the proposed action such as light pollution, the potential for increased weeds and domestic animals, and human traffic.

20. Although the referral states that a buffer zone will be included between the development and the mangroves and high tide roosting site at Cassim Island, it does not provide sufficient information to be confident that this will reduce the impacts on migratory shorebirds.

21. The Department advised that the proposed action is likely to have a significant impact on the ecological character of the Moreton Bay Ramsar wetland. In addition, advice from the Department's Wetland Section concludes that the impacts on the ecological character of the site will be difficult to mitigate and offset.

22. I agreed with the Department's advice in this regard.

23. Therefore, I concluded that the proposed action is likely to have a significant impact on the ecological character of the Moreton Bay Ramsar wetland.

<u>Listed migratory species</u>

24. The referral notes that habitat used by migratory shorebirds for foraging or roosting within Toondah Harbour and roosting habitat adjoining the project area are characterised as 'important habitat' for migratory shorebirds under the *EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*.

25. Eleven migratory shorebirds were recorded within or immediately adjacent to the project area during the proponent's field surveys. These include:

- Grey-tailed Tattler (*Tringa brevipes*);
- Ruddy Turnstone (*Arenaria interpres*);
- Great Knot (*Calidris tenuirostris*) (also listed as critically endangered);
- Red-necked Stint (*Calidris ruficollis*);
- Bar-tailed Godwit (*Limosa lapponica baueri*) (also listed as vulnerable);
- Whimbrel (*Numenius phaeopus*);
- Eastern Curlew (*Numenius madagascariensis*) (also listed as critically endangered);
- Terek Sandpiper (*Xenus cinereus*); and
- Curlew sandpiper (*Calidris ferruginea*) (also listed as critically endangered).

26. Migratory shorebirds use two different habitat types within or adjacent to the project area, namely intertidal mudflats that provide feeding habitat when exposed at low tide, and stands of mangrove trees, offshore sandbars and shoreline saltmarsh and claypan areas that provide high tide roost sites.

27. The referral states that the proposed action is likely to have both direct and indirect impacts on migratory shorebirds through clearing of approximately 40 hectares of foraging habitat for dredging and land reclamation, and disturbance during construction including changes to water quality during dredging and reclamation works. However, the referral also states that the project area is not considered to be a major foraging site in terms of diversity or numbers of migratory shorebirds as similar habitat is found throughout Moreton Bay, and the project site provides less than 0.001% of feeding habitat within the Ramsar wetland. The Department considered that the loss of this foraging habitat, combined with the indirect impacts of the proposal, is likely to have a significant impact on migratory shorebirds.

28. Surveys undertaken by the proponent mapped large areas of intertidal foraging habitats in the project area, comprising areas of mudflat, sandflat, seagrass and areas of surface coral rubble, and two high tide roost sites directly adjacent to the project area.

29. The Department also noted that important roosting sites, Cassim Island and Nandeebie Claypan, are in close proximity to the proposed action. It is likely that the proposed action will have indirect impacts on these roosting sites, including noise and visual disturbance as a result of increased human use of the area.

30. The survey results provided in the referral that confirmed that Cassim Island, located approximately 100 metres east of the project boundary, and the Nandeebie Claypan, to the south of the project area, are important roosting habitat for migratory shorebirds based on the relatively large total numbers of migratory shorebirds using these roost sites. Up to 920 migratory shorebirds of four species known to roost in mangrove trees were recorded at Cassim Island, while up to 1,060 migratory shorebirds were recorded roosting at the Nandeebie Claypan.

31. The *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (2013) and the *EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (2017) provide that a proposed action will be likely to have a significant impact on migratory species where the proposal will substantially modify, destroy or isolate an area of important habitat for migratory species.

32. The proposed action will reduce the area of occupancy for migratory shorebird species by removing approximately 40 hectares of foraging habitat; adversely affecting important roosting habitat and modifying, destroying, isolating and decreasing the availability and quality of habitat through indirect impacts such as light, noise and human interaction.

33. The Department's Migratory Species Section advised that the proposed action will seriously disrupt the lifecycle (feeding, migration and resting behaviour) of an ecologically significant population of the Eastern Curlew and Bar-tailed Godwit, as well as other listed migratory species, such as Whimbrels and Grey-tailed Tattlers, through the removal of, or disturbance to, foraging and roosting habitat in or near the referral area. Additional impacts will result from linking important offshore roosting sites with the mainland as it will interfere with the recovery of the Eastern Curlew by removing important habitat and causing an increase in ongoing disturbance.

34. I agreed with the Department's advice and concluded that the proposed action is likely to have a significant impact on listed migratory shorebird species.

Other Migratory species

35. Moreton Bay supports important foraging populations of green, hawksbill and loggerhead turtles and is close to the southern-most extent of their range. The *Marine Bioregional Plan for the Temperate East Marine Region* (2012) considered Moreton Bay a significant feeding ground for the green turtle.

36. The Department's Migratory Species Section advised that light pollution, vessel disturbance and habitat modification (though dredging and infrastructure/coastal development) are known threats to migratory marine species. The Department considered it likely that the proposed action will increase these threats to migratory marine species and reduce the area of occupancy of the species.

37. Based on this advice and other information available to the Department, such as the Species Profile and Threats database and information from the referral documentation, the Department concluded that the proposed action is likely to have significant impacts on other migratory species such as:

- Loggerhead turtle *(Caretta caretta)*;
- Green Turtle *(Chelonia mydas)*;
- Hawksbill Turtle *(Eretmochelys imbricata);*
- Indo-pacific humpback dolphin (*Sousa chinensis*); and
- Dugong (*Dugong dugon*).

38. I agreed with the Department's advice.

39. In light of the matters set our in paragraphs 24 – 38, I concluded that the proposed action is likely to have a significant impact on listed migratory species.

### Listed threatened species and communities

40. The Department advised that the likelihood of direct and indirect impacts, the importance of habitat in, and immediately adjacent to, the project area and the lack of adequate mitigation and management measures to minimise these impacts and concluded that the proposed action is likely to have a significant impact on the critically endangered eastern curlew.

41. The critically endangered eastern curlew occurs seasonally around the Australian coastline, with up to 3500 birds estimated to visit Moreton Bay (9% of the flyway population). The eastern curlew habitat in the Moreton Bay wetland is internationally important as it supports more than 1% of the individuals in a population of the migratory eastern curlew (*EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species 2017*).

42. The Department advised that the project site contains intertidal foraging habitat for the eastern curlew with seven individuals recorded during surveys undertaken in 2015. Important roosting sites, the Nandeebie Claypan and Cassim Island, are also immediately adjacent to the project area with up to 180 eastern curlew having been recorded at the Nandeebie Claypan roosting site. Although there are a number of available roost sites for the eastern curlew within the region, the Nandeebie Claypan is considered to be an important site within Moreton Bay.

43. I considered that the referral proposes a buffer zone of 100-200m between the development and the mangroves and high tide roosting site at Cassim Island. However, the referral does not provide adequate information on whether they would be sufficient to manage the impacts to the eastern curlew. The *Conservation Advice for Numenius madagascariensis* (eastern curlew) (2015) states that the species is easily disturbed by human interaction within 250m.

44. Based on information available to the Department and the nature of the proposed action that includes removal of onshore vegetation, intertidal mudflats and seagrass beds, the Department considers that the proposed action is also likely to have significant impacts on other threatened species such as:

- Great Knot (*Calidris tenuirosris*) – critically endangered;
- Curlew Sandpiper (*Calidris ferruginea*) – critically endangered;
- Bar-tailed Godwit (*Limosa lapponica baueri*) – vulnerable;
- Koala (*Phascolarctos cinereus*) (combined populations of Qld, NSW and the ACT) – vulnerable;
- Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable;
- Loggerhead turtle (*Caretta caretta*) – endangered;
- Green Turtle (*Chelonia mydas*) – vulnerable; and

- Hawksbill Turtle *(Eretmochelys imbricate)* – vulnerable.

45. In light of the matters set out in paragraphs 40 – 44, I agreed with the Department's that the proposed action was likely to have a significant impact on the Eastern Curlew and other listed threatened species.

**World Heritage properties**

46. The proposed action is unlikely to have a significant impact on world heritage values of a world heritage property, because the Department's Environmental Reporting Tool (ERT) did not identify any world heritage properties located within or adjacent to the proposed action area. Therefore, I decided that sections 12 and 15A cannot be controlling provisions for the action.

**National Heritage places**

47. The proposed action is unlikely to have a significant impact on national heritage values of a national heritage place, because the Department's Environmental Reporting Tool (ERT) did not identify any national heritage places located within or adjacent to the proposed action area. Therefore, I decided that sections 15B and 15C cannot be controlling provisions for the action.

**Commonwealth marine environment**

48. The proposed action is not being undertaken in a Commonwealth marine area.

49. The proposed action is unlikely to have a significant impact on the environment in a Commonwealth marine area, because it does not occur in the vicinity of a Commonwealth marine area.

50. For these reasons, I decided that sections 23 and 24A cannot be controlling provisions for the action.

**Commonwealth action**

51. The referring party is not a Commonwealth agency, therefore I decided section 28 cannot be a controlling provision for the action.

**Commonwealth land**

52. The proposed action is not being undertaken on Commonwealth land.

53. The proposed action is unlikely to have a significant impact on the environment on Commonwealth land because it is not being undertaken in the vicinity of Commonwealth land.

54. For these reasons, I decided that sections 26 and 27A cannot be controlling provisions for the action.

**Nuclear action**

55. The proposed action does not meet the definition of a nuclear action as defined in the EPBC Act. Therefore, I decided that sections 21 and 22A cannot be controlling provisions for the action.

**Great Barrier Reef Marine Park**

56. The proposed action is not being undertaken in the Great Barrier Reef Marine Park.

57. The proposed action is not being undertaken in the vicinity of the Great Barrier Reef Marine Park and, therefore, is unlikely to have a significant impact on the environment in the Great Barrier Reef Marine Park.

58. For these reasons, I decided that sections 24B and 24C cannot be controlling provisions for the action.

**Commonwealth Heritage places overseas**

59. The proposed action is not being undertaken outside the Australian jurisdiction. Therefore, I decided that sections 27B and 27C cannot be controlling provisions for this action.

**A water resource, in relation to coal seam gas development and large coal mining development**

60. The proposed action is not an action that involves coal seam gas or a large coal mining development. Therefore, I decided that sections 24D and 24E cannot be controlling provisions for this action.

**Reasons for decision**

61. I considered the information before me was adequate to make a decision under section 75 of the EPBC Act.

62. In making my decision I took account of submissions from relevant Commonwealth and State Ministers as well as the matters required to be taken into account under section 75 of the EPBC Act.

63. In making my decision, I took account of the precautionary principle (section 391 of the EPBC Act) which states that a lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage. I considered that a controlled action decision will require any uncertainties in the referral (e.g. around the potential effectiveness of mitigation measure and availability of offsets) to be clarified through further detailed assessment.

64. In view of my findings above, I was satisfied that the proposed action will, or is likely to have a significant impact on the ecological character of a declared Ramsar wetland (Moreton Bay), listed threatened species and listed migratory species.

65. I therefore decided that the proposed action is a controlled action and the controlling provisions are section 16 and 17B (wetlands of international importance), sections 18 and 18A (listed threatened species and communities) and sections 20 and 20A (migratory species).

Signed

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JOSH FRYDENBERG

8 June 2017

## Annexure A – Relevant EPBC Act provisions

Section 68 of the EPBC Act relevantly provides:

(1) A person proposing to take an action that the person thinks may be or is a controlled action must refer the proposal to the Minister for the Minister's decision whether or not the action is a controlled action.

(2) A person proposing to take an action that the person thinks is not a controlled action may refer the proposal to the Minister for the Minister's decision whether or not the action is a controlled action.

Section 75 of the EPBC Act relevantly provides:

(1) The Minister must decide:

(a) whether the action that is the subject of a proposal referred to the Minister is a controlled action; and

(b) which provisions of Part 3 (if any) are controlling provisions for the action.

Note: The Minister may revoke a decision made under subsection (1) about an action and substitute a new decision. See section 78.

(1AA) To avoid doubt, the Minister is not permitted to make a decision under subsection (1) in relation to an action that was the subject of a referral that was not accepted under subsection 74A(1).

Minister must consider public comment

(1A) In making a decision under subsection (1) about the action, the Minister must consider the comments (if any) received:

(a) in response to the invitation under subsection 74(3) for anyone to give the Minister comments on whether the action is a controlled action; and

(b) within the period specified in the invitation.

Considerations in decision

(2) If, when the Minister makes a decision under subsection (1), it is relevant for the Minister to consider the impacts of an action:

(a) the Minister must consider all adverse impacts (if any) the action:

(i) has or will have; or

(ii) is likely to have;

on the matter protected by each provision of Part 3; and

(b) must not consider any beneficial impacts the action:

(i) has or will have; or

(ii) is likely to have;

on the matter protected by each provision of Part 3.

Note: ***Impact*** is defined in section 527E.

(2A) For the purposes of subsection (2), if the provision of Part 3 is subsection 15B(3), 15C(5), 15C(6), 23(1), 24A(1), 24D(3), 24E(3), 26(1) or 27A(1), then the impacts of the action on the matter protected by that provision are only those impacts that the part of the action that is taken in or on a Commonwealth area, a Territory, a Commonwealth marine area or Commonwealth land:

(a) has or will have; or

(b) is likely to have;

on the matter.

(2AA) For the purposes of subsection (2), if the provision of Part 3 is subsection 24B(1) or 24C(1) or (3), then the impacts of the action on the matter protected by that provision are only those impacts that the part of the action that is taken in the Great Barrier Reef Marine Park:

(a) has or will have; or

(b) is likely to have;

on the matter.

(2B) Without otherwise limiting any adverse impacts that the Minister must consider under paragraph (2)(a), the Minister must not consider any adverse impacts of:

(a) any RFA forestry operation to which, under Division 4 of Part 4, Part 3 does not apply; or

(b) any forestry operations in an RFA region that may, under Division 4 of Part 4, be undertaken without approval under Part 9.

Designating a proponent of the action

(3) If the Minister decides that the action is a controlled action, the Minister must designate a person as proponent of the action.

Consent to designation

(4) The Minister may designate a person who does not propose to take the action only if:

(a) the person agrees to being designated; and

(b) the person proposing to take the action agrees to the designation.

Timing of decision and designation

(5) The Minister must make the decisions under subsection (1) and, if applicable, the designation under subsection (3), within 20 business days after the Minister receives the referral of the proposal to take the action.

Note: If the Minister decides, under subsection 75(1), that the action is a controlled action, the Minister must, unless the Minister has requested more information under subsection 76(3) or section 89, decide on the approach to be used for assessment of the relevant impacts of the action on the same day as the Minister makes the decision under subsection 75(1)—see subsection 88(2).

Time does not run while further information being sought

(6) If the Minister has requested more information under subsection 76(1) or (2) for the purposes of making a decision, a day is not to be counted as a business day for the purposes of subsection (5) if it is:

(a) on or after the day the Minister requested the information; and

(b) on or before the day on which the Minister receives the last of the information requested.

Running of time may be suspended by agreement

(7) The Minister and the person proposing to take the action may agree in writing that days within a period worked out in accordance with the agreement are not to be counted as business days for the purposes of subsection (5). If the agreement is made, those days are not to be counted for the purposes of that subsection.

Section 176 of the EPBC Act relevantly provides:

(1) The Minister may prepare a bioregional plan for a bioregion that is within a Commonwealth area. In preparing the plan, the Minister must carry out public consultation on a draft of the plan in accordance with the regulations.

(2) The Minister may, on behalf of the Commonwealth, co-operate with a State or a self-governing Territory, an agency of a State or of a self-governing Territory, or any other person in the preparation of a bioregional plan for a bioregion that is not wholly within a Commonwealth area.

(3) The co-operation may include giving financial or other assistance.

(4) A bioregional plan may include provisions about all or any of the following:

(a) the components of biodiversity, their distribution and conservation status;

(b) important economic and social values;

(ba) heritage values of places;

(c) objectives relating to biodiversity and other values;

(d) priorities, strategies and actions to achieve the objectives;

(e) mechanisms for community involvement in implementing the plan;

(f) measures for monitoring and reviewing the plan.

(4A) A bioregional plan prepared under subsection (1) or (2) is not a legislative instrument.

(5) Subject to this Act, the Minister must have regard to a bioregional plan in making any decision under this Act to which the plan is relevant.

391 Minister must consider precautionary principle in making decisions

Taking account of precautionary principle

(1) The Minister must take account of the precautionary principle in making a decision listed in the table in subsection (3), to the extent he or she can do so consistently with the other provisions of this Act.

Section 391 of the EPBC Act relevantly provides:

(2) The ***precautionary principle*** is that lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage.

Decisions in which precautionary principle must be considered

(3) The decisions are:

**Decisions in which precautionary principle must be considered**

| **Item** | **Section decision is made under** | **Nature of decision** |
|---|---|---|
| 1 | 75 | whether an action is a controlled action |
| 2 | 133 | whether or not to approve the taking of an action |
| 3 | 201 | whether or not to grant a permit |
| 4 | 216 | whether or not to grant a permit |
| 5 | 238 | whether or not to grant a permit |

| Decisions in which precautionary principle must be considered | | |
|---|---|---|
| **Item** | **Section decision is made under** | **Nature of decision** |
| 6 | 258 | whether or not to grant a permit |
| 6A | 269AA | whether or not to have a recovery plan for a listed threatened species or a listed threatened ecological community |
| 7 | 269A | about making a recovery plan or adopting a plan as a recovery plan |
| 7A | 270A | whether or not to have a threat abatement plan for a key threatening process |
| 7B | 270B | about making a threat abatement plan or adopting a plan as a threat abatement plan |
| 8 | 280 | about approving a variation of a plan adopted as a recovery plan or threat abatement plan |
| 9 | 285 | about making a wildlife conservation plan or adopting a plan as a wildlife conservation plan |
| 10 | 295 | about approving a variation of a plan adopted as a wildlife conservation plan |
| 10A | 303CG | whether or not to grant a permit |
| 10AA | 303DC | whether or not to amend the list of exempt native specimens |
| 10B | 303DG | whether or not to grant a permit |
| 10C | 303EC | about including an item in the list referred to in section 303EB |
| 10D | 303EN | whether or not to grant a permit |
| 10E | 303FN | about declaring an operation to be an approved wildlife trade operation |
| 10F | 303FO | about declaring a plan to be an approved wildlife trade management plan |
| 10G | 303FP | about declaring a plan to be an accredited wildlife trade management plan |
| 10H | 303GB | whether or not to grant an exceptional circumstances permit |
| 11 | 316 | about making a plan for managing a property that is included in the World Heritage List and is entirely within one or more Commonwealth areas |
| 11A | 324S | about making a plan for managing a National Heritage place |

| Decisions in which precautionary principle must be considered | | |
|---|---|---|
| **Item** | **Section decision is made under** | **Nature of decision** |
| 12 | 328 | about making a plan for managing a wetland that is designated for inclusion in the List of Wetlands of International Importance kept under the Ramsar Convention and is entirely within one or more Commonwealth areas |
| 13 | 338 | about making a plan for managing a Biosphere reserve entirely within one or more Commonwealth areas |
| 13A | 341T | about endorsing a plan for managing a Commonwealth Heritage place |
| 14 | 370 | about approving a management plan for a Commonwealth reserve |

FOI 180411
Document 14c

**THE HON JOSH FRYDENBERG MP**

**MINISTER FOR THE ENVIRONMENT AND ENERGY**

MS17-000774

The Hon Darren Chester MP
Minister for Infrastructure and Transport
Parliament House
CANBERRA ACT 2600

08 JUN 2017

Dear ~~Minister~~ Darren

This is to advise you of my decision on the referral of the proposed action, to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 km south of Brisbane.

As the Minister for the Environment and Energy, I have decided under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

The information that I have considered indicates that the proposed action is likely to have a significant impact on:

- wetlands of international importance (sections 16 & 17B)
- listed threatened species and communities (sections 18 & 18A)
- listed migratory species (sections 20 & 20A)

Please note that this decision only relates to the potential for significant impacts on matters protected by the Australian Government under Chapter 2 of the EPBC Act.

At this stage, a decision has not been made on the approach that must be used to assess the project.

Once a decision on the assessment approach has been made, a notice will be published on the Department's website.

A copy of the document recording this decision is enclosed.

Questions about the referral process or this decision, can be directed to the project manager, s22 [redacted] by email to s22 [redacted] @environment.gov.au, or telephone 02 6274 s22 [redacted]

Yours sincerely

Josh Frydenberg

FOI 180411
Document 14d

**THE HON JOSH FRYDENBERG MP**

**MINISTER FOR THE ENVIRONMENT AND ENERGY**

MS17-000774

The Hon Jackie Trad
Queensland Deputy Premier and
Minister for Infrastructure and Planning
PO Box 15009
CITY EAST QLD 4002

08 JUN 2017

Dear ~~Deputy Premier~~ Jackie

I am writing to advise you of my decision on the referral of the proposed action, to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 km south of Brisbane.

As the Minister for the Environment and Energy, I have decided under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

I note that the footprint of the proposed development is substantially within the Moreton Bay Ramsar wetland site and includes the permanent removal of an area of the wetland though the excavation of a marina and the approximately 40 hectares of land reclamation. The ecological character of this wetland is nationally and internationally protected under the Convention on Wetlands of International Importance (the Ramsar Convention).

The information that I have considered indicates that the proposed action is likely to have a significant impact on wetlands of international importance, and nationally listed threatened species and migratory species. A copy of the document recording this decision is enclosed.

Although I have decided that the proposed action will be assessed under the EPBC Act, I note that significant challenges remain in regard to the approval of this project. In particular, the requirement, under section 138 of the EPBC Act, that when deciding whether or not to approve the taking of an action, I must not act inconsistently with Australia's obligations under the Ramsar Convention. I would expect the more detailed environmental impact assessment process will consider these issues as well as other likely impacts of the proposal.

At this stage, a decision has not been made on the approach that must be used to assess the project. I have asked officials of the Department of the Environment and Energy to liaise with Queensland officials to determine whether this project can be assessed under the bilateral agreement between Queensland and the Commonwealth.

Questions about the referral process or this decision can be directed to the project manager, s22 [redacted]@environment.gov.au, telephone 02 6274 s22 [redacted]

I have also written to Queensland Minister for Environment and Heritage Protection, the Hon Steven Miles MP, to advise him of my decision.

Yours sincerely

Josh Frydenberg

**THE HON JOSH FRYDENBERG MP**

**MINISTER FOR THE ENVIRONMENT AND ENERGY**

MS17-000774

Senator the Hon Nigel Scullion
Minister for Indigenous Affairs
Parliament House
CANBERRA ACT 2600

0 8 JUN 2017

Dear ~~Senator~~ Nigel

This is to advise you of my decision on the referral of the proposed action, to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 km south of Brisbane.

As the Minister for the Environment and Energy, I have decided under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

The information that I have considered indicates that the proposed action is likely to have a significant impact on:

- wetlands of international importance (sections 16 & 17B)
- listed threatened species and communities (sections 18 & 18A)
- listed migratory species (sections 20 & 20A)

Please note that this decision only relates to the potential for significant impacts on matters protected by the Australian Government under Chapter 2 of the EPBC Act.

At this stage, a decision has not been made on the approach that must be used to assess the project.

Once a decision on the assessment approach has been made, a notice will be published on the Department's website.

A copy of the document recording this decision is enclosed.

Questions about the referral process or this decision, can be directed to the project manager, s22 by email to s22 @environment.gov.au, or telephone 02 6274 s22

Yours sincerely

Josh Frydenberg

FOI 180411
Document 14f

**THE HON JOSH FRYDENBERG MP**

**MINISTER FOR THE ENVIRONMENT AND ENERGY**

MS17-000774

08 JUN 2017

Mr Peter Saba
General Manager – Queensland Developments
Walker Group Holdings Pty Ltd
GPO Box 652
Brisbane QLD 4000

Dear Mr Saba

I am writing to advise you of my decision in relation to the Toondah Harbour Development, Queensland (EPBC 2017/7939) proposed by Walker Group Holdings Pty Ltd, which was referred for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

I note that the footprint of the proposed development is substantially within the Moreton Bay Ramsar wetland site and includes the permanent removal of an area of the wetland though the excavation of a marina and the approximately 40 hectares of land reclamation. The ecological character of this wetland is nationally and internationally protected under the Convention on Wetlands of International Importance (the Ramsar Convention).

I have decided under section 75 of the EPBC Act that the proposed action is a controlled action and, as such, it requires further assessment and a decision about whether approval for it should be given under the Act. A copy of the document recording this decision is enclosed. Please note that this decision only relates to the potential for significant impacts on matters protected by the Australian Government under Chapter 2 of the EPBC Act.

Although I have decided that the proposed action will be assessed under the EPBC Act, I note that significant challenges remain in regard to the approval of this project. In particular, the requirement, under section 138 of the EPBC Act, that when deciding whether or not to approve the taking of an action, I must not act inconsistently with Australia's obligations under the Ramsar Convention. I would expect the more detailed environmental impact assessment process will consider these issues as well as other likely impacts of the proposal.

I have asked my Department to liaise with the Queensland government to determine the particular assessment approach that will be used for this project, including whether it can be assessed under the bilateral agreement with Queensland.

Please note, under subsection 520(4A) of the EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000* your assessment is subject to cost recovery. A fee schedule will be provided to you once the decision on the assessment approach has been determined.

If you have any questions about the referral process or this decision, please contact the project manager, s22 [redacted] by email to s22 [redacted]@environment.gov.au, or telephone 02 6274 s22 [redacted]

Yours sincerely

Josh Frydenberg

FOI 180411
Document 14g

THE HON JOSH FRYDENBERG MP

MINISTER FOR THE ENVIRONMENT AND ENERGY

MS17-000774

08 JUN 2017

The Hon Steven Ciobo MP
Minister for Trade, Tourism and Investment
Parliament House
Canberra ACT 2600

Dear Minister Josh

This is to advise you of my decision on the referral of the Toondah Harbour Development to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina. I am writing to you as this project has been granted 'Tourism Major Project Facilitation' status.

As the Minister for the Environment and Energy, I have decided under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

The information that I have considered indicates that the proposed action is likely to have a significant impact on:

- wetlands of international importance (sections 16 & 17B)
- listed threatened species and communities (sections 18 & 18A)
- listed migratory species (sections 20 & 20A)

Please note that this decision only relates to the potential for significant impacts on matters protected by the Australian Government under Chapter 2 of the EPBC Act.

At this stage, a decision has not been made on the approach that must be used to assess the project.

Once a decision on the assessment approach has been made, a notice will be published on the Department's website.

A copy of the document recording this decision is enclosed.

Questions about the referral process or this decision, can be directed to the project manager, [redacted] by email to [redacted]@environment.gov.au, or telephone 02 6274 [redacted]

Yours sincerely

Josh Frydenberg

**THE HON JOSH FRYDENBERG MP**

**MINISTER FOR THE ENVIRONMENT AND ENERGY**

MS17-000774

08 JUN 2017

The Hon Dr Steven Miles
Minister for Environment and Heritage Protection
GPO Box 2454
BRISBANE QLD 4001

Dear Minister Steven

I am writing to advise you of my decision on the referral of the proposed action, to develop a mixed use residential, commercial, retail and tourism precinct including new ferry terminals and a marina at Toondah Harbour, 30 km south of Brisbane.

As the Minister for the Environment and Energy, I have decided under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

I note that the footprint of the proposed development is substantially within the Moreton Bay Ramsar wetland site and includes the permanent removal of an area of the wetland though the excavation of a marina and the approximately 40 hectares of land reclamation. The ecological character of this wetland is nationally and internationally protected under the Convention on Wetlands of International Importance (the Ramsar Convention).

The information that I have considered indicates that the proposed action is likely to have a significant impact on wetlands of international importance, and nationally listed threatened species and migratory species. A copy of the document recording this decision is enclosed.

Although I have decided that the proposed action will be assessed under the EPBC Act, I note that significant challenges remain in regard to the approval of this project. In particular, the requirement, under section 138 of the EPBC Act, that when deciding whether or not to approve the taking of an action, I must not act inconsistently with Australia's obligations under the Ramsar Convention. I would expect the more detailed environmental impact assessment process will consider these issues as well as other likely impacts of the proposal.

At this stage, a decision has not been made on the approach that must be used to assess the project. I have asked officials of the Department of the Environment and Energy to liaise with

Queensland officials to determine whether this project can be assessed under the bilateral agreement between Queensland and the Commonwealth.

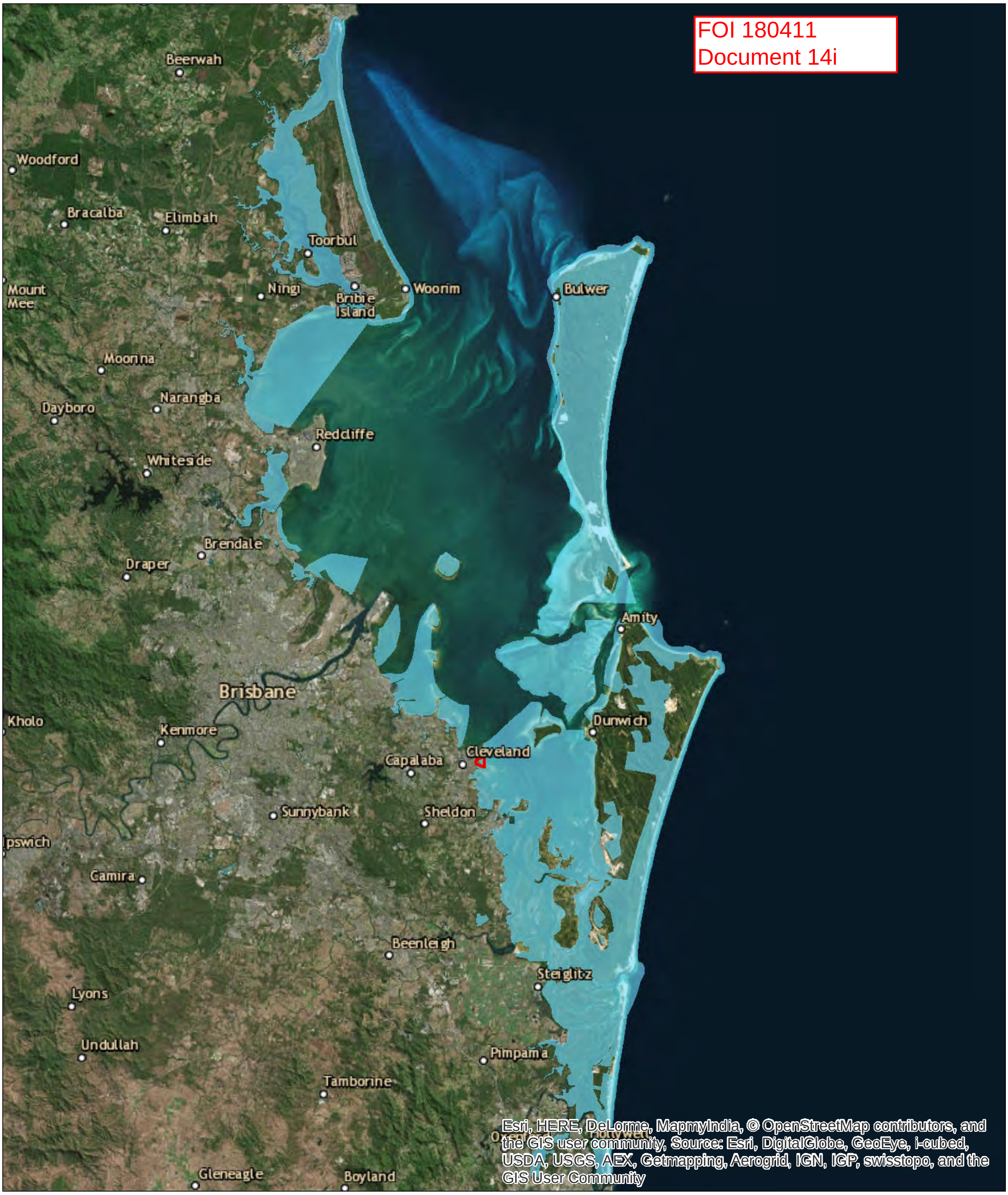
Questions about the referral process or this decision, can be directed to the project manager, [redacted] by email to [redacted]@environment.gov.au, or telephone 02 6274 [redacted]

I have also written to Queensland Deputy Premier, the Hon Jackie Trad, to advise her of my decision.

Yours sincerely

Josh Frydenberg

FOI 180411
Document 14i




**Legend**

PDA - Toondah Harbour

Moreton Bay RAMSAR wetland

***Figure 1*** *Site Context*

***File ref.*** 8444 E Site Context A
***Date*** *20/04/2017*
***Project*** *Toondah Harbour*

0 5 10 20 *Kilometers*

N

*Scale (A4): 1:575,379 [ GDA 1994 MGA Z56 ]*

saunders havill group



*Layer Sources QLD GIS Layers (QLD Gov. Information Service 2014)*


**Legend**

PDA - Toondah Harbour

Referral Area

Indicative Dredge Area

***Figure 2*** *Site Aerial*

***File ref.*** 8444 E Site Aerial E

***Date*** *11/05/2017*

***Project*** *Toondah Harbour*

0 50 100 200 300 *Meters*

*Scale (A4): 1:8,000 [ GDA 1994 MGA Z56 ]*

N

saunders havill group



*Layer Sources QLD GIS Layers (QLD Gov. Information Service 2014)*

A part of BMT in Energy and Environment

BMT WBM

"Where will our knowledge take you?"

# Moreton Bay
# Ecological Character Description

## Final Report

December 2008

Queensland Government
Environmental Protection Agency

# Ecological Character Description – Moreton Bay Ramsar Site

# FINAL REPORT

***Offices***

*Brisbane*
*Denver*
*Karratha*
*Melbourne*
*Newcastle*
*Perth*
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*Vancouver*

| | |
|---|---|
| Prepared For: | Queensland Environmental Protection Agency |
| Prepared By: | BMT WBM Pty Ltd (Member of the BMT group of companies) |

# DOCUMENT CONTROL SHEET

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| | |
|---|---|
| ***Title*** : | Ecological Character Description – Moreton Bay Ramsar Site |
| ***Author :*** | Greg Fisk, Darren Richardson, s47F , s47F , s47F , s47F r, s47F |
| ***Synopsis :*** | This report comprises the Ecological Character Description (ECD) for the Moreton Bay Ramsar site. Prepared in accordance with the draft National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands, the report identifies the critical services, components and processes of the site and identifies limits of acceptable change, knowledge gaps and monitoring requirements in relation to these critical elements. |

## REVISION/CHECKING HISTORY

| REVISION NUMBER | DATE OF ISSUE | CHECKED BY | | ISSUED BY | |
|---|---|---|---|---|---|
| 0 | 30 May 2008 | | ABM | | GWF |
| 1 | 14 July 2008 | | DLR | | GWF |
| 2 | 24 October 2008 | | DLR | | GWF |
| 3 | 12 December 2008 | | DLR | | GWF |

## DISTRIBUTION

| DESTINATION | REVISION | | | |
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| | 0 | 1 | 2 | 3 |
| Queensland EPA | 1 (1 Electronic) | 1 (1 Electronic) | 1 (1 Electronic) | 1 (1 Electronic) |
| BMT WBM File | - | 1 | 1 | 1 |
| BMT WBM Library | PDF | PDF | PDF | PDF |

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# ACKNOWLEDGEMENTS

This report was prepared by BMT WBM Pty Ltd with expert input from Austecology Pty Ltd (fauna) and Converge Heritage + Community Pty Ltd (cultural heritage) under contract to the Queensland Environmental Protection Agency (EPA). The consultant project team wish to express their thanks to EPA's project manager, Gay Deacon and members of the Inter-Governmental Steering Group formed for the project for their assistance and guidance. We would also like to recognise and thank the members of the Knowledge Management Committee convened for the project and the scientists of the Healthy Waterways Scientific Expert Panel (SEP) whom provided invaluable advice and guidance about the identification of critical wetland processes, habitat and species limits of acceptable change, information gaps and monitoring priorities. Appendix A contains a list of members of these committees.

Photos that appear in the Report are supplied by BMT WBM or the Queensland Environmental Protection Agency unless otherwise noted. Figures that have been reproduced (without modification) from other sources have been referenced accordingly.

**Disclaimer**: In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Any conclusions drawn or recommendations made in the report are done in good faith and take no responsibility for how this information and report are used subsequently by others. Note also that the views expressed, and recommendations provided in this report are those of the report authors and do not necessarily reflect those of the persons or organisations that have contributed their views or other materials.

**Use of terms and information sources**: All definitions and terms used in this report were correct at the time of production in October 2008. The version of the *Draft National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* used in preparing this ECD was dated January 2008.

Within this report, the conservation status of a species may be described as *endangered, vulnerable, rare, migratory, near threatened* or *least concern wildlife*. These terms are used in accordance with the provisions of the Queensland *Nature Conservation Act 1992* (NC Act) and its regulations and amendments, and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Threatened is a common term used to collectively describe *Endangered* and *Vulnerable* species.

The terms *shorebirds* and *waders* are generic terms used to describe both resident and migratory species from the following families: Scolopacidae; Burhinidae; Haematopodidae; Recurvirostridae; Charadriidae; and Glareolidae.

The term waterbird refers to waterbird species found predominantly on freshwater ecosystems in Australia from the six major orders Anseriformes (ducks, geese and Black Swan), Podicipediformes (grebes), Pelecaniformes (Australian Pelican and cormorants), Ciconiiformes (herons, ibis, spoonbills and bitterns), Gruiformes (cranes, rails, crakes and gallinules), and Charadriiformes (waders and terns) (after Kingsford & Norman 2002).

**Citation**: When finalised, this report can be cited as follows:

*BMT WBM. (2008). Ecological Character Description of the Moreton Bay Ramsar Site. Prepared for the Queensland Environmental Protection Agency. Brisbane.*

# LIST OF ABBREVIATIONS:

| | |
|---|---|
| ANZECC/ARMCANZ | Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand |
| CAMBA: | China-Australia Migratory Bird Agreement |
| CEA | Community, Education and Awareness |
| CFISH | Commercial Fisheries Information System |
| CPUE | Catch per unit effort |
| CRL | Consolidated Rutile Limited |
| DEWHA | Department of Environment, Water, Heritage and the Arts |
| DPI&F: | Queensland Department of Primary Industries and Fisheries |
| EAC: | East Australian Current |
| ECD: | Ecological Character Description |
| EFO | Environmental Flow Objective |
| EHMP: | Ecosystem Health Monitoring Program |
| EPA: | Queensland Environmental Protection Agency |
| EPBC: | Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* |
| FHA | Fish Habitat Area |
| GAP | Global Action on Peatlands |
| GBRMPA | Great Barrier Reef Marine Park Authority |
| GCCC | Gold Coast City Council |
| HAT: | Highest Astronomical Tide |
| IMCRA | Integrated Marine and Coastal Regionalisation of Australia |
| IUCN | International Union for Conservation of Nature |
| JAMBA: | Japan-Australia Migratory Bird Agreement |
| KMC: | Knowledge Management Committee |
| LAT: | Lowest Astronomical Tide |
| LAC: | Limit(s) of Acceptable Change |
| LTMP, CFISH, RFISH | Long Term Monitoring Program |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MBSIA EMS | Moreton Bay Seafood Industry Association Environmental Management Sytstem |
| MHWS: | Mean High Water Springs |
| MNP | Marine National Park |
| NCA: | Queensland *Nature Conservation Act 1992* |
| NCR: | Queensland *Nature Conservation (Wildlife) Regulations 2006* |
| NES | National Environmental Significance |
| NRM: | Natural Resource Management |
| NSW NPWS | New South Wales National Parks and Wildlife Service |
| OUM | Office of Urban Management |
| ORV | Off road vehilces |
| PIFU | Planning and Information Forecasting Unit |
| QPW: | Queensland Parks and Wildlife (part of the Queensland EPA) |
| QWSG | Queensland Wader Study Group |
| RCC | Regional Coordination Committee |
| RE: | Regional Ecosystem |
| REDD: | Regional Ecosystem Description Database |
| RFISH | Recreational Fishing Information System |
| RIS: | Ramsar Information Sheet |
| ROKAMBA: | Republic of Korea- Australia Migratory Bird Agreement |
| ROP | Resource Operation Plan |
| SDR | Seagrass Depth Range |
| SEP | Scientific Expert Panel |
| SEQ | Southeast Queensland |
| SEQ HWP | Southeast Queensland Healthy Waterways Partnership |

| | |
|---|---|
| SEQROC | South East Queensland Regional Organisation of Councils |
| SEQTOLSMA | South East Queensland Traditional Owners Land and Sea Management Alliance |
| SGAP | Scoety for Growing Australian Plants |
| sp.: | Species (singular) |
| spp.: | Species (plural) |
| TSSC | Threatened Species Scientific Commuttee |
| UQ | University of Queensland |
| WASO | Water Allocation and Security Objective |
| WRP: | Water Resource Plan prepared under the *Queensland Water Act 2000* |

# 1 EXECUTIVE SUMMARY

The Moreton Bay wetland aggregation is one of 65 wetland areas in Australia that have been listed as a wetland of international importance under the *Convention on Wetlands of International Importance especially as Waterfowl Habitat* or, as it is more commonly referred to, the Ramsar Convention (the Convention). Moreton Bay was listed as a Ramsar site under the Convention in 1993 in recognition of its outstanding coastal wetland values and features.

This report provides the first version of the Ecological Character Description (ECD) for the Moreton Bay Ramsar site. The report has been prepared in accordance with the *Draft National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* (January 2008) hereafter referred to as the National Framework.

Following the methodology set out in the National Framework, Table 1-1 summarises the critical services/benefits provided by the Moreton Bay Ramsar site and the underlying critical ecosystem components and processes nominated by this ECD. The critical wetland services/benefits nominated were based on the attributes of the site as identified in the Ramsar Nomination Criteria as well as identifying critical cultural and provisioning services provided by the site in terms of human use. Together, these critical wetland components and processes provide the basis for the identified services/benefits to continue to be provided by the wetland in the future.

As part of this study, the digital Moreton Bay Ramsar site boundary has been updated in accordance with the Mapping Specifications and Guidelines promulgated under the Ramsar Convention by the Australian Government. The Moreton Bay Ramsar boundary is largely confined to nearshore estuarine waters within the Bay and extends over tidal lands that are State-owned or under aligned tenures where the long term management intent for the area is consistent or complementary with the objectives of the Ramsar Convention. In general terms, the site includes the waters and tidal wetlands of Pumicestone Passage, selective areas of the Western Bay, large areas of the Southern Bay including the Broadwater, and the banks and shoals of the Eastern Bay including the ocean beaches and marine areas immediately offshore from the barrier islands. Freshwater and transitional wetland areas within the boundaries of the site are found on the sand islands of Bribie, Moreton, North Stradbroke and South Stradbroke Islands.

A key feature of the Moreton Bay Ramsar site is its large size, the diversity of wetland habitats present within it and the connectivity between wetland habitat types in areas such as Pumicestone Passage and the Southern Bay which have complex mosaics of tidal flats, saltmarsh, mangroves and seagrass assemblages. While many wetlands such as mangroves and saltmarsh are well represented across the >1100 $km^2$ site, other wetland habitat features have much more localised distribution such as the peatlands of Eighteen Mile Swamp on North Stradbroke Island, the dune lakes and freshwater springs and streams on the sand islands, and coral reef communities in and around Peel Island.

Despite being situated at the doorstep of a growing major capital city, there are several important reference habitats within the site that are representative of the bioregion and remain in a near natural state. The six important reference habitat areas include seagrass and shoals, tidal flats, mangroves and saltmarsh, inshore coral communities, freshwater wetlands and ocean beaches and foredunes.

The ECD defines endangered and vulnerable wetland species associated with the site as critical ecosystem (or supporting) services. These include marine fauna such as turtles and dugong, two nationally-threatened freshwater fish species (Oxleyan pygmy perch and honey blue-eye), several wetland-dependant avifauna species, and selected wetland dependant non-avian species such as water mouse, Illidge's ant blue butterfly and acid frogs that are of high conservation value at National and/or International levels. Endangered wetland vegetation communities and flora species have also been identified on the Bay islands as a critical service/benefit.

In addition to these species, important populations (that address the 1% criterion within the Ramsar Nomination Criteria) are identified in relation to migratory and resident shorebird species.

Cultural and provisioning services/benefits identified as being significant in the context of the Ramsar site include commercially and recreationally important fisheries, the significance of the site to indigenous people, and the site's importance and use for research and education and for tourism and recreational uses.

The ten (10) critical services/benefits outlined in the ECD are underpinned by a range of wetland ecosystem processes and components. Key processes identified in the study include broad and local scale hydrodynamics and coastal processes, hydrology (particularly as it relates to groundwater interaction on the Bay islands and freshwater inflows into the Pumicestone, Western Bay and Southern Bay regions), water and sediment quality, energy and nutrient dynamics (primary productivity, nutrient and carbon cycling), climate, geomorphology and a range of biological processes (such as growth, reproduction, and feeding).

Critical ecosystem components include the 22 different wetland types identified in the Ramsar site (using the Ramsar wetland classification typology) which support its noteworthy wetland flora and fauna.

The study has sought to define the natural variability and limits of acceptable change for the critical services/benefits, components and processes identified in the ECD as they relate to the site's Nomination Criteria. A summary of the limits of acceptable change (LACs) is shown in Tables 1-2 to 1-4 which should be read together in assessing any changes to the ecological character of the site. Critical habitat types within the Ramsar area as well as specific wetland species of conservation significance (and the various wetland processes that underpin them) are the focus of the limits of acceptable change. As outlined in the tables, where there are insufficient data to set a limit of acceptable change with confidence, interim limits of acceptable change are supplied with a view to triggering management investigation and action to assess if a change to ecological character has or may occur.

The study has found that while there have been observable changes to the condition of wetland habitats in some areas of the site since nomination in 1993, these changes are not perceived by the study team or the advisory committees consulted as part of the study as representing a loss to any of the ten critical services/benefits that define ecological character.

Public awareness and management responses to impacts that have occurred in the 15 year period since nomination have been considerable. Significant investment has been made toward improvement of point-source water quality, intensive environmental monitoring and the preparation and implementation of many plans and strategies that ultimately aim to conserve environmental values of the Bay in a way that is consistent with the wise use paradigm of the Ramsar Convention

Recent or continuing impacts that are notable in the context of the site and may affect future ecological character are identified as disturbance/reduction in habitat quality for migratory shorebirds, decreasing water quality in the Southern and Western Bay areas, seagrass loss in Deception Bay and the Southern Bay (and its potential affect on fisheries, dugong and turtle populations) and increasing incidence and intensity of *Lyngbya* algal blooms.

Closely related to the discussion on impacts, a range of threatening processes and activities have been identified in the ECD based on a review of literature sources, the opinions and views of the advisory committees for the project and the expert opinion of the study team. While not exhaustive, key threats that have the potential to influence ecological character have been identified and assessed in terms of the future risk. Where possible this risk has also been assessed against the perceived effectiveness of the regulatory/management regime, with the risk of the threat to ecological character reduced where the regime is seen as effective or improving.

Key threat issues identified are (in no particular order of importance):

- Harmful interactions with wetland species;
- Sustainability of fishing and harvesting;
- Sediment and nutrient input into the Bay from point and non-point sources;
- Groundwater extraction;
- Urban encroachment into the Ramsar boundary and adjacent wetland areas;
- Significant changes to wetland ecosystem processes from major infrastructure/development projects;
- Oil spills or other large scale marine pollution incident; and
- Impact on coastal wetlands from climate-change induced sea level rise and related threats.

Information gaps, monitoring recommendations and recommendations in relation to communication education and awareness messages are also identified in the ECD. Thematic information gaps identified as being most important for future monitoring for the site include:

- Additional research and monitoring expenditure to establish an ecological character baseline for the near-natural representative habitats, particularly those more localised habitats within the Ramsar site such as the freshwater wallum habitats of the Bay islands, the Eastern Bay coral reefs and peatlands such as Eighteen Mile Swamp;
- The need for better information and data sets about the presence and natural history of critical wetland species and their habitat including for example, surveys of vulnerable and endangered plant species on the Bay islands, aquatic species such as Oxleyan pygmy perch and more systematic surveys of important avifauna species and populations;

- Better information and understanding about the natural variability of critical wetland fauna populations and key attributes and controls on those populations (including whether or not any non-avian fauna species meet the 1% population requirement in Ramsar Nomination Criterion 9);

- The ecological character thresholds of particular habitats and communities to changes in key attributes/controls such as water quality and hydrology need additional investigation. Noting that any interim limits of acceptable change stated in the ECD should be revised as improved information becomes available;

- Resilience of habitats, community structure and key species to acute or prolonged impacts from water quality degradation such as nutrient enrichment, increased levels of salinity and sedimentation/turbidity (eg. similar to the approach in ANZECC for toxicants); and

- Consultation and involvement of traditional owners of the Moreton Bay Ramsar site if a greater understanding of historic and contemporary wetland values of the site to indigenous people is to be obtained and appreciated.

Monitoring needs and recommendations presented in the ECD relate broadly to obtaining data to assess future changes to ecological character (as defined by the Nomination Criteria for the site) and corresponding critical services/benefits as they relate to wetland habitats, species and populations and the cultural services discussed above. Principally, these monitoring recommendations relate to:

- Broad-scale observation/monitoring to ensure each wetland type outlined in the ECD continues to be represented across the site;

- Wetland habitat extent monitoring (noting that a precursor to being able to do this will be to establish a better correlation between EPA wetland mapping and the Ramsar Classification System);

- Habitat condition monitoring (principally in the form of monitoring underlying wetland ecosystem processes such as water quality and hydrological process or surrogate biological indicators such as crab burrow density);

- More targeted surveys of the threatened flora and fauna species (perhaps on a five year or ten year basis) to assess presence/absence or population changes of noteworthy species or communities; and

- More regular counts of roosting and feeding shorebirds with a particular emphasis on those species that meet the 1% population criteria.

In making recommendations for future monitoring of the Ramsar site, the information gaps and monitoring needs identified in the ECD were also considered in the broader context of the Southeast Queensland Healthy Waterways Partnership's Ecosystem Health Monitoring Program (EHMP) and the monitoring program being implemented to assess the effect of proposed re-zoning of the Moreton Bay Marine Park by the Queensland EPA.

To ensure close alignment between these initiatives, a special sub-group of the Southeast Queensland Healthy Waterways Partnership Scientific Expert Panel (SEP) met several times with the consultant study team and the Knowledge Management Committee to workshop and discuss synergies and commonality between the existing and proposed monitoring programmes (refer Appendix A). A separate report outlining the outcomes of these discussions has been produced by BMT WBM (2008b) as part of the ECD project.

While specific priorities and methodologies for monitoring were not sought to be developed through the workshop process, the information collected provides a basis for the next phase of monitoring and sampling design under EHMP and other monitoring regimes that is cognisant of the important/significant habitats and species, key attributes and associated stressors and threats affecting the Moreton Bay Ramsar site.

Finally, in terms of communication, education and awareness messages, the critical elements of the Ramsar site nominated in this ECD that are perhaps not being fully articulated include:

- The importance of freshwater wallum and peatland wetland habitats on the Bay islands and adjacent to Pumicestone Passage and the unique aquatic fauna that exists in these areas such the Oxleyan pygmy perch, water mouse and acid frogs. This also includes the associated critical wetland flora and communities identified in this report (noting that significant work is needed by to better identify and survey the extent and values of these endangered and vulnerable communities and species);
- In keeping with the wise use paradigm of the Ramsar Convention, promotion of the diversity of sustainable wetland-based tourism and recreational values of the Ramsar site;
- The current state of fisheries resources and the need for continued conservation of fish habitat;
- The use and significance of the site to Indigenous people; and
- The importance of Moreton Bay for migratory shorebirds.

**Table 1-1 Critical Services Summary**

| Critical Service/Benefit | Underlying Critical Components | Underlying Critical Processes |
|---|---|---|
| **S1.** The Moreton Bay Ramsar site contains a **diversity** of wetland habitat types that are **representative** of a major coastal wetland aggregation and in many areas show a high degree of **connectivity** between habitat types<br><br>**S2.** Moreton Bay Ramsar site contains several critical **wetland habitat types**. For reporting purposes, reference sites have been selected within these critical habitat types that are in a **near natural state** and are **representative** of the habitat type within the broader biogeographic region<br><br>**S3.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered **marine/aquatic fauna**<br><br>**S4.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered **wetland-dependent terrestrial fauna** species<br><br>**S5.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered **wetland flora** species and endangered and of concern **wetland regional ecosystems**<br><br>**S6.** Moreton Bay Ramsar site supports significant **populations** (more than 20 000 in total and over 1% of the population size of particular populations) of **migratory and resident shorebirds**<br><br>**S7.** The tidal fish habitats and fish and invertebrate populations of the Moreton Bay Ramsar site support valuable **recreational and commercial fishing** activities<br><br>**S8.** Moreton Bay Ramsar site has important **cultural values and significance** to indigenous peoples<br><br>**S9.** Moreton Bay Ramsar site is an important site for **research and education**<br><br>**S10.** Moreton Bay Ramsar site provides and supports significant **tourism and recreational uses** in the region | **Wetland habitats,** including six near-natural reference habitats as follows (links to S2):<br>• S2A Seagrass and shoals in the Eastern Banks area<br>• S2B Tidal flats and associated estuarine assemblages within Pumicestone Passage<br>• S2C Mangroves and saltmarsh in the Southern Bay<br>• S2D Coral communities of the Eastern Bay<br>• S2E Freshwater wallum and peatland habitats on the Bay islands<br>• S2F Ocean beaches and foredunes on Moreton Island<br><br>**Wetland-dependant fauna and flora species**, including:<br>• Marine: dugongs, green and loggerhead turtles (link to S3)<br>• Aquatic: Oxleyan pygmy perch and honey blue eye (link to S3)<br>• Wetland-dependant terrestrial fauna species: Little tern, beach stone-curlew, Illidge's ant blue butterfly, Australian painted snipe, acid frogs, water mouse, Australasian bittern (link to S4)<br>• Wetland-dependant terrestrial flora species: Vulnerable and Endangered flora species including swamp orchids, knotweed and swamp daisy (links to S5)<br><br>Noteworthy **flora communities** within the Ramsar site that are endangered or of concern regional ecosystems (links to S5)<br><br>Noteworthy **populations** of migratory and resident shorebirds (links to S6)<br><br>**Fisheries** of recreational and commercial significance and their habitats (links to S7) | **Physical Coastal Processes.** Hydrodynamic controls on habitats through tides, currents, erosion and accretion<br><br>**Hydrology.** Patterns of tidal inundation and freshwater flows to wetland systems<br><br>**Groundwater.** For those wetlands influenced by groundwater interaction, the level of the groundwater table and groundwater quality<br><br>**Energy and Nutrient Dynamics.** Primary productivity and the natural functioning of carbon and nutrient cycling processes<br><br>**Biological Processes.** Important biological processes such as growth, reproduction, recruitment, migration and dispersal<br><br>**Water Quality.** Water quality that provides aquatic ecosystem values within wetland habitats<br><br>**Climate.** Patterns of temperature, rainfall and evaporation<br><br>**Geomorphology**. Key geomorphologic/ topographic features of the site |

**Table 1-2 Summary of Limits of Acceptable Change**

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| **Criterion 1**: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region. | Criterion 1 is based on the site containing at least one particularly notable wetland habitat type, and this wetland type is maintained in natural or near-natural condition.<br>**Wetland Types and Extent**<br>The ECD/RIS list twenty-two (22) wetland types within the site (using the Ramsar Classification Methodology). An unacceptable change will have occurred if it can be demonstrated that one or more of these wetland types have been lost.<br>**Wetland Condition**<br>A change in natural or near-natural condition at one of the six (6) reference sites[1] or more broadly across that habitat type at a whole-of-site scale are defined as follows**:**<br>• **Seagrass meadow** cover and extent has declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Eastern Bay) or has resulted in measurable changes to the local population status of dugongs and green turtles, or fisheries stocks (all seagrass areas);<br>• **Unvegetated intertidal flats** and associated microphytobenthos and marine fauna community structure has changed to such levels that it in the medium to long-term (>5 years), can no longer be considered to be in pristine or near-pristine condition (Pumicestone Passage) or has resulted in measurable changes to avifauna populations or fisheries stocks (all tidal flat areas);<br>• **Mangrove and saltmarsh** habitat extent and community structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered to be in pristine or near-pristine condition (Southern Bay) or has resulted in measurable changes to avifauna populations or fisheries stocks (all mangrove and saltmarsh areas);<br>• **Coral community** and reef habitat structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered to be in pristine or near-pristine condition (Eastern Bay coral communities) or has resulted in measurable changes to the extent or condition of the habitat (eg. coral dominated reefs algal dominated);<br>• **Freshwater wallum** wetland **/peatland** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (North Stradbroke or Moreton Islands) or has resulted in measurable changes to the local population status of | **Habitat Extent**<br>At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, communities or habitat at this spatial scale.<br>**Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4 |

[1] These representative habitat types and locations have been selected on the basis of their role in ecosystem functioning across the site and are important habitats for threatened species, communities and populations that are relevant to other Criteria in the table.

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| | threatened flora and fauna species or communities (see Criterion 2 below);<br>• **Ocean beach and foredune** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Moreton Island) or has resulted in measurable changes to the local population status of avifauna or nesting usage by avifauna and marine turtles (all ocean beaches and foredune areas). | |
| **Criterion 2**: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities. | Criterion 2 is based on the site containing at least one vulnerable or endangered species or threatened ecological community. The ECD/RIS lists several species/communities within the site that meet this criterion which include:<br>• Marine Species - dugongs, green and loggerhead turtles<br>• Freshwater Fish - Oxleyan pygmy perch and honey blue eye<br>• Avifauna - little tern, beach stone-curlew, painted snipe, Australasian bittern<br>• Wetland-dependant non-avian fauna - Illidge's ant blue butterfly, acid frogs and water mouse<br>• Nationally Endangered wetland flora species including several swamp orchids, knotweed and swamp daisy<br>An unacceptable change will have occurred if it can be demonstrated that one or more of these threatened species or threatened communities is lost within the site.<br>In particular, a change to character would be demonstrated if the following were to occur:<br>• The wetland becomes unsuitable as habitat for one or more threatened species or community listed in this ECD; or<br>• Threatened animal and plant species identified in the ECD no longer occur at the site. | **Species/Populations**<br>Detectable decline in local abundance/population of the key species.<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |
| **Criterion 3**: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region | Criterion 3 is based on the site containing a large proportion of species that are not well represented in the wider region. An unacceptable change will have occurred if it can be demonstrated that there has been a reduction in the number of species occurring within the site, and that this has resulted in a loss in biodiversity within the bio-region.<br>In this context, a change to character would be demonstrated if the following were to occur:<br>• Habitats have become unsuitable for wetland flora or fauna species or populations listed in the critical services of this ECD (see Criterion 2)<br>• Noteworthy animal and plant species identified in the ECD are no longer present (see Criterion 2)<br>• Populations of noteworthy species (see Criterion 2 above) no longer recorded in previous abundances (i.e. possible loss of genetic diversity) | **Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4<br>**Species/Populations**<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |



BMT WBM

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| | • Overall vertebrate fauna biodiversity is measurably and significantly reduced | |
| **Criterion 4**: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions. | Criterion 4 is based on the site representing critical refugia for any species, and the site maintaining critical life-cycle processes for any species.<br>An unacceptable change will have occurred if it can be demonstrated that the site no longer provides a refugia function for important flora and fauna species (see Criterion 2) or if critical life-cycle processes are no longer being supported.<br>The following are considered to represent the key critical life-cycle functions in the Moreton Bay Ramsar site -<br>• Feeding and nesting habitat for green and loggerhead turtles that could impact the local population<br>• Feeding and breeding habitat for dugong that could impact the local population<br>• Refuge habitat for freshwater fish of conservation significance that could impact the local population<br>• Roosting habitat for migratory waterbirds that could impact the local population<br>• Critical overwintering habitat and a flyway staging area (both northern and southern migration routes) for migratory waterbirds | **Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4<br>**Species/Populations**<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |
| **Criterion 5**: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds. | The site no longer supports the required abundance of waterbirds under this Criterion | That the total number of waterbirds at the site always exceeds 20,000 individuals<br>Greater than 10% reduction in over a 10 year period of numbers of bar-tailed godwit, Eastern curlew, or Pacific golden plover which are surrogates for assessing shorebird abundance generally. |
| **Criterion 6**: A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of waterbird. | The site no longer supports the 1% of individuals of populations for the key species in the ECD which are:<br>• bar-tailed godwit<br>• whimbrel<br>• Eastern curlew<br>• terek sandpiper<br>• grey-tailed tattler<br>• curlew sandpiper | Greater than 20% reduction in any three year period over five years for any of the eight migratory shorebird species (which exceed the 1% threshold). |

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| | • pied oystercatcher<br>• Pacific golden plover<br>• lesser sand plover | |
| **Criterion 7**: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity. | Long term impacts on the sustainability of populations of important commercial and recreational species that occur within the site (or in adjacent areas of the Bay) including:<br>• bream, flathead, whiting, luderick, mullet, tailor, mackerel, sharks, baitfish, eels, pink snapper and other key finfish species;<br>• king, tiger, endeavour, banana, greasyback and school prawns;<br>• blue swimmer, mud, red spot, spanner and coral crabs and Callianasid shrimp (yabbies);<br>• squid, cuttlefish, gastropods, rock oysters, bivalves and *beche-de-mer*. | A long-term loss of fish/shellfish stocks, which results in the reduction in the sustainability of key Bay fisheries, should be considered a trigger for assessing potential changes to ecological character. |
| **Criterion 8**: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. | Medium to long-term (>5 years) reduction in the extent or condition of wetlands or other areas and a corresponding measurable impact on important spawning, nursery or migration pathways for fisheries. | At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, life-stages, communities or habitat at this spatial scale.<br><br>In assessing this interim LAC, attention should be given to assessing changes in the extent of mangroves, saltmarsh, seagrass and tidal flat environments, which represent key nursery habitats to many commercially important species within the site. |

**Table 1-3 Summary of Limits of Acceptable Change – Critical Habitats**

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| **Seagrass** | See 'Natural Variability' column | See below<br>Turbidity/light | Variable across site. Refer to EHMP data. | n/d | *H. ovalis*:<br>H1. Min. light requirement = 16% SI [P,Q]<br>H2. Duration = >30 days at 0% SI [P,S]<br>*Z. muelleri*:<br>H3. Duration = >30 days at 5% SI [P,Q]<br>H4. Critical thresholds = >30% SI [Q,R,]; 0.9 Kd ($m^{-1}$) [P,R]; 10 mg/L [P,R]<br>H5. If site values exceed levels in H1 to H4, use default baseline turbidity values at seagrass sites as default trigger values (see SDR sites below) [J] | S1, S2, S3, S6, S8 |
| | | Seagrass depth limit/range (SDR) | | n/d | Medium term (>5 years) median SDR value should not fall below the following interim default SDR values [N]:<br>H6. Pumicestone Passage HEV = -0.8 m<br>H7. Pumicestone Passage SMD = -1.2 m<br>H8. Deception Bay North SMD = -3m<br>H9. Waterloo Bay HEV = -1.9m<br>H10. Central Bay HEV/ SMD = -2.2m<br>H11. Eastern Bay HEV = -3.5m<br>H12. Eastern Bay SMD = -2.2m<br>H13. Southern Bay HEV/ SMD = -1.3m | |
| | | Long-term change in tidal hydraulics and sedimentation patterns (short to medium term) | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008)[A]. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H14. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater above background [B]. | |
| **Unvegetated tidal flats** | Pumicestone Passage, Waterloo Bay, Bramble Bay, Eastern Banks. | Freshwater flows | Waterway-specific & highly variable over time. Baseline hydraulic conditions as per 'Existing-case' scenarios in Moreton WRP. | n/d<br><br>Quantitative environmental flow requirements of key local species and habitats unknown | H15. As a minimum, compliance with EFOs outlined in Moreton WRP for Nodes A-E | S1, S2, S3, S4, S6, S8 |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | Tidal hydraulics & sedimentation patterns (short to medium term) | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008) [A]. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H16. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater above background [B] | |
| | | Long term (>50 years) changes to tidal inundation and sediment dynamics patterns & processes due to sea level rise | -0.22 mm/year change over last 26 years of data collection [C] | n/d<br><br>Impacts dependent on sedimentation rate relative to sea level rise | H17. A change in frequency, duration & magnitude of tidal inundation between:<br>• MHW and MSL;<br>• MSL and MLW<br>• MLW and LAT<br>• Such that it results in >10% change (above background) in the extent of unvegetated habitat at these levels, and results in [B]. | |
| | | Spionidae and Capitellidae worm densities, and sediment TOC, as indicators of organic enrichment | Highly variable in space and time | n/d | Using methods as per ANZECC, assess whether the following are exceeded:<br>H18. Interim high range – Capitellidae or Spionidae densities >1000 individuals per $m^2$<br>H19. Interim low range – n/d | |
| | | Crab burrow densities. This is a potential non-destructive, rapid assessment technique for assessing potential changes in crab abundances, which may be linked to changes in ecosystem condition [U] | | | n/d.<br>H20. There is a need to investigate (i) whether robust and cost-effective methods can be developed, and if so (ii) proceed to establish threshold criteria based on sampling of appropriate indicator species at a range of references sites. | |
| **Mangroves and Saltmarsh** | Southern Bay<br>Pumicestone Passage<br>Western Bay | Freshwater flows | H21. As a minimum, compliance with EFOs outlined in Moreton WRP for Nodes A-E (see also H15) plus nodes outlined in Logan WRP (Note G) and Gold Coast (Note A) WRPs. This should be assessed using SunWater IQQM models. | | | S1, S2, S7, S8 |
| | | Tidal hydraulics | H22. Refer to unvegetated flats, i.e. H16 | | | |
| | | Tidal inundation patterns | H23. Refer to unvegetated flats, i.e. H17 | | | |
| | | Crab burrow densities | n/d | n/d | H24. n/d. Refer to H20 | |
| | | Mangrove die-back extent | n/d | n/d | H25. n/d. There is a need to map the | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | and hypersaline areas | | | distribution and extent of mangrove die-back (aerial photography & ground-truthing) to establish existing conditions. Monitoring should be undertaken on a 5 year basis.<br><br>H26. Salinity should not be > 40-50 g/L (low tide) to reduce the risk of impacts to mangrove health[V].<br>H27. Where ambient salinity exceeds levels in H26, & mangroves and saltmarsh are demonstrated to be in good condition, derive local trigger values based on ambient/background data. [J] | |
| **Coral Communities (Eastern Bay)** | Central and Eastern Bay – Myora, Peel Island, etc | Turbidity | <1, 1, 1 NTU [E] | n/d.<br><br>Tolerance limits of most local species are largely unknown. | H28. Long-term (>5 day) average turbidity should not exceed >3 NTU [H]<br>H29. Use default baseline conditions at coral reef sites as default interim trigger values for turbidity & other attributes [J] | S1, S2, S3, S8 |
| | | pH | 8.2, 8.3, 8.4 [E] | | | |
| | | TN | 100, 120, 160 μg/L [E] | | | |
| | | TP | 5, 9, 12 μg/L [E] | | | |
| | | Water temperature | 12.5° to 32°C (Reef flat); 16 to 28°C (Moreton Bay surface waters [F] | | | |
| | | Sedimentation rates (mg/cm$^2$/day) [G] | Peel Is = 2 to 32<br>Myora = 5.9 to 16.1 | n/d<br>Tolerance limits are:<br>• highly species-specific.<br>• not available for local species<br>• dependent on duration & frequency of exposure to sedimentation<br><br>Available baseline sedimentation data has limited temporal coverage (1 year). | H30. Sedimentation should not exceed background variability and lead to measurable impacts to coral communities [K] | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | Coral bleaching frequency & extent | n/d<br>Incidence of coral bleaching is not reported in EHMP. | n/d | H31. The frequency & duration of bleaching events should not increase to such levels where measurable impacts to coral communities occur [K] | |
| | | Reef community structure (cover of numerically dominant taxa) | Site specific, and variable in time for some macrophyte species. Refer to EHMP (2006) data for a description of baseline conditions. | n/d | H32. >5% loss in hard and/or soft coral cover > background temporal variability [L] | |
| **Wallum freshwater wetlands** | Bay Islands Pumicestone Passage | Groundwater hydrology | Waterway-specific & highly variable over time. Baseline hydraulic conditions as per 'Existing-case' scenarios in Logan WRP (& underlying modelling). | n/d | H33. As a minimum, compliance with EFOs outlined in future draft Logan WRP (North Stradbroke Island) [M]<br>H34. No changes in water levels at Blue Lake, or the Blue Lake Overflow discharge channel, such that a detectable community or ecosystem change occurs [B] | S1, S2, S4, S5, S7 |
| | | Invertebrates | 20th percentile:<br>Taxa richness = 12<br>PET richness = 2<br>SIGNAL = 3.32 | n/d | H35. No change in water quality or invertebrate biotic indices, outside the bounds of natural variability. Note that water quality and biotic indices show great change among different waterbodies, hence there is a need to derive local trigger values based on ambient/background data. [J] | |
| | | pH [I] | Blue L. = 4.9 to 5.2<br>Brown L. = 4.6 to 5.0 | | | |
| | | EC (µS/cm) [I] | Blue L. = 90<br>Brown L.= 90 | | | |
| | | Secchi (m) [I] | Blue L. = 4.9 to 6.9<br>Brown L. = 0.7 | | | |
| | | DO (% saturation) [I] | Blue L. = 86 to 95<br>Brown L. = 90 to 99 | | | |
| | | Chlorophyll a (µg/L) [I] | Blue L. = 0.6 to 2.4<br>Brown L. = 14 | | | |
| | | TP (µg/L) [I] | Blue L. = 2 to 6<br>Brown L. = 15 | | | |
| | | Water Temp (deg C) [I] | Blue L. = 19 to 26 | | | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | | Brown L. = 19 to 26 | | | |
| | | Turbidity (NTU) [I] | Blue L. = <1 to 1 | | | |
| | | | Brown L. = 9 | | | |
| | | Ammonia ($\mu$g/L) [I] | Blue L. = 2 to 7 | | | |
| | | | Brown L. = 9 | | | |
| | | Total N ($\mu$g/L) [I] | Blue L. = 90 to 130 | | | |
| | | | Brown L. = 500 | | | |
| | | NOX ($\mu$g/L) [I] | Blue L. = 6 to 37 | | | |
| | | | Brown L. = 3 | | | |
| **Ocean beaches and foredunes** | High-energy beaches and foredunes of Bribie, Moreton and North and South Stradbroke Islands | Long-term change in tidal hydraulics and sedimentation patterns (short to medium term) leading to change in beach morphology | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008)[A] or long term aerial photograph analysis. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H36. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater, relative to background [B]. | S1, S2, S3, S4, S7 |
| | | Groundwater inflows | Highly site-specific. Groundwater flows bring nutrients into the beach system and into the swash zone and control invertebrate and nearshore phytoplankton communities | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H37. No measurable medium term (>5 years) change to groundwater supply/flows into beach systems relative to background [B]. | |
| | | Density of *Pipis* or other indicator species linked to changes in ecosystem condition | Highly variable in space and time | n/d | H38. There is a need to establish threshold criteria based on sampling of appropriate indicator species at a range of references sites. Refer to H20. | |

**Table 1-4 Summary of Limits of Acceptable Change – Critical Species**

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| Oxleyan pygmy perch | Bay Islands, Pumicestone Passage | No long-term reduction in population densities of Oxleyan pygmy perch in waterbodies, outside the range of natural variability.<br><br>No reduction in the total number of waterbodies inhabited by Oxleyan pygmy perch within the site. | pH | 4.2 to 7.2 [A] | n/d<br><br>No experimental determination of physiological tolerances<br><br>All information on habitat preferences based on environmental conditions in which this species has been recorded | H39. Long term average should not >6.5<br>H40. If above this value, adopt 20$^{th}$, 50$^{th}$ & 80$^{th}$ percentile values of reference site conditions in which population has been recorded. The 75$^{th}$ confidence limit should not be > these values. | S1, S2, S3 |
| | | | Dissolved Oxygen | > 2 mg/L [B] | | H41. Long-term median should not be <5 mg/L. If above this value, then adopt percentile values described in H40 | |
| | | | Turbidity | Clear, tannin stained waters (1 to 300 NTU) [A, B] | | H42. Long-term median should not > 1 NTU. If above this value, then adopt percentile values described in H40 | |
| | | | EC/Salinity | <330 μS/cm [A] | | H43. Long term average should not exceed 300 μS/cm. If above this value, then adopt percentile values described in H40 | |
| | | | Water levels | 0.2[A, B] to 5[C] m, depending on water body characteristics. Mean weighted depth of captures = 0.63 m [A], whereas OPP Recovery Plan indicates most OPP captures in 0.3 to 0.4 m depth range [F]. | | H44. n/d. Trigger value may vary depending on particular requirements and local habitat conditions, i.e. avoidance of competition with eastern Gambusia or maintenance of fish passage. Local trigger values therefore need to be developed, although water depths <0.2 m unlikely to allow maintenance of OPP populations.<br>H45. Drying. Where adjoining permanent refugia is absent, drying of a known habitat will cause local extinction at the site. | |
| | | | Groundwater hydrology | Low flow <0.3 m/sec [A] | | H46. Flow <0.1 m/second. If >, then If above this value, then adopt percentile values described in H40 | |
| | | | Emergent macrophyte cover and undercut banks | 60-80% emergent macrophyte cover (typically sedges), undercut banks, woody debris & root masses. | | H47. >50% reduction in emergent vegetation cover, above background variability, such that it results in such that it results in a measurable, short-term (1-5 years) flow-on effects to OPP populations and/or key ecosystem functions. | |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Eastern Gambusia in freshwater reaches of Little Canalpin Ck.** | Absent in freshwater reaches, but found in lower estuarine/brackish environs | n/d | H48. Presence of Eastern Gambusia in Little Canalpin Creek represents a trigger for further investigation of viability of this sub-population. | |
| | | | Oxleyan pygmy perch abundance | This species has low population densities, hence empirical limits are difficult to set. On North Stradbroke Is., average CPUE is typically 0-0.6 individuals/trap /hour*. | n/d | H49. No fish recorded during >5 sampling events, using various combinations of sampling methods (e.g. box traps, electro-fishing and seine netting), should trigger further investigations of whether waterbody continues to provide suitable OPP habitat, and the identification of drivers for change. | |
| Honey blue-eye | Pumicestone Passage | No long-term reduction in population densities of honey blue-eye in waterbodies, outside the range of natural variability.<br><br>No reduction in the total number of waterbodies inhabited by honey blue-eye within the site. | pH | 4.4 to 6.8 [A] | n/d<br><br>No experimental determination of physiological tolerances<br><br>All information on habitat preferences based on environmental conditions in which this species has been recorded | H50. Long term median should not be >6.5, or if above this value:<br>H51. Adopt 20$^{th}$, 50$^{th}$ & 80$^{th}$ percentile values of reference site conditions as described in H40 | S1, S2, S3 |
| | | | Dissolved Oxygen | > 6.8 mg/L [A] | | H52. Long-term median should not be <5 mg/L.<br>H53. If background above this value, then adopt percentile values described in H40 | |
| | | | Turbidity | Clear, tannin stained waters (<17 NTU) [A] | | H54. Long-term median should not > 1 NTU.<br>H55. If background above this value, then adopt percentile values described in H40 | |
| | | | EC/Salinity | <900 μS/cm [A] | | H56. Long term median should not exceed 700 μS/cm.<br>H57. If background above this value, then adopt percentile values described in H40 | |
| | | | Water levels | n/d | | H58. n/d. Trigger value may vary depending on particular requirements, i.e. avoidance of competition with eastern Gambusia or maintenance of fish passage. Local trigger values need to be developed.<br>H59. Drying. Where adjoining permanent refugia is absent, drying of a known habitat will cause local extinction at the site. | |
| | | | Groundwater hydrology | Low flow <0.3 m/sec [A] | | H60. Median flow velocity <0.1 m/second.<br>H61. If background above H22, then adopt percentile values using approach described in H40 | |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Emergent macrophyte cover and undercut banks | High aquatic plant cover, typically sedges [A] | | H62. >50% reduction in emergent vegetation cover, above background variability, such that it results in such that it results in a measurable, short-term (1-5 years) flow-on effects to Honey Blue-eye populations and/or key ecosystem functions.. | |
| | | | Honey blue-eye abundance | This species typically has low population densities [A], hence empirical limits are difficult to set. | n/d | H63. No fish recorded during >5 sampling events, using various combinations of sampling methods (e.g. box traps, electro-fishing and seine netting), should trigger further investigations of whether waterbody continues to provide suitable habitat, and the identification of drivers for change. | |
| Dugong | Eastern Bay<br>Pumicestone Passage<br>Southern Bay | Detectable decline in local abundance of dugong outside the range of natural variability | Turbidity, nutrients and chlorophyll *a* | Refer to seagrass indicators in Habitat Table 4-4 | | | S1, S2, S3, S9 |
| | | | Seagrass depth limit (and extent) | Refer to seagrass in Habitat Table 4-4 | | | |
| | | | Dugong population densities | 503 ± 63 (S.E) (July) to 1019 ± 166 (S.E) (December) individuals in 1995 (Lanyon 2003) [D]. Recent population modelling suggests local population size of ~970 ±75 animals [E]. | n/d | H64. A decline in dugong abundance to <800 individuals for 2-3 successive years may represent a trigger for further investigation. Note however that these figures should be considered as indicative only, as there is insufficient available information on the population dynamics and genetics of dugongs to develop a reliable interim trigger value. | |
| Marine Turtles: green turtle loggerhead turtle | Eastern Bay<br>Pumicestone Passage<br>Southern Bay | Detectable decline in green and loggerhead turtles outside the range of natural variability | Turbidity, nutrients & chlorophyll *a* | Refer to seagrass indicators in Habitat Table 4-4 | | | S1, S2, S3, S9 |
| | | | Seagrass depth limit (and extent) | Refer to seagrass in Habitat Table 4-4 | | | |
| | | | Green and loggerhead turtle population dynamics & breeding readiness | n/d | n/d | H65. n/d. Insufficient available information on the population dynamics, growth rates and breeding readiness of turtles to develop a reliable interim trigger value. | |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| Wallum Acid Frogs | Wallum habitats on Bay Islands and Pumicestone Passage | Significant population declines outside the range of natural variability in either of the four acid frog species | Water quality:<br>• non-turbid<br>• tannin-stained<br>• oligotrophic (low nutrient)<br>• naturally acidic | pH 3.0-5.5 as derived from dissolved organic acids leached from humus). | n/d | H66. Significant decline in the numbers of the four acid frog species for important populations on North Stradbroke and Moreton Islands. | S4 |
| | | | Absence of predatory fish | n/d | n/d | H67. Presence of Eastern Gambusia may represent a threat to local populations | S4 |
| | | | Wallum wetland vegetation | n/d | n/d | H68. Greater than 5% reduction over five years of wallum wetland vegetation cover. | S4 |
| | | | Ground water hydrology and freshwater flows | n/d | n/d | H69. No long-term change in groundwater hydrology such that it causes alterations to water quality, water levels and wetland flora and fauna, outside the bounds of natural variation. | S4 |
| Beach stone-curlew | Outer Bay islands, Pumicestone Passage, mangrove habitats of southern Moreton Bay. | Significant declines in key habitat areas | Mangroves and associated intertidal flats (roost and feeding); sandy beaches (feeding), foredunes (breeding sites) | n/d | n/d | H70. Lack of observation of beach stone-curlew in any three year period over five years within the following areas: Pumicestone Passage (Toorbul north to Bells Creek); Bulwer to North Point (Cape Moreton); Cape Cliff (Cape Moreton) to Eagers Creek; Little Sandhills to Mirapool Lagoon; Amity to Point Lookout; Peel Island; Jumpinpin (includes southern end tip of North Stradbroke Island and associated mangrove islands); western side of South Stradbroke Island. | S4 |
| Water mouse | Pumicestone Passage, North Stradbroke Island, Southern Moreton Bay (e.g. Steiglitz, Jacobs Well, Pimpama River Conservation Area, Coomera River, & South Stradbroke Island). | Significant declines in the usage of nests and the diversity of nest types used. | Relatively large areas of intertidal flats in association with mangroves (feeding), marine intertidal invertebrate prey, supralittoral wetlands, including salt marsh and sedgelands (nesting sites) | n/d | n/d | H71. Greater than 20% reduction in the number of active/recently active water mouse nests or greater than 15% reduction in usage of any one of the diversity of nest types used (following Van Dyck and Gynther 2003) over five years for important populations associated with North Stradbroke Island, southern Moreton Bay (e.g. Macleay Island, Coomera & Pimpama Rivers, South Stradbroke Island) and Pumicestone Passage (e.g. Bribie Island, Donnybrook). | S4 |
| | | | Tidal conditions | n/d | n/d | H72. Any detectable long-term change to tidal regimes at spatial scales >5 km. | S4 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| Australian painted snipe | Freshwater swamps of outer Bay islands (e.g. 18 Mile Swamp). | Lack of records for any 10 year period. | Densely vegetated permanent of seasonal wetlands | n/d | n/d | H73. Loss of more than 20% of the extent of vegetated freshwater wetland habitat. | S4 |
| Australasian Bittern | Freshwater swamps of outer Bay islands (e.g. 18 Mile Swamp). | Lack of records for any 10 year period. | Densely vegetated permanent of seasonal wetlands | n/d | n/d | H74. Loss of more than 20% of the extent of vegetated freshwater wetland habitat. | S4 |
| Little Tern | Open waters of Bay, Caloundra sandbanks, beaches & sand spits of outer Bay islands, South Stradbroke Island. | Significant decline in abundance, outside the range of natural variability. | Nearshore and offshore open waters and rivers; water quality sufficient to support abundance of surface active baitfish; high-tide roost sites. | n/d | n/d | H75. Significant decline in the numbers of Little Tern, outside the range of natural variability, over five years as determined at key roost sites (e.g. northern Pumicestone Passage; South Stradbroke Island). | S4 |
| Illidge's ant blue butterfly | Mangrove communities of Redland Bay, Hays Inlet, Fisherman Islands, outer Bay islands, and Coomera Island | Lack of records for any three year period. | Large areas of mangroves with mature trees bearing senescing limbs and dead branchlets which support the *Crematogaster* sp. ant; also adjacent supralittoral forests. | n/d | n/d | H76. Greater than 10% reduction over five years of mangrove cover and associated intertidal habitats. | S4 |
| Migratory Shorebirds | Intertidal sand/mud flats, rocky shores and mangrove communities throughout the site, intertidal areas of coarse rubble associated with | Decline in shorebird abundance and species diversity. | Diversity and abundance of epi/infauna of the intertidal flats; diversity of disturbance-free high tide roost spatially | n/d | n/d | H77. Greater than 10% reduction over five years of any one of the following components – mangrove cover and associated intertidal habitats; and supralittoral salt marsh habitats.<br>H78. Any detectable long-term change to tidal regimes at spatial scales >5 km.<br>H79. No long-term reduction in water quality and ecosystem condition in the estuarine sections of | S6 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | central bay islands (Mud, St. Helena and Green islands) and western shores (Wellington Point and Redcliffe Peninsula), high tide roost sites throughout the site (natural and artificial). | | proximate to suitable feeding grounds. | | | each major catchment area (as determined through the EHMP).<br>H80. Greater than 10% reduction in over a 10 year period of numbers of bar-tailed godwit, Eastern curlew, or Pacific golden plover which are surrogates for assessing shorebird abundance generally.<br>H81. Greater than 20% reduction in the in any three year period over five years for any of the eight migratory shorebird species (which exceed the 1% threshold). | |
| Threatened Flora Communities: Endangered and Of Concern Regional Ecosystems | Bribie Island, Moreton Island, Southern Moreton Bay Islands, Southern Bay | Detectable decline in extent of Regional Ecosystems.<br><br>Loss of sensitive plant species and change to alternate community type.<br><br>(Loss of dependent fauna). | Groundwater hydrology | Waterway-specific and variable over time. | n/d<br><br>Quantitative groundwater requirements of ecosystems unknown. | H82. No significant reductions in water table depth, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br>H83.<br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| | | | Fire regimes | Variable over time and between different vegetation types. | n/d<br><br>Specific fire regime requirements of ecosystems unknown. | H84. No significant changes in fire frequency or intensity, relative to background variability, such that it results in such that it results in a measurable, medium-term (>5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>No significant changes in fire frequency or intensity such that ecological integrity of ecosystems is not maintained. Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Geomorphology:<br>• Erosion<br>• Sedimentation<br>• Soil type | Erosion and sedimentation variable over time. Soil type not variable over relevant time scale. | | H85. No significant changes in erosion or sedimentation processes, or changes to soil characteristics, relative to background variability, such that it results in such that it results in a measurable, medium-term (>2 to 5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| Vulnerable and Endangered wetland plants:<br>*O. hygrophila*<br>*P. elatior*<br>*P. australis*<br>*P. bernaysii*<br>*P. tancarvilleae* | Bay Islands: swamps, lakes and waterways | Detectable decline in local abundances of plant species. | Groundwater hydrology | Waterway-specific and variable over time. | n/d<br><br>Quantitative groundwater requirements of flora species unknown. | H86. No significant reductions in water table depth, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| | | | Water Quality:<br>• Toxicants<br>• Nutrients<br>• Turbidity<br>• Salinity, pH | Waterway-specific and variable over time. | n/d<br><br>No experimental determination of flora species water quality tolerances. | H87. No change in water quality indices outside bounds of natural variability. Adopt 20$^{th}$, 50$^{th}$ & 80$^{th}$ percentile values of reference site conditions in which population has been recorded. The 75$^{th}$ confidence limit should not be > these values.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, species should continue to exist at current conservation status. | S5 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Freshwater flows and inundation | Waterway-specific and variable over time. | n/d<br><br>No quantification of frequency, duration and extent of freshwater inundation requirements for flora species. | H88. No significant reductions in flow regimes, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, species should continue to exist at current conservation status. | S5 |
| | | | Geomorphology:<br>• Erosion<br>• Sedimentation<br>• Soil type | Erosion and sedimentation variable over time. Soil type not variable over relevant time scale. | n/d<br><br>No quantification of geomorphologic requirements of flora species. | H89. No significant changes in erosion or sedimentation processes, or changes to soil characteristics, relative to background variability, such that it results in such that it results in a measurable, medium-term (>2 to 5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | |

# 2 INTRODUCTION

This Section provides general information about the Ecological Character Description (ECD) process and the Moreton Bay Ramsar site.

## 2.1 Background to the Study

The Moreton Bay wetland aggregation is one of 65 wetland areas in Australia that have been listed as a wetland of international importance under the *Convention on Wetlands of International Importance especially as Waterfowl Habitat* or, as it is more commonly referred to, the Ramsar Convention (the Convention). Moreton Bay was listed as a Ramsar site under the Convention in 1993 in recognition of its outstanding coastal wetland values and features.

The Convention sets out the need for contracting parties to conserve and promote wise use of wetland resources. In this context, an assessment of ecological character of each listed wetland is a key concept under the Ramsar Convention.

Under Resolution IX.1 Annex A: 2005, the ecological character of a wetland is defined as:

> *The combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.*

The definition indicates that ecological character has a temporal component, generally using the date of listing under the Convention as the point for measuring ecological change over time. As such, the description of ecological character should identify a wetland's key elements and provide an assessment point for the monitoring and evaluation of the site as well as guide policy and management, acknowledging the inherent dynamic nature of wetland systems over time.

This report provides the Ecological Character Description (ECD) for the Moreton Bay Ramsar site. In parallel with the preparation of the ECD, the Ramsar Information Sheet (RIS) for the site is being updated and the associated Ramsar maps and digital GIS boundaries of the site have been reviewed and documented in a separate report (refer BMT WBM 2008d). Additional reports have also been prepared that are companion documents to this ECD. These include:

- A report reviewing and documenting management actions relevant to the critical services/benefits, components and processes of the ECD (refer BMT WBM 2008a);
- A report documenting the discussions and outcomes of the expert panel review process for the ECD undertaken with members of the Scientific Expert Panel of the Southeast Queensland Healthy Waterways Partnership (refer BMT WBM 2008b)
- A report reviewing and documenting the relevant wetland management goals and indicators relevant to the services/benefits, components and processes of the ECD (refer BMT WBM 2008c).

These reports have been prepared over a period of ten months by the consultant study team led by BMT WBM Pty Ltd under contract with the Queensland Environmental Protection Agency (EPA). This has occurred with input from the EPA Project Management Team for the study, a Project

Steering Committee made up of officials from the Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA) and Queensland Government agencies, and a Knowledge Management Committee (KMC) comprising Government and non-Government individuals with expertise and/or local research experience working within the Ramsar site. As outlined above, parts of the ECD were also subject to review and discussion as part of a workshop process with scientists from the Southeast Queensland Healthy Waterways Partnership Scientific Expert Panel (SEP). Appendix A contains a list of the representatives of each of these committees and workshop processes and provides a summary of meeting dates.

## 2.2 Scope and Purpose of this Study

The *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands January 2008* (hereafter referred to as the National Framework), provides a comprehensive approach to preparation of ECD studies in Australia taking into account the obligations of the Convention, domestic legislative requirements under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and best practice approaches in other jurisdictions. Refer to Section 3.2.7 for a description of the policy and legilslative framework governing the site.

Figure 2-1 shows the key steps of the ECD process from the National Framework document.

Based on the National Framework document, the key purposes of undertaking an ECD are as follows:

- Contribute to meeting the obligations of the Convention and EPBC Act for the site;
- Through a review of existing information, data and literature, supplement the description of ecological character in the Ramsar Information Sheet (RIS) for the wetland;
- Quantify, where possible, the natural variation and/or limits of acceptable change to the ecological character of the site such that it can be measured over time including as part of assessments under the EPBC Act and other impact assessment legislation at a State and local level; and
- Identify information and knowledge gaps that will assist in measuring changes to ecological character over time and prioritise future monitoring and management planning for the site.

As such, the key audiences for this document are expected to be:

- The Queensland Environmental Protection Agency as the site manager;
- Other Queensland Government Agencies (and local government) that make decisions that could affect the ecological character of the site;
- The regional natural resource management (NRM) body constituted for the area;
- The Department of Environment, Water, Heritage and the Arts in terms of decision-making under the EPBC Act; and
- Other sectors of the community with a scientific or general interest in the Moreton Bay Ramsar site.

It is understood that this ECD (including updated Ramsar Map and updated Ramsar Information Sheet) submitted by the consultant team to the EPA will be assessed as part of a whole-of-Government process. If acceptable, the ECD will then be forwarded to the Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA) for consideration.

If endorsed by DEWHA, the document will then be forwarded to the Ramsar Secretariat and formally registered in the context of a supporting document under the Ramsar Convention.

Ecological Character Description

**1. Introduction to the description**
Site details, purpose of the description and relevant legislation

↓

**2. Describe the site**
Site location, climate, maps and images, tenure, wetland criteria and types

↓

**3. Identify and describe the critical components, processes and services**
3.1 Identify all possible components, processes and benefits
3.2 Of these, identify the critical components, processes and benefits responsible for determining the ecological character of the site
3.3 Describe each of the critical components, processes and benefits

↓

**4. Develop a conceptual model for the wetland**
Depict the critical components and processes of the wetland (e.g. hydrology, biogeochemical processes, biota and vegetation, and their relationships)

↓

**5. Set limits of acceptable change**
Determine limits of acceptable change for critical components, processes and services of the site

↓

**6. Identify threats to the ecological character of the site**
use information from Steps 3-5 and other information to identify the actual or likely threats to the site

↓

**7. Describe changes to ecological character**
Describe any changes to the ecological character of the site since the time of listing; include information on the current condition of the site

↓

**8. Summarise the knowledge gaps**
Use information from Steps 3-7 to identify the knowledge gaps

↓

**9. Identify site monitoring needs**
Use information from Steps 3-8 to identify monitoring needs

↓

**10. Identify communication and education messages**
Identify any communication and education message highlighted during the development of the description

↓

**11. Compile the description of the ecological character**

**12. Prepare or update the Ramsar Information Sheet**
Submit as a companion document to the ecological character description

**Figure 2-1 Key Steps in Preparing an Ecological Character Description**

(Source: National Framework document, Jan 2008)

## 2.3 Key Terminology

Wetland ecosystem processes, components and wetland services/benefits are core terminology used in the National Framework document for defining ecological character. The sections below outline the definitions and meanings of those terms used generally throughout the report. Specific definitions of these and other commonly used terms are contained in the Glossary in Section 9.

### 2.3.1 Wetland Processes

Wetland ecosystem processes are defined as the dynamic forces within the ecosystem between organisms, populations and the non-living environment. Interactions can be physical, chemical or biological. Examples include:

- Climate – rainfall, temperature, evaporation
- Hydrology – water balance, flooding and inundation regime
- Geomorphology and physical processes – topography, soils, sedimentation processes, erosion
- Energy and nutrient dynamics – primary production, decomposition, carbon cycle
- Biological Processes such as:
  - (a) Biological maintenance – reproduction, migration, dispersal, pollination
  - (b) Species interactions – competition, predation, succession, disease, infestation

### 2.3.2 Wetland Components

Wetland ecosystem components are the physical, chemical and biological parts or features of a wetland. Examples include:

- Physical form – wetland type, geomorphology
- Wetland soils – profiles, permeability, physico-chemical properties
- Water quality – physico-chemical properties such as salinity or pH
- Biota – flora, fauna and habitats

It is noted in the National Framework that some components may be viewed as both wetland components and wetland processes (eg. geomorphology, water quality).

### 2.3.3 Wetland Services/Benefits

The terms benefits and services are defined within the Millennium Ecosystem Assessment (2005) and adopted as part of the National Framework document in the context of the 'benefits that people receive from ecosystems'.

However, the National Framework notes that wetland ecosystem services and benefits are based on or underpinned by wetland components and processes and can be both of direct benefit to humans (eg. food for humans or livestock) or of indirect benefit (eg. wetland provides habitat for biota which contribute to biodiversity). In this context, benefits and services can also be short term or long term.

The National Framework breaks down wetland services/benefits into four categories. The categories and examples of services/benefits in each category are listed below:

- Provisioning services – products obtained from wetlands such as water or food
- Regulating services – water quality regulation, flood regulation and other natural functions
- Cultural services – relating to education, recreation, tourism, cultural heritage and similar values
- Supporting services – biodiversity and other ecosystem services

Figure 2-2 from the National Framework document shows a generic conceptual model of the interaction between ecosystem processes, components and services/benefits for a wetland. In general terms, the model shows how wetland ecosystem processes interact with wetland components to generate a range of wetland services/benefits. These services/benefits can be broadly applicable to all wetlands ecosystems (such as primary productivity) or specific to a given site (eg. breeding habitat for an important avifauna species or population).

## 2.4 Report Structure

The report has been structured largely in accordance with the key steps outlined in the National Framework and as shown in Figure 2.1. Sections 4 and 5 provide an essentially non-technical ecological description. Readers requiring more detailed information (including key citations) of ecological character (and associated limits of acceptable change) are referred to section 7 of the ECD report.

**Table 2-1 Key Steps in Preparing an Ecological Character Description and Relevant Report Sections**

| Framework step | Report section |
|---|---|
| Introduction to ECD | 2; 3.2.7 |
| Describe Site | 3 |
| Identify and describe critical components, processes and services | 4 |
| Develop a conceptual model for the wetland | 7 |
| Set limits of acceptable change | 4.3; 7 |
| Identify threats to the ecological character of the site | 5.2 |
| Describe changes to ecological character | 5.1 |
| Summarise knowledge gaps | 6.1 |
| Identify site monitoring needs | 6.2 |
| Identify communication and education messages | 6.3 |
| Compile the description of the ecological character | 7 |

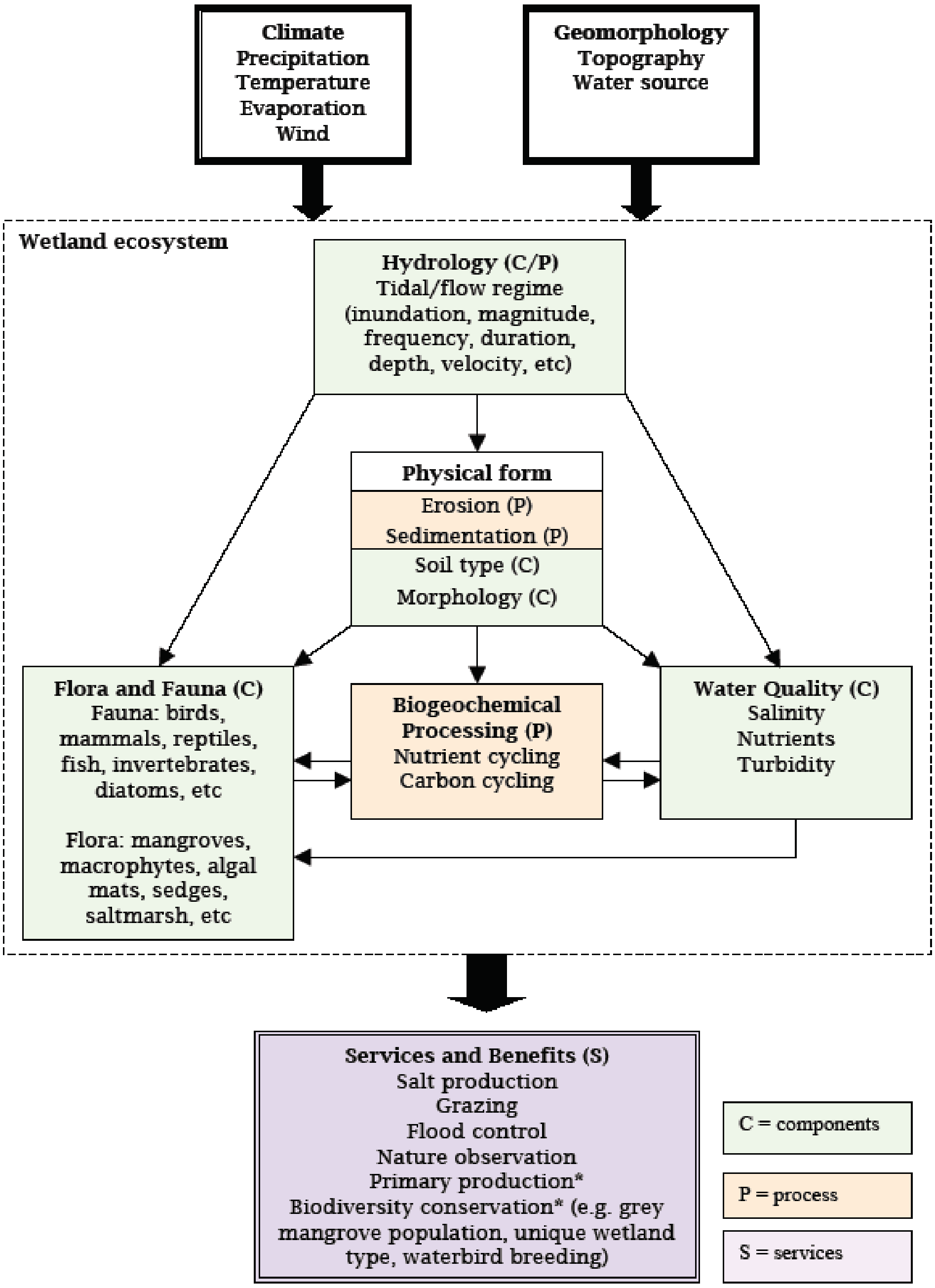



**Figure 2-2 Generic conceptual model showing interactions between wetland ecosystem processes, components and services/benefits**

(Source: National Framework document Jan 2008)

# 3 SITE CONTEXT

This Section of the report provides an overview and description of the Moreton Bay Ramsar site. The wetland habitat components of the site, the wetland processes that influence those habitats and the nomination criteria for which the site has been declared under the Convention are discussed.

These components, processes and criteria are important considerations in the selection of the critical components, processes and wetland benefits/services that make up the basis of the ECD, addressed in Sections 4 - 6 of the Report.

## 3.1 Site Details – Summary

Summary details of the site for the purposes of the ECD are provided in Table 3-1.

**Table 3-1 Details of the Moreton Bay Ramsar site**

| **Ramsar Site Name** | **Moreton Bay Ramsar site** |
|---|---|
| Area | Total Area: 120 525 ha |
| Date of Listing | 1993 |
| Dates Used for Description | 1993 (time of listing) |
| Justification for Date of Description | See above |
| Original Description Date | This is the first ECD undertaken for the site. As part of this project, the Ramsar Information Sheet (last updated in 1999) has also be updated and re-issued. |
| Compiler's Name | BMT WBM Pty Ltd with expert input from Austecology Pty Ltd and Converge Heritage + Community Pty Ltd under contract with the Queensland Environmental Protection Agency. |
| Ramsar Information Sheet | Last updated 1999 (by the Queensland EPA). Updated as part of current ECD by BMT WBM (2008). |
| Management Plan | There is no single plan relevant to the Ramsar site (refer Appendix B). Instead, a number of statutory management plans apply over broader areas of Moreton Bay and Southeast Queensland for which the boundaries of the Moreton Bay Ramsar site are a subset.<br>The two primary management plans relevant to the Ramsar site are:<br>• *Marine Park (Moreton Bay) Zoning Plan 1997* (currently under review)<br>• *South-east Queensland Regional Coastal Management Plan (2006)*<br>Other statutory plans/mechanisms relevant to the Ramsar site include:<br>• National Park and other protected area management plans<br>• The SEQ Regional Plan (2005-2026) |

| Ramsar Site Name | Moreton Bay Ramsar site |
|---|---|
| | • Environmental Values and Water Quality Objectives under the *Environmental Protection (Water) Policy 1997*<br>• Fisheries Management Plans (East Coast Trawl and Coral Reef Finfish) and Fish Habitat Areas declared under the *Fisheries Act 1994*<br>• *Water Resource (Logan Basin) Plan 2007*<br>• *Water Resource (Moreton) Plan 2007*<br>• *Water Resource (Gold Coast) Plan 2006*<br>• Local Government Planning Schemes<br>These statutory documents are supported by several key non-statutory natural resource management plans and strategies. The most notable relevant to the Ramsar site include:<br>• The Healthy Waterways Strategy 2007-2012<br>• The SEQ Catchments Natural Resource Management Plan, *The Future in Balance* (2004) (currently under review)<br>• EPA Shorebird Management Strategy 2005 |
| Management Authority | The Ramsar site predominantly includes Queensland waters.<br>Land areas above high water mark within the Ramsar site are largely State-owned lands managed by various State agencies and local governments as trustees of reserves and similar tenured land. There are some areas of leasehold and freehold land in the Western Bay area of the site.<br>The Queensland Environmental Protection Agency (EPA) is the lead agency for planning and management of wetlands in Queensland noting that other Departments also play a crucial role in the management of wetland resources such as the Department of Primary Industries and Fisheries and the Department of Natural Resources and Water. EPA is considered as the nominal 'site manager' for the Moreton Bay Ramsar site. |

## 3.2 Description of the Site

Section 3.2 and its subsections provide the general description of the site. This section is set out as follows:

- Section 3.2.1 – Describes the Ramsar site boundary
- Section 3.2.2 – Provides an overview of the wetland habitats present within the site
- Section 3.2.3 – Provides an overview of broad and local wetland processes that underpin and influence the site
- Section 3.2.4 – Provides an overview of the uses and tenure of land within and surrounding the site

- Section 3.2.5 – Provides an overview of the natural and cultural values of the site
- Section 3.2.6 – Provides an overview and summary of the policy framework for the site particularly in terms of relevant International, Commonwealth, State and regional plans and strategies

### 3.2.1 The Ramsar Site Boundary

Moreton Bay is located roughly mid-way along the east coast of Australia from 27 – 28 degrees latitude, placing it about 400 km south of the Tropic of Capricorn. A locality map of the Bay (with the Ramsar site boundary overlain) is shown in Figure 3-1.[2]

The broad study area for this ECD includes the Bay, its sand barrier islands and adjoining catchment areas. The Bay and its catchment areas are a component of the broader Southeast Queensland Region (or SEQ region as referred in this Report) which extends north to the Sunshine Coast (generally to northern boundary of the Sunshine Coast Regional Council), south across the Gold Coast and its hinterland to the border with New South Wales, and west to the Great Dividing Range.

Guidelines under the Ramsar Convention favour the use international or national biogeographic regions in the context of interpretation of Ramsar Nomination criteria and other aspects of the Convention. In this context, the Interim Marine and Coastal Regionalisation for Australia (IMCRA- version 4 - June 2006) have been adopted. Under this classification system, Moreton Bay lies within the Tweed-Moreton (TM) marine and coastal bioregion. From a terrestrial biogeographic perspective, the site is situated in the SEQ bioregion, based on the Interim Biogeographical Regionalisation for Australia (IBRA- version 6.1 – October 2008).

References within the report to the planning area or project area refer to those areas that are included within the nominated boundaries of the Moreton Bay Ramsar site (hereafter referred to as the Ramsar site or simply, 'the site').

As shown in Figure 3-1, the boundaries of the Ramsar site are essentially a series of discontinuous polygons that are generally limited to nearshore estuarine areas to a depth of roughly 6m below LAT (consistent with the definition of wetlands within the Convention). However, the boundary also extends selectively over State-controlled lands or similar above the high water mark in some locations including most notably, the Bay islands.

In addition, the site excludes major rivers such as the Brisbane and the Logan and in many cases does not extend up the smaller adjoining estuaries and creeks to their full tidal extent.

Specific observations about the site boundaries (moving from North to South) are as follows:

- The site includes the waters and tributaries of Pumicestone Passage;
- The site only includes selected intertidal and subtidal areas of the Western Bay;
- The site includes the Southern Bay and sandy channels of the Broadwater region;

[2] Minor modifications to the site boundary have been made as part of the current study and are documented as part of a separate mapping report (refer BMT WBM 2008d).

- The site excludes deeper marine areas and sand banks within the Central and Northern Bay;
- The site includes the ocean beach habitats of all the main sand islands and adjacent marine areas to a distance of approximately 50 m;
- The site includes all of Moreton Island, but has limited coverage on North and South Stradbroke Islands, Bribie Island and the Southern Bay Islands.

The discontinuous nature of the site is significant as most important wetland species identified in the nomination criteria for the site (refer RIS 1999 and outlined in this ECD in later sections), such as migratory shorebirds, turtles and dugong are highly mobile both within the site and across much larger habitat ranges.

Thus, while the approach within the ECD has been to identify those species and habitats that are most salient to the areas contained within the boundaries of the site (eg. core habitat), it is accepted that many of these species will only use the areas within the site from time to time. Likewise, threats and controls on these species and habitats may also be occurring outside the boundaries of the site, and as such, maintenance of ecological character can be highly reliant on other conservation and management regimes.

Figures 3-2 to 3-5 provide a 'snapshot' of the wetland habitat types, noteworthy flora and fauna that occur in the broader Moreton Bay region, water quality, coastal resource and marine park zoning, water resource planning and other planning information about the areas within the Ramsar site boundaries that will be described in the sections below. Given the size and diversity of wetland environments present in the Ramsar site, the site has been delineated into four areas for reporting purposes:

- Area 1 – Bribie Island and Pumicestone Passage
- Area 2 – Western Bay
- Area 3 – Moreton Island and Eastern Banks
- Area 4 – Stradbroke Islands and Southern Bay.

For all snap-shot descriptions note that:

- The term RE refers to regional ecosystems. Regional ecosystems are defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
- Water quality condition codes are taken from Environmental Health Monitoring Program (EHMP). Refer to Section 3.2.3.4 for background to these codes.


Title:
**Moreton Bay Locality Map**

Figure: **3-1**

Rev: **A**



N

0 10 20km

Approx. Scale

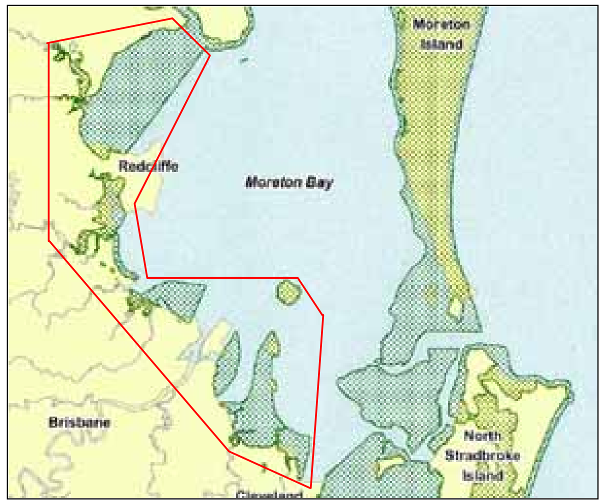
BMT WBM

www.wbmpl.com.au

Filepath : I:\B17004_I_BRH Moreton Bay Ramsar Site GWF\DRG\ECO_011_080530_Locality_Map.wor

## AREA 2: WESTERN BAY

### Location




### Protected / Conservation Areas

Endangered Wetland REs

-

Of concern Wetland REs

12.1.1 - *Casuarina glauca* open forest on margins of marine clay plains

12.3.11 – Eucalypt open forest on alluvial plains

Areas of Significance (Source: EPA Coastal Plan)

Significant coastal dunes (<1% area covered)

Declared Fish Habitat Area (~10% area covered)

Area of special interest for whales and dolphins

Seagrass (~20% area covered)

Critical shorebird habitat (<5% area covered)

Shorebird habitat (~35% area covered)

Wetlands (significant and coastal) (~90% area covered)

National Parks and Conservation Parks:

St Helena NP

Beachmere CP

King Island CP

Marine Parks (Source: Draft Marine Parks (Moreton Bay) Zoning Plan 2008)

Marine National Park Zone (~30% area covered)

Conservation Park Zone (~20% area covered)

Habitat Protection Zone (~40% area covered)

General Use Zone (~10% area covered)

### Ramsar Nomination Criteria

1 2 ⊾ 3 ⊾ 4 ⊾ 5 (⊾) 6 (⊾) 7 (⊾) 8 (⊾) 9

⊾ indicates within project area; (⊾) indicates within entire Ramsar site

### Ramsar Wetland types

Estuarine, based on RE
Estuarine, based on water body
Lacustrine, based on RE
Lacustrine, based on water body
Marine, based on water body
Palustrine, based on RE
Palustrine, based on water body
Riverine, based on RE
Riverine, based on water body

Source: EPA Wetland Mapping

| | Marine / Coastal Wetlands | Regional example |
|---|---|---|
| | A – Permanent shallow marine waters (<6m) | |
| ⊾ | B – Marine subtidal aquatic beds (kelp, seagrass) | |
| ⊾ | C – Coral reefs | |
| | D – Rocky marine shores, sea cliffs | |
| ⊾ | E – Sand, shingle or pebble shores; sandbars; dunes | |
| ⊾ | F – Estuarine waters | |
| ⊾ | G – Intertidal mud, sand or salt flats | |
| ⊾ | H – Intertidal marshes, including saltmarshes | RE12.1.2 |
| ⊾ | I – Intertidal forested wetlands, including mangroves | REs 12.1.3, 12.1.1 |
| | J – Coastal brackish / saline lagoons | |
| | K – Coastal freshwater lagoons | |
| | **Inland Wetlands** | |
| ⊾ | M – Permanent rivers / streams / creeks | |
| ⊾ | N – Seasonal / intermittent rivers / streams / creeks | |
| | O – Permanent freshwater lakes | |
| ⊾ | Tp – Permanent freshwater marshes / pools | RE 12.2.15 |
| ⊾ | Ts – Seasonal / intermittent freshwater marshes / pools | RE 12.2.15 |
| | U – Non-forested peatlands | |
| | W – Shrub-dominated wetlands; shrub swamps | |
| ⊾ | Xf – Freshwater, tree-dominated wetlands and swamps | REs 12.3.5, 12.3.6 |
| | Xp – Forested peatlands; peatswamp forests | |
| | Y – Freshwater Springs | |
| | **Man-made Wetlands** | |
| ⊾ | 9 - Canals, drainage channels and ditches | Dowse Lagoon |

Note: Based on EPA wetland codes; Only wetland types present within Moreton Bay are listed here

### Noteworthy Flora and Fauna likely to occur (Status NCA, EPBC respectively)

Terrestrial flora: *Acacia attenuata* (V,V), Hairy-joint Grass (V,V), Marbled Balogia (V,V), Heart-leaved Bosistoa (V,V), Three-leaved Bosistoa (V,V), Leafless Tongue-orchid (V,V), Macadamia Nut (V,V), Small-fruited Queensland Nut (V,V), Lesser Swamp-orchid (E,E), Minute Orchid (V,V), *Acacia baueri* subsp. *baueri* (V,-), Toadflax (V,V), *Corchorus cunninghamii* (E,E), *Cupaniopsis shirleyana* (V,V), *Gossia gonoclada* (E,E)

Aquatic flora: Frogbit (V), *Maundia triglochinoides* (V,-)

Birds: Coxen's Fig Parrot (E,E), Ground Parrot (V,-), Paradise Parrot (PE,EX), Swift parrot (E,E), Glossy Black Cockatoo (V,-), Squatter pigeon (V,V), Powerful Owl (V,-), Red Goshawk (E,V), Southern Giant-petrel (E,E), Northern Giant Petrel (V,V), Kermadec Petrel (-,V), Australian Painted Snipe (-,V), Campbell Albatross (-,V), Black-breasted Button Quail (V,V), Regent Honeyeater (E,E), Little Tern (E,-), Beach Stone-curlew (V,-), Red-tailed Tropic Bird (V,-),

Amphibians: Wallum Sedgefrog (V,V), Southern Barred Frog (E,E), Wallum Rocketfrog (V,-), Wallum Froglet (V,-), Tusked Frog (V,-)

Mammals (terrestrial): Large-eared Pied Bat (-,V), Grey-headed Flying Fox (-,V), Long-nosed Potoroo (-,V), Water Mouse (V,V), Koala (V,-), Spotted-tailed Quoll (V,E)

Reptiles: Loggerhead Turtle (E,E), Green Turtle (V,V), Three-toed Snake-tooth Skink (R,V), Leatherback Turtle (E,V), Pacific Ridley (E,V)

Insects: Illidge's Ant Blue (V,-), Australian Fritillary (E,-), Richmond Birdwing (V,-)

Mammals (aquatic): Southern Right Whale (R,E), Humpback Whale (R,V), Dugong (V,-)

Sharks: Grey Nurse Shark (E,CE), Great White Shark (-,V), Green Sawfish (-,V), Whale Shark (-,V)

Fish: Oxleyan Pygmy Perch (V,E)

Source: Wildlife online & EPBC online searches. Note that these searches indicate species that are likely – not necessarily known - to occur within the area. Critical wetland species known within the project area have been identified in the report.

### Water Quality

| Unit | Area | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| Freshwater | Caboolture Catchment | C+ | B- | B- | C- |
| | Pine Catchment | D+ | C | C | D |
| | Lower Brisbane Catchment | F | F | D- | F |
| | Redlands Catchment | F | F | F | D |
| Estuarine | Caboolture Estuary | D | D | D+ | C- |
| | Pine Estuary | C- | D | D | D+ |
| | Brisbane Estuary | D+ | D- | D- | D- |
| | Cabbage Tree Estuary | F | F | D- | D- |
| | Tingalpa Estuary | D+ | D | D | D- |
| | Epraprah Estuary | D | D | C- | NG |
| Marine | Deception Bay | D | C- | D+ | C+ |
| | Bramble Bay | D+ | D+ | D+ | D |
| | Waterloo Bay | B+ | B- | B- | B |

Source: Ecosystem Health Monitoring Program (Healthy Waterways)

### Water Resource Outcomes (Source: Water Resource (Moreton) Plan 2007)

Estuarine reaches: Minimise changes to brackish habitats

Moreton Bay and Pumicestone Channel: Minimise changes to the natural movement and delivery of sediment, and the delivery of freshwater, natural nutrients and organic matter

Boondall Wetlands: Provide freshwater flows to maintain long-term inflow patterns and ecological functions

**Figure 3-3 Snapshot of Western Bay**

## AREA 3: MORETON ISLAND AND EASTERN BANKS

### Location


### Protected / Conservation Areas

Endangered Wetland REs

-

Of concern Wetland REs

12.3.8 – Swamps with *Cyperus* spp., *Schoenoplectus* spp.

Areas of Significance (Source: EPA Coastal Plan)

Significant coastal dunes (100% area covered)

Declared Fish Habitat Area (~80% area covered)

Area of special interest for whales and dolphins

Seagrass (~80% area covered)

Critical shorebird habitat (<5% area covered)

Shorebird habitat (~65% area covered)

Wetlands (significant and coastal) (~40% area covered)

National Parks and Conservation Parks:

Moreton Island NP

Marine Parks (Source: Draft Marine Parks (Moreton Bay) Zoning Plan 2008)

Marine National Park Zone (~45% area covered)

Conservation Park Zone (~15% area covered)

Habitat Protection Zone (~40% area covered)

### Ramsar Nomination Criteria

1✓ 2✓ 3✓ 4✓ 5 (✓) 6 (✓) 7 (✓) 8 (✓) 9

✓ indicates within project area; (✓) indicates within entire Ramsar site

### Ramsar Wetland types


Estuarine, based on RE
Estuarine, based on water body
Lacustrine, based on RE
Lacustrine, based on water body
Marine, based on water body
Palustrine, based on RE
Palustrine, based on water body
Riverine, based on RE
Riverine, based on water body

Source: EPA Wetland Mapping

| | Marine / Coastal Wetlands | Regional example |
|---|---|---|
| ✓ | A – Permanent shallow marine waters (<6m) | |
| ✓ | B – Marine subtidal aquatic beds (kelp, seagrass) | |
| ✓ | C – Coral reefs | |
| ✓ | D – Rocky marine shores, sea cliffs | Cape Moreton |
| ✓ | E – Sand, shingle or pebble shores; sandbars; dunes | |
| ✓ | F – Estuarine waters | |
| ✓ | G – Intertidal mud, sand or salt flats | |
| ✓ | H – Intertidal marshes, including saltmarshes | RE12.1.2 |
| ✓ | I – Intertidal forested wetlands, including mangroves | REs 12.1.3, 12.1.1 |
| | J – Coastal brackish / saline lagoons | |
| ✓ | K – Coastal freshwater lagoons | |
| | **Inland Wetlands** | |
| ✓ | M – Permanent rivers / streams / creeks | Spitfire Creek |
| ✓ | N – Seasonal / intermittent rivers / streams / creeks | |
| ✓ | O – Permanent freshwater lakes | Lake Jabiru |
| ✓ | Tp – Permanent freshwater marshes / pools | RE 12.2.15 |
| ✓ | Ts – Seasonal / intermittent freshwater marshes / pools | RE 12.2.15 |
| | U – Non-forested peatlands | |
| | W – Shrub-dominated wetlands; shrub swamps | |
| ✓ | Xf – Freshwater, tree-dominated wetlands and swamps | RE 12.2.5 |
| | Xp – Forested peatlands; peatswamp forests | |
| | Y – Freshwater springs | |
| | **Man-made Wetlands** | |
| | 9 - Canals, drainage channels and ditches | |

Note: Based on EPA wetland codes; Only wetland types present within Moreton Bay are listed here

### Noteworthy Flora and Fauna likely to occur (Status NCA, EPBC respectively)

Terrestrial flora: Marbled Baloghia (V,V), Lesser Swamp-orchid (E,E), Minute Orchid (V,V), *Acacia baueri* subsp. *baueri* (V,-), Swamp Orchid (E,E), Ball Nut (V,V)

Aquatic flora: N/A

Birds: Swift Parrot (E,E), Glossy Black Cockatoo (V,-), Tristan Albatross (-,E), Campbell Albatross (-,V), Southern Giant-petrel (E,E), Northern Giant Petrel (-,V), Kermadec Petrel (-,V), Australian Painted Snipe (-,V), Black-breasted Button Quail (V,V), Regent Honeyeater (E,E), Little Tern (E,-), Beach Stone-curlew (V,-), Red-tailed Tropic Bird (V,-)

Amphibians: Wallum Sedgefrog (V,V), Wallum Rocketfrog (V,-), Wallum Froglet (V,-)

Mammals (terrestrial): Long-nosed Potoroo (-,V), Grey-headed Flying Fox (-,V), Water Mouse (V,V)

Reptiles: Loggerhead Turtle (E,E), Green Turtle (V,V), Leatherback Turtle (E,V), Pacific Ridley (E,V), Three-toed Snake-tooth Skink (R,V),

Insects: Illidge's Ant Blue (V,-)

Mammals (aquatic): Blue Whale (R,E), Southern Right Whale (R,E), Humpback Whale (V,V), Dugong (V,-)

Sharks: Grey Nurse Shark (E,CE), Great White Shark (-,V), Green Sawfish (-,V), Whale Shark (-,V)

Fish: Oxleyan Pygmy Perch (V,E)

Source: Wildlife online & EPBC online searches. Note that these searches indicate species that are likely – not necessarily known - to occur within the area. Critical wetland species known within the project area have been identified in the report.

### Water Quality

| Unit | Area | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| Freshwater | - | - | - | - | - |
| Estuarine | - | - | - | - | - |
| Marine | Eastern Bay | A- | A | A | A |
| | Eastern Banks | A | A | A | A |

Source: Ecosystem Health Monitoring Program (Healthy Waterways)

### Water Resource Outcomes

Moreton Bay and Pumicestone Channel: Minimise changes to the natural movement and delivery of sediment, and the delivery of freshwater, natural nutrients and organic matter

(Source: Water Resource (Moreton) Plan 2007)

**Figure 3-4 Snapshot of Moreton Island and Eastern Banks**

## AREA 4: STRADBROKE ISLANDS AND SOUTHERN BAY

### Location


### Protected / Conservation Areas

Endangered Wetland REs

-

Of concern Wetland REs

12.1.1 - *Casuarina glauca* open forest on margins of marine clay plains

12.3.11 – Eucalypt open forest on alluvial plains

Areas of Significance (Source: EPA Coastal Plan)

Significant coastal dunes (~60% area covered)

Declared Fish Habitat Area (~25% area covered)

Area of special interest for whales and dolphins

Seagrass (~10% area covered)

Critical shorebird habitat (<1% area covered)

Shorebird habitat (~70% area covered)

Wetlands (significant and coastal) (~65% area covered)

National Parks and Conservation Parks:

Blue Lake NP

Bird Island CP, Cobby Cobby Island CP, Coomera Island CP, Goat Island CP, Kangaroo Island CP, Myora CP, S. Stradbroke Island CP, South Stradbroke Island CP2, Woogoompah Island CP

Marine Parks (Source: Draft Marine Parks (Moreton Bay) Zoning Plan 2008)

Marine National Park Zone (~25% area covered)

Conservation Park Zone (~20% area covered)

Habitat Protection Zone (~55% area covered)

### Ramsar Nomination Criteria

1⊾ 2⊾ 3⊾ 4⊾ 5(⊾) 6(⊾) 7(⊾) 8(⊾) 9

⊾ indicates within project area; (⊾) indicates within entire Ramsar site

### Ramsar Wetland types

Estuarine, based on RE

Estuarine, based on water body

Lacustrine, based on RE

Lacustrine, based on water body

Marine, based on water body

Palustrine, based on RE

Palustrine, based on water body

Riverine, based on RE

Riverine, based on water body

Source: EPA Wetland Mapping

| | Marine / Coastal Wetlands | Regional example |
|---|---|---|
| ⊾ | A – Permanent shallow marine waters (<6m) | |
| ⊾ | B – Marine subtidal aquatic beds (kelp, seagrass) | |
| ⊾ | C – Coral reefs | Peel Island |
| ⊾ | D – Rocky marine shores, sea cliffs | Point Lookout |
| ⊾ | E – Sand, shingle or pebble shores; sandbars; dunes | |
| ⊾ | F – Estuarine waters | Nerang Estuary |
| ⊾ | G – Intertidal mud, sand or salt flats | |
| ⊾ | H – Intertidal marshes, including saltmarshes | RE 12.1.2 |
| ⊾ | I – Intertidal forested wetlands, including mangroves | REs 12.1.3, 12.1.1 |
| ⊾ | J – Coastal brackish / saline lagoons | Lake Coombabah |
| ⊾ | K – Coastal freshwater lagoons | |
| | **Inland Wetlands** | |
| ⊾ | M – Permanent rivers / streams / creeks | Little Canalpin Creek |
| ⊾ | N – Seasonal / intermittent rivers / streams / creeks | |
| ⊾ | O – Permanent freshwater lakes | Brown Lake |
| ⊾ | Tp – Permanent freshwater marshes / pools | RE 12.2.15 |
| ⊾ | Ts – Seasonal / intermittent freshwater marshes / pools | RE 12.2.15 |
| ⊾ | U – Non-forested peatlands | 18 Mile Swamp |
| ⊾ | W – Shrub-dominated wetlands; shrub swamps | RE 12.2.12 |
| ⊾ | Xf – Freshwater, tree-dominated wetlands and swamps | REs 12.2.5, 12.2.7, 12.3.5 |
| ⊾ | Xp – Forested peatlands; peatswamp forests | 18 Mile Swamp |
| ⊾ | Y – Freshwater springs | Myora Springs |
| | **Man-made Wetlands** | |
| ⊾ | 9 - Canals, drainage channels and ditches | Couran Cove |

Note: Based on EPA wetland codes; Only wetland types present within Moreton Bay are listed here

### Noteworthy Flora and Fauna likely to occur (Status NCA, EPBC respectively)

Terrestrial flora: *Acacia attenuata* (V,V), Marbled Baloghia (V,V), Heart-leaved Bosistoa (V,V), Three-leaved Bosistoa (V,V), Native Jute (E,E), Stinking Cryptocaria (V,V), Leafless Tongue-orchid (V,V), Macadamia Nut (V,V), Small-fruited Queensland Nut (V,V), Swamp Daisy (E,E), Swamp Orchid (E,E), Lesser Swamp Orchid (E,E), Yellow Swamp Orchid (E,E), Minute Orchid (V,V), *Thelypteris confluens* (V,-), *Acacia baueri* subsp. *baueri* (V,-), Toadflax (V,V), Shiny-leaved Coondoo (E,E)

Aquatic flora: Frogbit (-,V), *Persicaria elatior* (V,E)

Birds: Coxen's Fig Parrot (E,E), Swift parrot (E,E), Glossy Black Cockatoo (V,-), Glossy Black Cockatoo eastern (V,-), Powerful Owl (V,-), Red Goshawk (E,V), Tristan Albatross (-,E), Campbell Albatross (-,V), Southern Giant-petrel (E,E), Northern Giant Petrel (V,V), Black-throated Finch (V,E), Kermadec Petrel (-,V), Australian Painted Snipe (-,V), Black-breasted Button Quail (V,V), Regent Honeyeater (E,E), Beach Stone-curlew (V,-), Little Tern (E,-), Red-tailed Tropic Bird (V,-),

Amphibians: Wallum Sedgefrog (V,V), Southern Barred Frog (E,E), Wallum Rocketfrog (V,-), Wallum Froglet (V,-), Tusked Frog (V,-)

Mammals (terrestrial): Large-eared Pied Bat (-,V), Spotted-tail Quoll (V,E), Brush-tailed Rock Wallaby (-,V), Long-nosed Potoroo (-,V), Grey-headed Flying Fox (-,V), Water Mouse (V,V), Koala (V,-)

Reptiles: Loggerhead Turtle (E,E), Green Turtle (V,V), Leatherback Turtle (E,V), Flatback Turtle (V,V), Hawksbill Turtle (V,V), Pacific Ridley (E,V), Three-toed Snake-tooth Skink (R,V), *Ophioscincus truncatus* (R,-)

Insects: Illidge's Ant Blue (V,-), Richmond Birdwing (V,-)

Mammals (aquatic): Blue Whale (-,E), Southern Right Whale (-,E), Humpback Whale (V,V), Dugong (V,-)

Sharks: Grey Nurse Shark (E,CE), Great White Shark (-,V), Green Sawfish (-,V), Whale Shark (-,V)

Fish: Oxleyan Pygmy Perch (V,E)

Source: Wildlife online & EPBC online searches. Note that these searches indicate species that are likely – not necessarily known - to occur within the area. Critical wetland species known within the project area have been identified in the report.

### Water Quality

| Unit | Area | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| Freshwater | Logan Catchment | D | D+ | D | C |
| | Pimpama/Coomera Catchment | B- | C+ | B+ | C |
| | Nerang Catchment | A- | C+ | B+ | A- |
| Estuarine | Logan Estuary | D- | F | D- | D |
| | Pimpama Estuary | C+ | C | C | C |
| | Coomera Estuary | B | A- | B+ | B |
| | Nerang Estuary | B | B | B | B |
| Marine | Southern Bay | B- | D | D+ | C |
| | Broadwater | B+ | B- | C- | C- |

Source: Ecosystem Health Monitoring Program (Healthy Waterways)

### Water Resource Outcomes

Estuarine reaches: Minimise changes to brackish habitats

Moreton Bay and Pumicestone Channel: Minimise changes to the natural movement and delivery of sediment, and the delivery of freshwater, natural nutrients and organic matter

(Source: Water Resource (Moreton) Plan 2007; Water Resource (Gold Coast) Plan 2006)

**Figure 3-5 Snapshot of Stradbroke Islands and Southern Bay**

### 3.2.2 Overview of Wetland Types

In seeking to characterise the types of wetlands within the boundaries of the Moreton Bay Ramsar site, it is important to recognise that the site has a high level of habitat diversity, ranging from perched freshwater lakes and sedge swamps, to intertidal mudflats and mangroves to sub-tidal seagrass habitats. For this report, the Ramsar Classification System for Wetland Types (approved by Recommendation 4.7 and amended by Resolutions VI.5 and VII.11 of the Conference of the Contracting Parties) is used.

As shown in the area 'snapshots' above, detailed mapping of wetlands within the region has been undertaken by the Queensland EPA as part of a State-wide mapping programme under the Queensland Wetlands Programme. The EPA mapping method uses a combination of Queensland Regional Ecosystem (RE) vegetation mapping and water body mapping (interpreted from satellite imagery) to classify wetlands into broad categories of marine, estuarine, riverine, lacustrine and palustrine types. Although there are broad overlaps between the EPA classification and the Ramsar classification systems (lacustrine ~ lake, palustrine ~ marshes/pools, riverine ~ river channel), these systems have limited analogies due to the finer-scale of wetland categorization under the Ramsar typology which provides up to 12 marine/coastal wetland types, up to 20 inland wetland types and up to 10 human-made wetland types.

To assist in this regard, the EPA has developed and made available for the study a draft cross-referencing table that assigns particular RE types with Ramsar habitat classification types. Using this table and the EPA mapping supplied, the presence of Ramsar wetland types within the Moreton Bay Ramsar site has been refined and the following habitat types are seen as being represented:

- 11 marine/coastal wetland types;
- 10 inland wetland types; and
- 1 man-made wetland type

Further description and examples of these types is contained in the sections below.

### 3.2.2.1 *Marine/Coastal Wetland Types (11)*

Photos of estuarine and marine wetland environments in the Moreton Bay region (Source: EPA and BMT WBM photo library)

Type A: Permanent shallow marine waters

This wetland type incorporates marine waters that are less than six metres deep at low tide, including sea bays and straits. Within the Moreton Bay Ramsar site, shallow marine waters are located along the length of the offshore islands on the seaward boundary.

Type B: Marine subtidal aquatic beds

This wetland type is represented within the Moreton Bay Ramsar site by seagrasses that form meadows in quiet, clear, shallow waters. These seagrass beds provide food and habitat for turtles, dugong, and commercially and recreationally important fish and invertebrate populations in Moreton Bay. Within the Ramsar site, seagrass beds cover an area of 24,078 hectares and are predominantly located in Pumicestone Passage, the Eastern Banks and Southern Moreton Bay.

Type C: Coral reefs

Moreton Bay is close to the southern limit of reef-building corals. Within the Ramsar site, coral reef communities occur around Peel, St Helena, Mud and Green Islands, and from Wellington Point to Raby Bay. The presence of coral communities are limited in the Western Bay (around Mud and St Helena Island) as a result of historical coral limestone extraction which has since ceased. In total, 1,152 hectares of coral reef are present within the Ramsar site. Of particular importance is the area on the northern side of Peel Island and Myora reef in the Eastern Bay.

Type D: Rocky marine shores

This wetland type is characterised by exposed rocky marine shores, including rocky offshore islands and sea cliffs. Rocky shores provide habitats for a wide range of algae, marine invertebrates and fish species. Approximately 200 hectares of rocky shores are present within the Ramsar site, with representative examples including the rocky headlands of Point Lookout on North Stradbroke Island and Cape Moreton on Moreton Island, as well as rocky shores inside the bay such as Toorbul Point at the entrance to Pumicestone Passage.

Type E: Sand, shingle or pebble shores

This wetland type includes sand bars, spits and sandy islets, as well as dune systems and humid dune slacks. Within the Moreton Bay Ramsar site, approximately 3,000 hectares of sandy shores are present, typically located along the eastern shorelines of the Bay Islands.

Type F: Estuarine waters

This wetland type includes permanent water of estuaries and estuarine systems of deltas. Due to the protection provided by the large offshore islands, estuarine waters are widespread within the Moreton Bay Ramsar site from Pumicestone Passage to the Southern Bay.

Type G: Intertidal mud, sand or salt flats

This wetland type encompasses habitats comprised of alluvial deposits of sand and mud that accumulate on intertidal flats. Many invertebrate species inhabit these intertidal flats, and at low tides they are an important feeding ground for waders. Intertidal flats are widespread within the Moreton Bay Ramsar site, covering an area in excess of 5,000 hectares. Specific locations including Pumicestone Passage, the Western Bay, the Southern Bay and the landward shores of North Stradbroke Island.

Type H: Intertidal marshes

This wetland type is represented in the Ramsar site by saltpan vegetation on marine clay plains, as well as saline or brackish sedgelands. There is approximately 2,522 hectares of saltmarsh / saltpan complexes within the Moreton Bay region (Duke *et al*. 2003), of which approximately 85% is contained within the Ramsar site. Characteristic vegetation communities are *Sporobolus virginicus* grasslands, and samphire herblands dominated by *Sarcocornia* species and *Suaeda australis*. Saltmarsh typically occurs in the upper-intertidal zone as a band along the landward edge of the mangrove zone. Protected intertidal marshes within Moreton Bay include Bribie Island National Park, Coombabah Lake Conservation Park and Southern Moreton Bay Island National Park.

Type I: Intertidal forested wetlands

This wetland type is represented in the Ramsar site by mangrove shrublands to low closed forest on marine clay plains and estuaries, as well as tidal freshwater swamp forests such as those primarily composed of *Casuarina glauca*. Mangrove forests occupy an area of approximately 15,300 hectares in Moreton Bay (Duke and Pederson 2003), of which approximately 85% is contained within the Ramsar site. Mangroves are important roosting and sheltering sites for a variety of shorebirds, and provide nursery grounds for fish and a diversity of invertebrate fauna. Protected intertidal forested wetlands within the Ramsar site include Bribie Island National Park, Buckleys Hole Conservation Park, Coombabah Lake Conservation Park, Moreton Island National Park and Southern Moreton Bay Islands National Park.

Type J: Coastal brackish/saline lagoons

This wetland type consists of brackish to saline lagoons with at least one relatively narrow connection to the ocean. It is represented within the Moreton Bay Ramsar site by Lake Coombabah, covering 222 hectares.

Type K: Coastal freshwater lagoons

This wetland type includes freshwater lagoons. Although not listed in the current RIS, this wetland type is represented within the Moreton Bay Ramsar site by various freshwater lagoons on the Bay islands such as Ibis Lagoon and Black Snake Lagoon on North Stradbroke Island.

#### *3.2.2.2 Inland Wetland Types (10)*

Photos of freshwater and transitional wetland environments in the Moreton Bay region (Source: BMT WBM photo library)

Type L: Permanent inland deltas

While listed in the current RIS (1999), this wetland type is not considered to be present in the Ramsar site.

Type M: Permanent rivers / streams / creeks

This wetland type incorporates permanent rivers, streams and creeks. Within the Moreton Bay Ramsar site, freshwater creeks include Spitfire Creek on Moreton Island and Little Canalpin Creek on North Stradbroke Island.

Type N: Seasonal rivers / streams / creeks

This wetland type incorporates seasonal rivers, streams and creeks. This wetland type was not included in the current RIS, but is believed to be represented within Moreton Bay in the context of ephemeral freshwater and semi-tidal creeks and streams in the Pumicestone Passage area.

Type O: Permanent freshwater lakes

Permanent freshwater bodies over 8 hectares in area are included in this wetland type. Representative examples within the Moreton Bay Ramsar site include Blue Lake on North Stradbroke Island, and Lake Jabiru on Moreton Island.

Type Q: Permanent saline / brackish / alkaline lakes

While listed in the current RIS (1999), this wetland type is not considered to be present in the Ramsar site.

Type Tp: Permanent freshwater marshes / pools

This wetland type includes ponds < 8 hectares in area, as well as marshes and swamps on inorganic soils with emergent vegetation that is waterlogged for at least most of the growing season. Vegetation communities in this category include palustrine wetlands such as freshwater swamps with *Cyperus*, *Schoenoplectus* and *Eleocharis* species, or coastal sedgelands with *Baumea* and *Juncus* species. Within the Moreton Bay Ramsar site, protected areas of this wetland type include Moreton Island National Park, Blue Lake National Park and Bribie Island National Park.

Type Ts: Seasonal / intermittent freshwater marshes / pools on inorganic soils

This wetland type includes sloughs, potholes and seasonally flooded meadows. Vegetation communities associated with this wetland type are typically sedge marshes, comparable in species composition to vegetation communities of the permanent freshwater marshes / pools (Type Tp). Protected areas of this wetland type include Blue Lake National Park and Bribie Island National Park.

Type U: Non-forested peatlands

This wetland type includes shrub or open bogs, and swamps. Although not currently included in the current RIS, this wetland type is represented within the Ramsar site by Eighteen Mile Swamp on North Stradbroke Island, one of the largest of its type in Queensland.

Type W: Shrub-dominated wetlands

This wetland type includes shrub swamps and shrub-dominated freshwater marshes. It is represented within the Moreton Bay Ramsar site by seasonally waterlogged closed heathland that covers a total area of 130 hectares. Flora composing these palustrine wetlands characteristically includes *Banksia*, *Epacris* and *Leptospermum* species. Protected shrub-dominated wetlands within the Ramsar site are located in Bribie Island National Park.

Type Xf: Freshwater tree-dominated wetlands

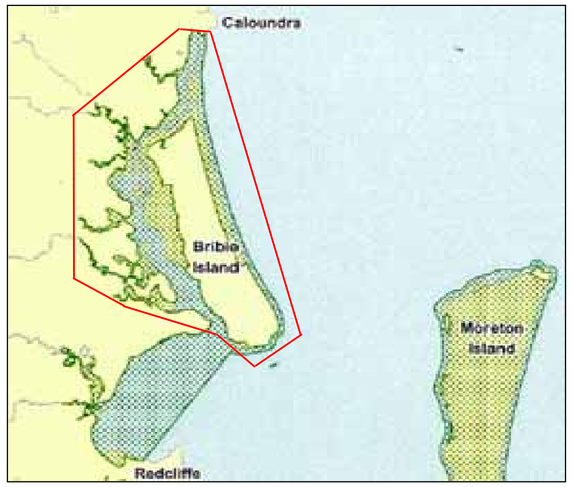
This wetland type includes freshwater swamp forests, seasonally flooded forests and wooded swamps on inorganic soils. It is represented in Moreton Bay by palustrine open forests dominated by *Melaleuca quinquenervia*, covering a total area of 8,596 hectares within the Ramsar site. The understorey varies in composition depending on the duration of water logging, and may include ferns, grasses, sedges and/or shrubs. Protected areas of freshwater tree-dominated wetlands include Bribie Island National Park, Coombabah Lake Conservation Park, Southern Moreton Bay Islands National Park, Buckley's Hole Conservation Park, Blue Lake National Park and Moreton Island National Park.

Type Xp: Forested peatlands

This wetland type incorporates peat swamp forests. Forested peatlands are present within Eighteen Mile Swamp on North Stradbroke Island. As outlined in the Ramsar Guidelines for Global Action on Peatlands (GAP), peatlands are increasingly being recognised as an important wetland resource at the global level through their role in contributing to global biodiversity, as an important carbon sink and through the retention of paleo-environmental information about previous landscapes and climate states.

## AREA 1: BRIBIE ISLAND AND PUMICESTONE PASSAGE

### Location




### Protected / Conservation Areas

Endangered Wetland REs

12.3.1 – Riverine notophyll vine forest on alluvial plains

Of concern Wetland REs

12.1.1 - *Casuarina glauca* open forest on margins of marine clay plains

12.3.4 - *Melaleuca quinquenervia, Eucalyptus robusta* open forest; on or near coastal alluvial plains

12.3.11 – Eucalypt open forest on alluvial plains

Areas of Significance (Source: EPA Coastal Plan)

Significant coastal dunes (~30% area covered)

Declared Fish Habitat Area (~65% area covered)

Area of special interest for whales and dolphins

Seagrass (~15% area covered)

Critical shorebird habitat (~1% area covered)

Shorebird habitat (~40% area covered)

Wetlands (significant and coastal) (~95% area covered)

National Parks and Conservation Parks:

Bribie Island NP

Buckley's Hole CP

Marine Parks (Source: Draft Marine Parks (Moreton Bay) Zoning Plan 2008)

Marine National Park Zone (~10% area covered)

Conservation Park Zone (~55% area covered)

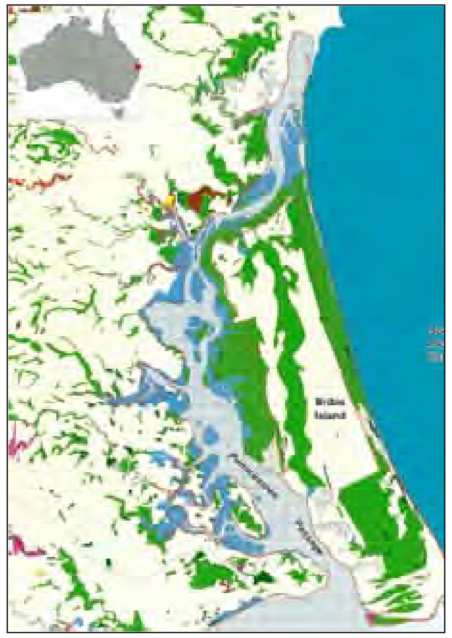
Habitat Protection Zone (~35% area covered)

### Ramsar Nomination Criteria

1✓ 2✓ 3✓ 4✓ 5 (✓) 6 (✓) 7 (✓) 8 (✓) 9

✓ indicates within project area; (✓) indicates within entire Ramsar site

### Ramsar Wetland types



Estuarine, based on RE
Estuarine, based on water body
Lacustrine, based on RE
Lacustrine, based on water body
Marine, based on water body
Palustrine, based on RE
Palustrine, based on water body
Riverine, based on RE
Riverine, based on water body

Source: EPA Wetland Mapping

| | Marine / Coastal Wetlands | Regional example |
|---|---|---|
| ✓ | A – Permanent shallow marine waters (<6m) | |
| ✓ | B – Marine subtidal aquatic beds (kelp, seagrass) | |
| | C – Coral reefs | |
| ✓ | D – Rocky marine shores, sea cliffs | Toorbul Point |
| ✓ | E – Sand, shingle or pebble shores; sandbars; dunes | |
| ✓ | F – Estuarine waters | |
| ✓ | G – Intertidal mud, sand or salt flats | |
| ✓ | H – Intertidal marshes, including saltmarshes | RE 12.1.2 |
| ✓ | I – Intertidal forested wetlands, including mangroves | REs 12.1.3, 12.1.1 |
| | J – Coastal brackish / saline lagoons | |
| ✓ | K – Coastal freshwater lagoons | |
| | **Inland Wetlands** | |
| ✓ | M – Permanent rivers / streams / creeks | |
| ✓ | N – Seasonal / intermittent rivers / streams / creeks | |
| | O – Permanent freshwater lakes | |
| ✓ | Tp – Permanent freshwater marshes / pools | RE 12.2.15 |
| ✓ | Ts – Seasonal / intermittent freshwater marshes / pools | RE 12.2.15 |
| | U – Non-forested peatlands | |
| ✓ | W – Shrub-dominated wetlands; shrub swamps | RE 12.2.12 |
| ✓ | Xf – Freshwater, tree-dominated wetlands and swamps | REs 12.2.7, 12.3.4, 12.3.5, 12.3.6 |
| | Xp – Forested peatlands; peatswamp forests | |
| | Y – Freshwater Springs | |
| | **Man-made Wetlands** | |
| ✓ | 9 - Canals, drainage channels and ditches | Skipper Canal |

Note: Based on EPA wetland codes; Only wetland types present within Moreton Bay are listed here

### Noteworthy Flora and Fauna likely to occur (Status NCA, EPBC respectively)

Terrestrial flora: *Acacia attenuata* (V,V), Heart-leaved Bosistoa (V,V), Three-leaved Bosistoa (V,V), Miniature Moss-orchid (V,V), Swamp Stringybark (E,E), Small-fruited Queensland Nut (V,V), Lesser Swamp-orchid (E,E), Yellow Swamp Orchid (E,E), *Prasophyllum wallum* (V,V), Minute Orchid (V,V), *Acacia baueri* subsp. *baueri* (V,-), Stinking Cryptocarya (V,V), *Macrozamia pauli-guilielmi* (E,E)

Aquatic flora: *Maundia triglochinoides* (V,-),

Birds: Coxen's Fig Parrot (E,E), Paradise Parrot (PE,EX), Swift parrot (E,E), Glossy Black Cockatoo (V,-), Squatter pigeon (V,V), Powerful Owl (V,-), Plumed Frogmouth (V,-), Red Goshawk (E,V), Southern Giant Petrel (E,E), Northern Giant Petrel (V,V), Kermadec Petrel (-,V), Australian Painted Snipe (-,V), Campbell Albatross (-,V), Beach Stone-curlew (V,-), Little Tern (E,-), Southern Emu-wren (V,-), Black-breasted Button Quail (V,V), Regent Honeyeater (E,E)

Amphibians: Wallum Sedgefrog (V,V), Southern Barred Frog (E,E), Wallum Rocketfrog (V,-), Wallum Froglet (V,-), Tusked Frog (V,-)

Mammals (terrestrial): Large-eared Pied Bat (-,V), Eastern Long-eared Bat (V,V), Grey-headed Flying Fox (-,V), Long-nosed Potoroo (-,V), Water Mouse (V,V), Spotted-tailed Quoll (V,E)

Reptiles: Loggerhead Turtle (E,E), Green Turtle (V,V), Leatherback Turtle (E,V), Hawksbill Turtle (V,V), Pacific Ridley (E,V), Three-toed Snake-tooth Skink (R,V)

Mammals (aquatic): Southern Right Whale (R,E), Humpback Whale (R,V)

Sharks: Grey Nurse Shark (E,CE), Great White Shark (-,V), Green Sawfish (-,V), Whale Shark (-,V)

Fish: Oxleyan Pygmy Perch (V,E), Honey Blue-eye (V,V)

Source: Wildlife Online & EPBC online searches. Note that these searches indicate species that are likely – not necessarily known - to occur within the area. Critical wetland species known within the project area have been identified in the report.

### Water Quality

| Unit | Area | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| Freshwater | Pumicestone Catchment | C- | C- | C+ | C |
| Estuarine | - | - | - | - | - |
| Marine | Pumicestone Passage | B- | B | C+ | B |

Source: Ecosystem Health Monitoring Program (Healthy Waterways)

### Water Resource Outcomes

Estuarine reaches: Minimise changes to brackish habitats

Moreton Bay and Pumicestone Channel: Minimise changes to the natural movement and delivery of sediment, and the delivery of freshwater, natural nutrients and organic matter

(Source: Water Resource (Moreton) Plan 2007)

**Figure 3-2 Snapshot of Bribie Island and Pumicestone Passage**

Type Y: Freshwater springs

This wetland type includes freshwater springs and oases. Freshwater springs are a feature of North Stradbroke Island where the watertable and natural land surface intersect such that a freshwater spring develops as a result of groundwater seepage. This wetland type is closely associated with Type M, as a number of streams and creeks on North Stradbroke Island are spring-fed. Within the Moreton Bay Ramsar site, an example of this wetland type is Myora Springs.

#### *3.2.2.3 Man-made Wetland Types (1)*

Type 9: Canals, drainage channels and ditches

The Ramsar boundary along the Western Bay includes waterbodies and features that are remnant wetland or drainage channels that are now heavily modified and largely artificial in nature. Examples include the entrance at Skipper Canal on Bribie Island, the entrance channel to the canal and harbour area at Couran Cove on South Stradbroke Island and parts of Dowse Lagoon in Sandgate, covering a total of 9 hectares within the Ramsar site.

### 3.2.3 Overview of Wetland Processes

Wetland habitat components within the site, as identified in the section above, are influenced by a range of both broad-scale and localised wetland ecosystem processes. These processes include physical processes, chemical processes, biological processes, geologic processes and combinations thereof.

This section provides an overview of the key wetland processes occurring within and external to the Ramsar site.

#### *3.2.3.1 Regional Climate and Hydraulic Processes*

The climate and oceanographic current patterns affecting Moreton Bay are influenced by both tropical and temperature features.

The East Australian Current (EAC) typically produces a flow of warm low-nutrient waters from the Coral Sea past Moreton Bay which has a number of effects as outlined in Abal *et al.* (2005) including:

- Transport of tropical larvae;
- Maintenance of relatively consistent water temperatures; and
- Low frequency of upwelling events.

In summer, the average maximum air temperature is about 28º – 29º C and the minimum ranges from 19º to 20º C. The average maximum temperature in winter is about 20º – 21º C and the minimum average ranges from 9º to 10º C.

Winds from the south-east are the prevailing summer winds with low pressure systems bringing rain to the region generally in summer and early autumn. The tropical influences in the summer months lead to heavy, periodic rainfall that causes significant runoff and occasional floods, with considerable silt, mud and sand washed down into the Bay during large events.

Fronts move from west to east in the winter months, generally bringing cool and dry conditions. Winds during winter months generally prevail from a southwest to northwest direction.

The site is occasionally subject to the effects of tropical cyclones which originate in the Coral Sea and may travel as far south as Moreton Bay before (usually) weakening into a low pressure system or rain depression as they cross the coast.

Median annual rainfall in the region is reported as being some 1500 mm with high variability within and among years. Rainfall in dry years is roughly less than half of the rainfall in wet years (Abal *et al.* 2005). Rainfall is also spatially variable, with coastal catchments receiving greater rainfall than western (inland) catchments in the region. This occurs, in part, as a result of on-shore winds and adiabatic cooling as clouds rise over the coastal ranges causing precipitation to form.

The wind climate of Moreton Bay is driven by the synoptic winds and diurnal pattern of sea and land breezes. The sea and land breeze effect is very pronounced in the inshore areas of the site, while greater winds speeds are recorded at more exposed areas such as Cape Moreton.

The dominant processes affecting water levels in the Bay region relate to:

- Astronomical tides;
- Storm surges associated with cyclones and low pressure systems;
- Wind stresses (and generation of local ‘sea’ waves as discussed above); and
- Potential sea level rise associated with climate change.

From a hydraulic perspective, Moreton Bay is a semi-enclosed waterbody with ocean connections *via*:

- the sand channels of the Northern Entrance Tidal Delta between Bribie and Moreton Islands;
- the South Passage entrance between Moreton and North Stradbroke Islands; and
- an (indirect) connection through the Gold Coast Broadwater system which has a connection to the ocean at Jumpinpin and the Gold Coast Seaway.

The ocean tide penetrates into the system through these separate entrances and is significantly amplified as it moves through the Bay. Tidal currents vary from 0.2 $ms^{-1}$ in the shallow western region to 1.0 $ms^{-1}$ in the deep channels to the north-east. Studies have shown that the Moreton Bay tidal incursion extends southward to the Southern Bay area to the vicinity of the southern end of Russell Island. South from this point, the Bay tides interact with the inflow from Jumpinpin and the Broadwater in a complex way. This complexity results from the natural geomorphology of the area and also the influence of the constructed Gold Coast seaway, which has caused tides in the Broadwater to be only slightly less than those in the ocean (Crimp 1992).

The Central Bay region is shallower in the western and southern areas and deeper (exceeding 20 m) in the eastern parts. This pattern is disturbed by the intrusion of coastal sands which are aggregating along the banks in both the Northern Entrance Tidal Delta as well as in the vicinity of South Passage.

Several streams enter the Bay from the mainland coastal plan including the Brisbane, Caboolture, Pine, Pimpama, Coomera and Logan Rivers and other small creeks and estuaries. Waterways connecting to the Bay are tidal for part of their length with larger waterways such as the Brisbane River exhibiting tidal extent as far as 70 km upstream from the mouth. However, as previously discussed, the major rivers are not included in the boundaries of the Ramsar site.

While the tidal rivers flowing into the Broadwater contribute a significant proportion to the tidal volume of water within that part of the overall system, the contribution of the streams entering Moreton Bay proper is small compared to the total tidal prism of the Bay (Crimp 1992). However, the nutrient and sediment input from these waterways can have significant effects on water quality and associated habitats as discussed in the water quality section below.

The mainland shoreline and Bay waters are largely sheltered from ocean (swell) waves by the outer Bay islands. As a result, wind 'sea' waves dominate swell waves and will develop quickly with the onset of winds, but also diminish quickly as winds ease (Crimp 1992).

Alternatively, the eastern shorelines of the Bay islands are strongly affected by oceanic wind and wave processes, which have caused the formation of high energy sandy beaches and rocky headlands as discussed in the geology section below.

#### *3.2.3.2 Geology and Geomorphology*

Stephens (in Crimp 1992) provides an insight to the geological formation of the Bay, which is one dominated by sea level change over geologic time scales. This has led to the laying of a series of sedimentary landscapes that regulate many present day geomorphologic processes.

During the low sea level phases of the Pleistocene ice ages, the present Bay formed as a terrestrial plain traversed by stream valleys of the ancestral Brisbane and Pine Rivers. Sea levels began to rise about 17 000 years Before Present (BP) peaking at the end of the post glacial marine transgression about 6 500 years ago.

As such, the present landscape of the Bay as a marine area has existed for only about 6 500 years during which time a great deal of sedimentation and changes to the morphological features of habitats have occurred. As a result of coastal progradation, the Bay is bordered by extensive estuarine flats and mangrove swamps along its western and southern shores.

Coastal headlands and most of the islands of Moreton Bay are formed of Tertiary age basalts and freshwater shales, Mesozoic age sandstones and Palaeozoic age metamorphic rocks with laterite soils developed at the surface.

The islands themselves are essentially drowned sand dune island barriers anchored by the rocky headlands that formed by wave and wind action during several cycles of sea level change. The resultant landscape on the islands consists of coastal swamps and beach ridges and a wide array of freshwater features such as perched and window lakes, streams and springs.

The modern sedimentation pattern within the Bay itself reflects long term sedimentation patterns since the last major sea level rise and shows the Bay is essentially filling from three sides:

- fluvial sand and mud from the Brisbane River (calculated by Stephens in Crimp 1992 at a supply of about 175 000 tonnes/year averaged over the past 6 500 years);
- marine sand from the South Passage (calculated at a supply of about 200 000 $m^3$/year over the past 7 000 years); and
- marine sand from the Northern Passage Tidal Delta (calculated at a supply of about 600 000 $m^3$/year over the past 6 500 years).

The central, deeper area of the Bay remains a non-depositional area.

Figure 3-6 shows a recent satellite image of the Bay produced by SEQ Catchments and partner organisations. This figure illustrates the depositional environments of the Northern Entrance and Southern Passage as well as the Brisbane River Delta, the complex bathymetry and hydrology of the Southern Bay and the relatively static, deeper areas within the Central Bay.

Moreton Bay is situated close to the southernmost limit of reef-building corals. Coral reefs formed in shallower areas of the Bay (along the margins of the large islands and between Mud and Peel islands) around 6 500 to 4 000 years BP in locations when conditions were suitable for growth. Since this time there has been little coral reef development. Some of these nearhsore reefs have since been degraded as a result of increased sediment and nutrient runoff following clearing of the catchment and urbanisation of the region over the past 150 years and from coral limestone mining.

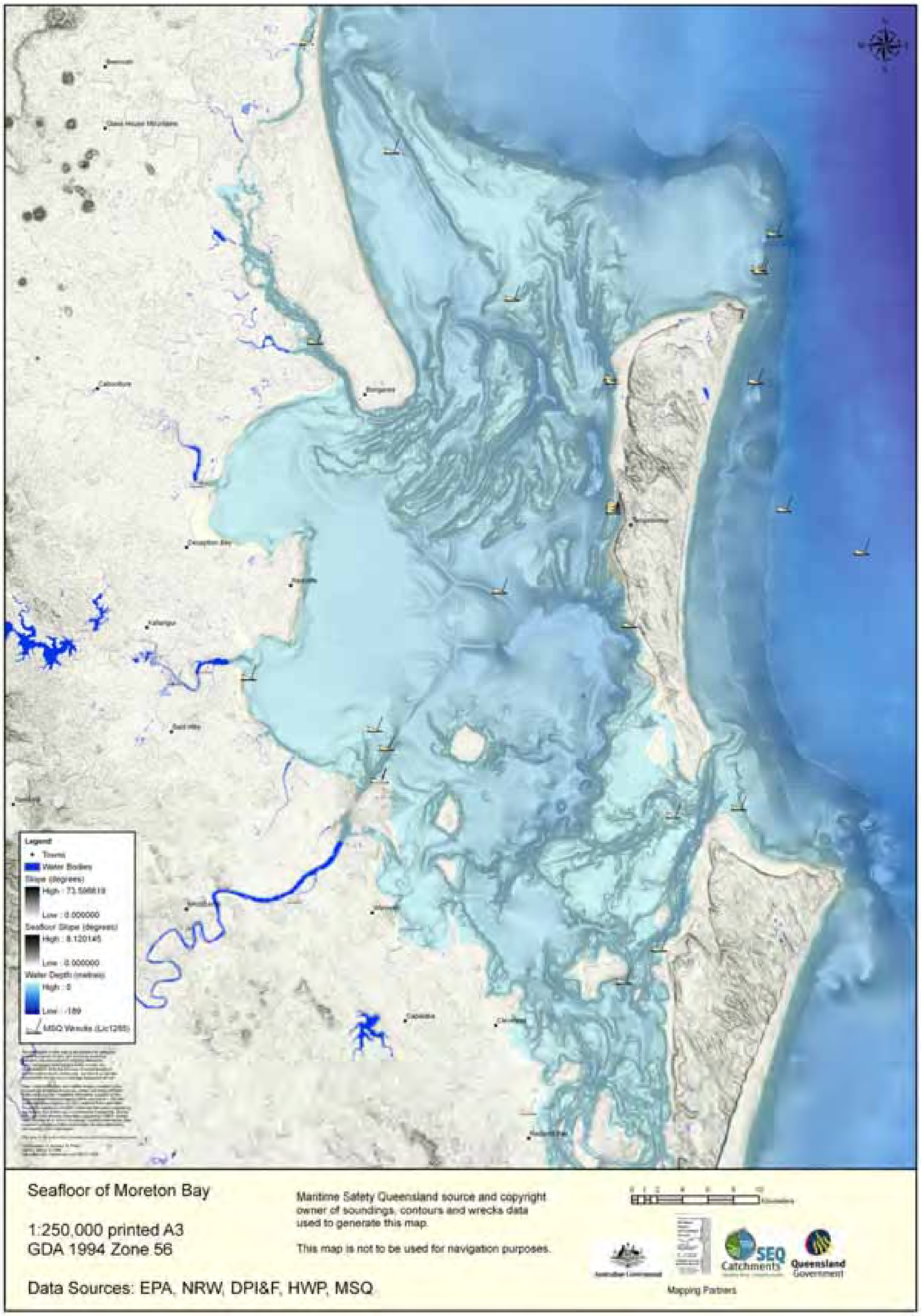



**Figure 3-6 Bathymetry of Moreton Bay**

*Source www.seqcatchments.com.au*

#### 3.2.3.3 Freshwater Flows

Coastal catchments between the Lamington Plateau in the south, extending north along the Great Dividing Range to the D'Aguilar Range drain into Moreton Bay. The combined catchment area draining to Moreton Bay is almost 22,000 $km^2$. Moreton Bay also receives smaller freshwater contributions from run-off from the barrier islands (Bribie, Moreton and North and South Stradbroke) and directly from rainfall.

The northern reach of Moreton Bay comprises Pumicestone Passage, which separates Bribie Island from the mainland. The mainland catchment area draining to Pumicestone Passage consists of a series of sub-catchments which are collectively identified in the Moreton Water Resource Plan as Pumicestone Creeks (State of Queensland 2007). The Western Bay area receives inflows from a series of catchments, the most northerly of which discharges to Deception Bay from the Caboolture River. South from Deception Bay, the Pine River and Cabbage Tree Creek discharge into Bramble Bay. The Brisbane River (which includes drainage from the Upper Brisbane, Stanley, Lockyer and Bremer River subcatchments) enters Moreton Bay between Bramble Bay and Waterloo Bay and the Redlands subcatchments also flow into Waterloo Bay. Further south and the Logan, Pimpama and Coomera Rivers drain to the Southern Bay and Gold Coast Broadwater areas.

Freshwater flows to Moreton Bay are characterised by limited inflow for most of the year with episodic, large-volume floods, which typically occur over summer and autumn months. These high flow events usually contribute to increased productivity of Western Bay environments at a time when shorebirds are most abundant in the area.

The implications of freshwater flows for locally occurring wetlands are largely dependent on the type of wetland, the quantity and quality of flow and/or the wetlands location relative to the freshwater influence. In general terms, freshwater dependent wetlands, such as those in and adjacent to freshwater reaches of watercourses, are those most influenced by freshwater flow patterns. The distribution of mangrove and saltmarsh wetlands are influenced mostly by physiographic features and tidal inundation, however their species composition can be determined by prevailing salinity regimes. Mudflats and seagrass beds can be affected by settlement of freshwater-borne sediments in brackish/saline environments – the former in an advantageous sense from accretion, the latter in a deleterious sense from potential smothering and loss of seagrass beds. Excessive nutrient inputs from freshwater in-flows from point and non-point sources can also impact on seagrass beds as is evidenced by the loss of seagrass from Bramble Bay and Southern Deception Bay and a few sites in Pumicestone Passage and southern Moreton Bay.

Freshwater flows to Moreton Bay have altered over time with development of both land and water resources. Urbanisation of the catchments of the Bay have resulted in significant increases in impervious surfaces, as natural surfaces such as grassland and forested areas are replaced by concrete. These surfaces increase the flow of urban pollutants (including sediment) into nearshore habitats causing altered nutrient sources, eutrophication, and other impacts that affect habitat quality (Young *et al.* 2006).

Over recent years in particular the demand for freshwater has challenged supply and a process of water allocation is being developed. Water Resource Plans (WRPs) provide a strategic framework for the management of water resources within a nominated area by specifying Environmental Flow Objectives (EFOs) and Water Allocation and Security Objectives (WASOs) that are intended to achieve, amongst other things, desired ecological outcomes. Recently developed regional WRPs are being implemented through Resource Operation Plans (ROPs) – currently being established - which will establish detailed water resource management rules for achieving the aspirational EFOs and WASOs set out in the WRPs, as well as a monitoring framework for assessing plan performance. These plans, when implemented, will further influence freshwater flows to Moreton Bay.

#### *3.2.3.4 Water and Sediment Quality*

The following water and sediment quality description has segregated the Ramsar site into the four broad areas previously introduced. Water quality condition in this section utilises monitoring information collected as part of the Southeast Queensland Healthy Waterways Partnership Ecosystem Health Monitoring Program (EHMP). The EHMP Annual Report Card provides an overall water quality rating for each area of the Bay, assessed against water quality guidelines (based on benmarks derived from reference data) for several key physio-chemical and biological parameters. Monitoring ratings range from A (excellent – reference conditions) to F (fail – poor water quality, major ecosystem impairment). Detail on the EHMP program and the methods used to derive scorecard values are provided in EHMP technical reports (EHMP 2006).

**Bribie Island and Pumicestone Passage**

Pumicestone Passage can be broken into three sub-areas when water and sediment quality issues are considered, with these sub-areas largely being controlled by the interplay between catchment inflows and tidal flushing. The northern and southern sections of Pumicestone Passage are well flushed by tidal processes and as such typically exhibit high to moderate water quality, especially so in the case of the southern section. The central sections of Pumicestone Passage, located around 'The Skids', have poorer water quality due to lower rates of tidal flushing (this is an area where tidal inflows from the north and south ends of the Passage meet, creating an area with lowered rates of net water exchange). Pumicestone Passage in recent years has been ascribed EHMP report card ratings of between $C^+$ and B for estuarine areas and $C^-$ to $C^+$ for freshwater areas.

There is little readily available, recent sediment grain size distruibution data for this area. Given tidal and catchment influences, it is expected that sediments within the northern and southern sections will be largely marine in nature, progressing to finer, more organic sediments in the central section. The presence of substantially deposits of acid sulfate soils within the catchment will almost certainly be reflected in the quality of sediments within the Passage.

In regard to wetland ecosystem processes in Pumicestone Passage, for most of the areas, natural or quasi-natural conditions still exist, though catchment land use change and large scale infrastructure development (eg. road/rail/water supply) pressures still exist. In general, intertidal wetlands above mean sea level in and adjacent to the Passage (eg. mangroves, tidal flats, saltmarsh) are strongly affected by hydrologic conditions whereby water quality is a more salient issue for sub-tidal vegetation and seagrass beds in the Passage which are undoubtedly under moderate stress.

For waters adjoining the eastern coastline of Bribie Island, water and sediment qualities will be high due to the absence of pollutant sources (e.g. point source discharges or major catchment inflows) and the high rates of tidal flows and net exchange of water.

**Western Bay**

The Western Bay can also be broken into three sub-areas when water and sediment quality issues are considered, with these largely being controlled by the interplay between point and diffuse (catchment) inflows and tidal processes. These sub-areas are Deception Bay, Bramble Bay and Waterloo Bay, and the respective estuarine/freshwater areas contiguous with these bays.

Bramble Bay exhibits the poorest water and sediment quality of these sub-areas, primarily due to the high rates of pollutant loading (both continual inflows of wastewater and intermittent, though high, inflows of catchment sourced pollutants), with a similar situation for the estuaries connected to Bramble Bay. EHMP report card ratings for Bramble Bay in recent years have ranged between D and $D^+$ while the Brisbane, Pine and Cabbage Tree Creek estuaries have respectively had $D^-$ to $D^+$, D to $C^-$ and F to $D^-$ grades.

Deception Bay also exhibits poor water quality, for reasons similar to Bramble Bay, though in the case of Deception Bay the per-unit-area rate of diffuse and point source loading is somewhat lower. Consequent EHMP ratings in Deception Bay have been D to $C^+$ and for the Caboolture Estuary $C^-$ to $B^-$.

Waterloo Bay is the portion of the western part of Moreton Bay with the highest water quality, primarily due to high rates of tidal flushing/water exchange caused by its close proximity to South Passage and also as there are low rates of point/diffuse pollutant loadings in this area. Waterloo Bay EHMP report cards in recent years have ranged between B- and B+. The estuaries entering Waterloo Bay exhibit poorer water quality due to their small size and proportionally higher rates of wastewater loads. In recent years, these estuaries have exhibited EHMP report card ratings of D- to D+ (Tingalpa Estuary) and D to C- (Eprapah Estuary).

In regard to wetland ‘functioning’, similar comments in regard to vegetation ‘above’ mean sea level as made for Pumicestone Passage apply, with the exception of there being far greater levels of disturbance due to anthropogenic effects. For the subtidal/seagrass areas, there are sub-area specific comments which can be made, as follows:

Deception Bay – the key factors affecting subtidal wetlands in this area are water quality related, specifically excessive nutrients and commensurate nuisance algal blooms (specifically the blue green cyanobacteria *Lyngbya*). There may well be a strong causative link between continually elevated phosphorus levels (due to regional pressures) and episodic loadings of iron (due to local pressures) and these lyngbya blooms. There have been major losses of seagrass from southern Deception Bay since declaration of the Ramsar site in 1993.

Bramble Bay – this area has seen almost the total loss of sub-tidal seagrass, undoubtedly due to excessive nutrient and sediment loads from point source and catchment loads.

Waterloo Bay – subtidal wetlands in this area are likely to be functioning in a robust manner due to the generally acceptable water quality levels.

Sediments in all of these bays and estuaries, especially Bramble and Deception Bay, are known (Dennison and Abal 1999) to be fine (silts and clays) and in most areas are highly organic. These sediments will undoubtedly comprise a major reservoir of carbon and nutrients and will be contributing to ongoing surface water quality degradation.

**Moreton Island and Eastern Banks**

The marine sections of this area exhibit reference/near-reference water quality conditions, as evidenced by EHMP report card ratings for recent years never falling below A-. As could be expected, this high water quality can be attributed to very high rates of tidal flow/exchange and very low rates of pollutant input. As a consequence of this, subtidal wetlands (seagrass) are found extensively and to some of the greatest depths in the entire Moreton Bay region, highlighting the unique nature of this area.

Marine sediments in this area are known (Dennison and Abal 1999) to be mostly fine to medium sand, that are mostly marine in origin. The relatively 'clean' nature of these sediments will be assisting in maintaining high water quality levels in the overlying water column.

The physio-chemical characteristics of freshwater lakes, creeks and marshes on Moreton Island vary among waterbodies. In common with other dune island wetland systems, these waterbodies typically have low nutrient concentrations (although some perched lakes can have high nitrogen concentrations at low water levels), low pH and electrical conductivity. Waterbodies with a peat substrate typically have low water transparency due to high concentrations of dissolved organic carbon (tannins, linols etc.), whereas waterbodies that are a predominantly fed by the regional water-table typically have clearer waters.

**Stradbroke Islands and Southern Moreton Bay**

Water quality in the marine sections of the Southern Bay is highly variable in space (i.e. strong east-west and to a lesser extent north-south gradients in water quality) and in time (i.e. strong influence of pulsed flood events).

The Southern Bay and the Gold Coast Broadwater had EHMP report card ratings respectively ranging from D to B- and C- to B+. In an estuarine context, EHMP report card ratings ranged from: heavily impacted (Logan/Albert, EHMP report cards F to D- in recent years), moderately impacted (Pimpama, EHMP report cards C+ to C in recent years) and slightly impacted (Coomera and Nerang, EHMP report cards respectively ranging between B and A- and constantly at a B level in recent years).

As evidenced by environmental monitoring work conducted after recent (2008) heavy flooding in the area, and previous reporting by Dennison and Abal (1999), this is a highly dynamic area in regard to water quality and wetland vegetation. The area is regularly affected by flood events which have seen the loss, and subsequent recovery of, subtidal seagrass beds.

There have also been losses of major areas of mangroves (not due to flooding) and subsequent colonization of former saltmarsh areas as a result of urban development (including on the Southern Bay islands), from sand mining activities and from natural hazards (in the case of hail damage at Cobby Cobby Island). In combination there are major concerns that the various existing processes affecting both water quality and wetland vegetation in this area, when combined with anticipated major population growth/land use change in the catchment could see (water quality driven) consistent and permanent reductions in the extent and health of wetland vegetation in this area.

Sediments in this area will range from sandy/marine in nature throughout much of Southern Moreton Bay and the Gold Coast Broadwater to highly organic silts and muds in the estuaries and less dynamic reaches of Southern Moreton Bay and the Broadwater. As per previous comments, where the sediments are fine and organic, they are highly likely to be contributing to degradation in overlying water quality levels.

Water quality conditions in freshwater environments on North Stradbroke Island are similar to that described for Moreton Island (see discussion above).

#### *3.2.3.5 Marine and Estuarine Nutrient Cycling*

Nutrient cycling in and around the wetlands of the Moreton Bay Ramsar site plays a key role, both in regard to functions within the wetlands, and to feedback processes between the wetlands and their proximate areas and the water quality within and overlying (in the case of seagrass beds) them. Nowhere in the region is this more important than in the heavily disturbed/impacted wetland areas of Bramble and Deception Bays. Detailed scientific studies of sediment quality and nutrient cycling processes in these areas (as reported in Dennison and Abal 1999) have indicated that natural denitrification processes in marine sediments are unable to reduce the rates of organic loading of benthic zones (due to a combination of point and diffuse carbon sources). Recent and ongoing efforts to reduce sewage carbon and nutrient loads to the region are being implemented to reduce these impacts.

Outside the above discussion on nutrient cycling which is essentially specific to Bramble and Deception Bays, nutrient budgeting work reported in Dennison and Abal (1999) highlights the following:

- The carbon budget of Moreton Bay is dominated by marine plants, predominantly phytoplankton in the water column. Mangroves and seagrasses constitute smaller sources of primary production in Moreton Bay (see Table 3-2);
- Nitrogen fixing and recycling within wetlands is small in comparison to point and diffuse sources; and phosphorus recycling is also small in comparison to point and diffuse sources.

#### *3.2.3.6 Groundwater Resources*

Groundwater (as reported in Dennison and Abal 1999) is not a major inflow or nutrient source to Moreton Bay as a whole and, as such, is likely to be having minimal overall impact on wetland functioning.

There are several, more localised, exceptions in this regard, which are noteworthy, as follows:

- The freshwater wetlands of Bribie Island and the western border of Pumicestone Passage, which will be heavily influenced by groundwater;
- The freshwater wetlands of Moreton Island and North Stradbroke Island, which will also be heavily influenced by groundwater; and
- The seagrass beds in and around Amity and Pelican Banks to the west of South Passage. There would appear to be a strong causative link between the dissolved iron content of groundwater upwellings in these areas and occasional occurrences of *Lyngbya* growth on the seagrass.

Recent studies undertaken by the Department of Natural Resources and Water on North Stradbroke Island (Marshall *et al.* 2006) have sought to identify and examine the groundwater dependent ecosystems, species and communities of the Island. This has been done particularly to formulate potential ecological consequences associated with groundwater extraction. However, the study found that it is not currently possible to evaluate the likelihood or magnitude of changes as a result of increased groundwater extraction in the absence of better hydrological and ecological understanding.

#### *3.2.3.7 Biological Processes*

Ecosystem functions are maintained and regulated by numerous, often interacting biological processes. While it is not possible to list and describe each of the biological processes operating within the Ramsar site, the following processes are thought to represent the most important controls operating over broad spatial scales (i.e. either whole of site, or key habitats within the site).

**Primary Productivity**

Primary productivity, which is the rate at which vegetative matter is produced within a habitat, is ultimately controlled by the availability of light, nutrients, temperature and salinity in estuaries. Preliminary primary productivity estimates for estuarine waters within Moreton Bay (Abal *et al.* 1998) suggest that phytoplankton contributes ~67.9% of primary productivity within the bay. The remaining one third is thought to be generated by seagrass (~16.8%) and mangroves (~15.3%). The high proportion of primary productivity by phytoplankton is a reflection of the large area of this group, whereas on productivity/area basis, seagrasses and mangroves are far more productive (Table 3-2).

The contribution of benthic micro-algae (microphytobenthos) and saltmarsh to primary productivity within the Bay has not been examined to date. In the context of the Ramsar site, which occurs in water depths below 6m and is therefore largely in the euphotic zone, it is likely that benthic microalgae are also important primary producers at this scale (Alongi 1990). Saltmarsh is also a contributor to total primary productivity in the Bay and can be highly productive on a unit area basis (Saenger *et al.* 1977; King 1981; Clarke and Jacoby 1994; Mazumder 2004).

**Table 3-2 Primary productivity estimates of seagrasses, mangroves and phytoplankton in Moreton Bay (Abal *et al.* 1998)**

| Group | Area (ha) | Primary productivity (tonnes C/day) | % Contribution |
|---|---|---|---|
| Seagrasses | 25000 | 105 | 16.8 |
| Mangroves | 13604 | 96 | 15.3 |
| Phytoplankton | 140000 | 424 | 67.9 |

Patterns in aquatic primary productivity in freshwater wetlands are thought to vary among wetland types. Water-table window lakes such as Blue Lake and Blue Lagoon, which having very low turbidity and colour (transparency), are nutrient poor ecosystems that are considered to be oligotrophic (Bayly 1964; Bowling 1988; Arthington *et al.* 1989; Outridge *et al*. 1989). However given the limited extent of aquatic macrophytes in these lakes compared to the total area of potential microalgae habitat, it possible that phytoplankton and benthic microalgae contribute a high proportion of total primary productivity within these lakes.

Macrophyte cover on perched lakes varies greatly among lakes, and can vary within lakes over time. For example, in 2000, Black Snake Lagoon on North Stradbroke Island had a large open water: littoral macrophyte area ratio, but due to low transparency resulting from high concentrations of tannins, is unlikely to have high microalgae productivity. Ibis Lagoon on North Stradbroke Island, a relatively permanent waterbody with high water transparency, had moderate cover of emergent macrophytes, and a high cover of benthic microalgae (periphyton). Ephemeral perched waterbodies (e.g. Mungaree Lagoon) and palustrine wetlands can have 100% aquatic macrophyte cover (WBM 2002c), and therefore primary productivity is likely be dominated by this component.

**Carbon Cycling by Bacteria**

As vegetative and animal matter begins to senesce and die, microbes invade the tissues and transform the organic material into more bio-available forms of carbon. While microalgae, and to a lesser extent mangroves and seagrasses, are responsible for primary productivity within estuarine and marine waters of the site, microbial breakdown is a key pathway for plant material entering the food-web in these ecosystems (Alongi 1990). This is especially true for marine macrophytes (seagrass, mangroves, saltmarsh), which with few notable exceptions (e.g. dugongs, some fish) are generally not directly grazed, but instead enter food-webs following microbial conversion of organic matter (Day *et al*. 1989). Carbon flows in sand island freshwater wetlands are not well known and require further investigation, although peatlands (such as Eighteen Mile Swamp on North Stradbroke Island) are exceedingly recognised as important sinks for carbon as actively accumulate organic matter.

In the context of energy flows through the ecosystem, some energy is lost during microbial respiration, some is leached as dissolved organic mater into the water, some is incorporated into microbial biomass, and some may be transformed to other organic compounds not incorporated in microbial cells. Of particular importance to higher trophic levels (i.e. consumers) is the conversion of detrital material into bacterial biomass, which is then in a bio-available form for animals (Day *et al.* 1989). Microbes also affect energy flow by using dissolved organic matter, which is largely unavailable to other estuarine community components (Day 1967; Nybakken 1982; Day *et al.* 1989).

Carbon cycling is intimately linked with nutrient cycling (see section above) and primary productivity. Note that autotrophic bacteria are primary producers, and also contribute to carbon cycling and nutrient flux.

**Zooplankton Grazing**

Grazing of phytoplankton by zooplankton is an important link in the chain of nutrient flux and energy flow in the coastal and estuarine waters of Moreton Bay (Greenwood 1998). Zooplankton has the following key roles in estuarine ecosystems:

- Transfer of energy through the food web, by transferring organic compounds derived from phytoplankton to higher trophic levels (secondary consumers), including species of direct economic significance;
- Regulation of community structure (species composition, abundance, biomass) of phytoplankton communities. In Moreton Bay, microzooplankters were responsible in one study for the majority of herbivorous grazing (ciliates in the <64µm fraction) (Dennison 1999). In this study, it was demonstrated that zooplankton grazers could account from between 10 and 100% of the total phytoplankton productivity and biomass per day. Therefore, grazing may partially control water quality at local scales.

It is also notable that the planktonic phase forms part of the life-cycle of most benthic and marine demersal fauna (meroplankton), including most species of direct fisheries significance.

While there is a relatively good information base describing estuarine marine zooplankton communities in Moreton Bay, comparatively little is known about the relationships between nutrient levels, phytoplankton dynamics and zooplankton composition, grazing and production, within different parts of the system (Greenwood 1998). No studies have examined zooplankton productivity and dynamics within dune island wetlands, although it is known that communities are depauperate and contain species that are restricted to humic, coastal waterbodies (Bayly 1964; Bensink and Burton 1975; Timms 1982; WBM 2002a,b).

**Bioturbation in Estuarine Sediments**

Bioturbation, a bottom-up process where biological activity (burrowing) disturbs the ocean floor, can be critical to the structural organisation of soft sediment communities. The main bioturbators include polychaete worms, burrowing crabs (particularly in mangroves) and other crustaceans (e.g. ghost nippers), rays, fish, dugongs and turtles.

Bioturbation results in the mixing of sediment layers. This mixing assists in the oxygenation of the sediment, increases rates of organic decomposition, and affects nutrient cycling processes (Day *et al*. 1989). Furthermore, bioturbation can breakdown micro-topographical features of the bed such as ripples and cross-bedding, which were demonstrated by Stephenson and Sadacharan (1983) to have an important role in structuring soft-sediment communities in Moreton Bay. Bioturbation has a strong influence on many aspects of benthic ecology including:

- physical properties of sediments;
- sediment-water biogeochemical processes, including nutrient cycling;
- seagrass productivity;
- mangrove ecosystem functioning; and

- benthic fauna community interactions, including predation, competition etc.

**Other Fauna Interactions**

Competition, predation, and disturbance all have an influence on freshwater and estuarine/marine community functioning. The influence of these processes on communities can vary across a range of spatial and temporal scales. Critical fauna interactions in the context of this ECD will be identified in the discussion of specific critical services in Section 7.

In general terms, the following fauna interactions are thought to be important in regulating community structure and ecosystem processes:

- Marine and Estuarine Fish - It is generally thought that populations of most fish species are regulated by non-equilibrium processes (i.e. predation, recruitment limitation) rather than density-dependent processes such as competition. While there is a large body of work examining populations controls and processes for reef fish (Hixon 1998; Levin 1998), with few exceptions there is comparatively little information describing the ultimate population controls for estuarine and coastal fish species. Since most fish species are part of an open population, the process/es that ultimately control populations can vary across multiple spatial scales, and may operate both within and external to the Ramsar site.

- Benthic macroinvertebrates – Numerous studies have examined the roles of competition, predation, larval supply, food supply and disturbance in structure in soft-sediment benthic macroinvertebrate communities. The relative importance of these processes can vary across a range of spatial and temporal scales (Seitz 1998). Of particular note, in parts of Moreton Bay it is known that a cyclic seasonal (spring) recruitment pulse occurs for many species of macroinvertebrate (Stephenson *et al*. 1978; Stephenson 1980a-c). Although not examined within empirical experimental frameworks, predation has been suggested to lead to major temporal changes in invertebrate prey abundance within Moreton Bay (Stephenson 1980b).

- Freshwater fish and decapod crustaceans – Unlike marine and estuarine fish populations, it is generally thought that many freshwater fish species (and some decapod crustacean species) on dune island wetlands form relatively discrete, closed populations (Page *et al.* 2006; Page and Hughes 2007). Biological processes operating at local (within-wetland) spatial scales may therefore be very important controls on these populations. With the notable exception of Oxleyan pygmy perch (Arthington 1996), few studies to date have examined the population ecology of these species.

### 3.2.4 Uses and Tenure

#### *3.2.4.1 Uses*

**Urban Development**

Southeast Queensland is one of the fastest growing regions in Australia with over 2.5 million people and a population that is increasing by just under 3% per annum. The latest Queensland Government projections by the Planning and Information Forecasting Unit (PIFU) estimate the current population of the Region at 30 June 2006 was 2.8 million people and is expected by 2011 to grow to between 3.0 and 3.1 million people. By 2026, this is expected to increase again to between 3.6 and 4.3 million people.

Urban and suburban developments are concentrated on the Brisbane River corridor and are rapidly expanding into areas along the North and South coast. There continues to be increasing pressure and demand for development of coastal and foreshore areas for residential and associated commercial development that can displace more appropriate coastal dependant uses.

**Fishing and Collecting**

The Moreton Bay region supports one of the most productive fisheries in Queensland, representing just under three percent of the Queensland coastline while annually producing about 20 percent of Queensland's commercial seafood catch by weight (RIS 1999). Vessels operating within the Moreton Bay Marine Park are reported to have landed approximately $24.1 million gross value of product each year during the three year period ending June 2006 (EPA 2007a).

The Bay is also a popular recreational fishing area. A variety of species are targeted, including yellowfin bream, whiting, tailor, flathead, Black bream, mackerel, snapper and mullet. Eight species of prawn and four species of crab are commercially important, with mud and blue swimmer crabs also being of recreational importance.

Commercial collection of fish and invertebrates for aquarium purposes occurs within the Bay as well as offshore reefs outside of the Ramsar site. Bait collection, food gathering and viewing of coral and aquarium fish species are popular recreational pursuits. Commercial oyster beds operated by licensed oyster growers, commercial baitworm and shell collection also occurs.

The boundaries of the Ramsar site are similar to those of the current Moreton Bay Marine Park excluding deeper areas in the Central Bay. Information presented within the Queensland Government document, *Have Your Say: Moreton Bay Marine Park* (2006) reports that on average 410 commercial fishing licences accessed the Marine Park annually from June 2003 to June 2006. In terms of the value of the fisheries, the report states that these vessels landed approximately $24.1 million gross value of product (that is the wharf price paid to commercial fishers) each year during this period (Queensland Government 2006).

**Recreation and Tourism**

The Bay is an important and well utilised area for recreational boating and water related activities, offering opportunities for a wide range of water-based recreation including fishing, sailing, power boating, water skiing, parasailing, jetskiing, sailboarding, scuba diving, bird watching, marine study and snorkelling. The southern area of the bay receives the heaviest boating use for most activities because of its sheltered waters and proximity to many boat launching facilities. Policies administered under the marine park zoning plan and Southeast Queensland regional coastal management plan closely regulate the construction of tidal canals and boat harbours including placement of private moorings and jetties in largely undeveloped natural waterways.

The three barrier islands (Moreton, North and South Stradbroke) have unspoilt beaches, topographic diversity within the dunal system and largely undisturbed natural scenery, forest and wetlands.

**Sea and Air Port Facilities**

The Port of Brisbane is the fastest growing capital city port on the east coast with the capability to handle a wide variety of cargoes. The Port has expanded significantly since the listing of the Ramsar site with the construction of the 230 ha Future Port Expansion reclamation area which extends from Fisherman Islands at the mouth of the Brisbane River into the Waterloo Bay. Maintenance dredging occurs within the shipping channels of the Bay as well as operational areas of the Port and Brisbane River (berths, swing basin, shipping channel) with the dredged material/spoil placed in the reclamation area.

Across the Brisbane River, the Brisbane Airport is Australia's fastest growing passenger airport with a $2.5 billion capital works programme over the next 10 years. These works involve upgrading road transport into the Airport, the expansion of the domestic and international terminals and the development of a New Parallel Runway (which was approved with conditions under the EPBC Act in August 2006) on the Brisbane Airport federal lease. The footprint of the New Runway (with the exception of proposed approach lighting) is situated outside of the boundaries of the Ramsar site in the Western Bay.

**Sand Mining and Extraction**

Silica and heavy mineral sands are extracted primarily from North Stradbroke Island, under commercial sand mining leases and relevant environmental authorities.

Marine sand is extracted for the construction industry in the northern bay banks near Spitfire Channel and Middle Banks. These sources are highly valued in a regional sense due to the diminishing resources available from mainland streams and terrestrial areas. A long term (20 year) Sand Extraction Strategy (underpinned by the Moreton Bay Sand Extraction Study 2001-2005) regulates the extraction of sand from the Bay for the construction industry and major infrastructure projects at the Port and Airport as outlined above.

**Water Extraction**

Redland Shire Council's mainland water supply is supplemented by water extracted from an unconfined aquifer on North Stradbroke Island in the vicinity of 18 Mile Swamp (Herring Lagoon).

In response to long term drought and significant water shortages in the region, large-scale groundwater extraction from North Stradbroke Island and Bribie Island is being investigated by the Queensland Water Commission as part of the SEQ Water Supply Strategy.

**Marina and Boat Harbours**

Several of the Bay's marinas and harbours provide bases for the transport operations which service surrounding locations and the bay islands, servicing commercial, recreational and residential demands.

#### 3.2.4.2 Tenure

Moreton Bay lies within Queensland waters. Most of the land adjoining the Bay consists of land under the control of the Queensland Government, but there are substantial areas of privately owned land along the western shore from Pumicestone Passage to the Southern Bay and Broadwater. In some cases, the property boundaries of this leasehold and freehold land extend to the high water mark (measured at mean high water springs(MHWS)).

Each of the Bay islands has different settlement patterns which can be summarised as follows:

- Moreton Island - several very small townships, a large tourist resort and the remainder of land held as protected area;
- North Stradbroke Island – three primary townships, large mining leases, protected areas and a range of other tenures;
- South Stradbroke Island - largely protected area and other State land tenures with a large tourist resort and several isolated settlements;
- Bribie Island - several large townships on the southern section and a range of reserves and protected areas in the undeveloped northern section.

As described previously, the declared boundaries of the Moreton Bay Ramsar site are predominantly Queensland State waters (unallocated State land) to a depth of 6m below lowest astronomic tide or following the boundaries of other declared regulatory zones in marine areas such as Fish Habitat Areas under the *Fisheries Act 1994*.

Land areas above high water mark included within the Ramsar site are also largely State-owned lands managed by various State agencies or by local governments as trustees of reserves and similar tenured land. This includes national parks, conservation parks, reserves, undeveloped esplanades and unallocated State land. Areas of freehold land in the Ramsar site are controlled by local government (Brisbane City Council in the case of the Boondall wetlands). Leasehold above and below high water mark is also largely excluded.

### 3.2.5 Noteworthy Flora and Fauna

The freshwater, estuarine and marine wetland habitats of Moreton Bay Ramsar site support a range of noteworthy flora and fauna species and important populations. In this context, it is recognised that there are a range of migratory species (many of which are of conservation significance such as cetaceans and sharks) that may also use habitat within the boundaries of the site from time to time. However, the focus of this ECD is on those species and populations that use the areas within the site as core habitat. Further discussion on this point is contained in Section 4 of the report.

A summary of these key species and populations are as follows:

- Moreton Bay supports a high abundance of shorebirds (Bamford *et al.* 2008). During the summer months, Moreton Bay habitats support over 3500 resident and between 40,000 to 50,000 migratory shorebirds (Thompson 1990a; Driscoll 1993; Watkins 1993; Driscoll 1997). This equates to approximately 10% of maximum number of shorebirds migrating to Queensland over the summer period (Driscoll 1993; Watkins 1993; Driscoll 1997);

- Moreton Bay also supports a high diversity of shorebirds. Ten resident and 32 migratory shorebird species are regularly recorded in Moreton Bay (Thomson 1990);

- Moreton Bay supports significant numbers of individual shorebird species (Watkins 1993; Driscoll 1997; and Bamford *et al.* 2008), including bar-tailed godwit *Limosa lapponica*, whimbrel *Numenius phaeopus*, eastern curlew *Numenius madagascariensis*, terek sandpiper *Xenus cinereus*, grey-tailed tattler *Heteroscelus brevipes*, curlew sandpiper *Calidris ferruginea,* pied oystercatcher *Haematopus longirostris*, Pacific golden plover *Pluvialis fulva*, and lesser sand plover *Charadrius mongolus*;

- Moreton Bay represents the southern limit of the dugong's (*Dugong dugon*) Australian distribution (Lanyon and Morrice 1997) and currently contains one of the largest populations of dugongs on the east coast of Australia (Marsh *et al.* 1996);

- Six species of marine turtle are known to use Moreton Bay as a feeding area. Two of these species - the green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) - have resident populations in Moreton Bay within the nearshore marine areas that are within the boundaries of the Ramsar site;

- Two nationally threatened 'wallum' habitat associated fish species occur within the Moreton Bay Ramsar site: Oxleyan pygmy perch (*Nannoperca oxleyana*) and honey blue-eye (*Pseudomugil mellis*);

- Moreton Bay supports populations of ten threatened wetland-dependant fauna species. These are: Illidge's ant blue butterfly *Acrodipsas illidgei,* wallum froglet *Crinia tinnula*, wallum rocketfrog *Litoria freycineti* and wallum sedgefrog *L. olongburensis*, beach stone-curlew *Esacus neglectus*, water mouse *Xeromys myoides,* Cooloola sedgefrog *Litoria cooloolensis*, Australian painted snipe *Rostratula australis,* little tern *Sterna albifrons* and Australasian bittern *Botaurus poiciloptilus*; and

- Numerous endangered and vulnerable flora species are known to occur within the Moreton Bay region, including five nationally-listed species that are wetland-dependent. Particularly noteworthy species include the endangered swamp daisy (*Olearia hygrophila*) that is endemic to North Stradbroke Island, known only from two locations on the island; and three endangered swamp orchid species (*Phaius australis, P. bernaysii* and *P. tancarvilleae*) that are rarely seen on mainland but are more frequently encountered on the bay islands (SGAP 2005).

### 3.2.6 Cultural Values

**Indigenous**

Moreton Bay was an important area for Indigenous people in the past as well as remaining so today (Fesl and Davies 2004). On many of the islands, in particular North Stradbroke Island, there is evidence of Aboriginal presence going back 20 000 years.

There are numerous archaeological site types that have been located within the broader wetland area in and around Moreton Bay and the Bay islands. These include:

- Stone Artefact Scatters
- Shell Middens
- Burials
- Scarred Trees
- Quarries
- Axe Grinding Grooves
- Stone Arrangements
- Burial Grounds

As outlined in the geological processes section above, the entire area of Moreton Bay was exposed as a dry, flat plain during the last glacial maximum in the Pleistocene period. The floodplain would have been regularly traversed by indigenous people of that time on their way to the Bay islands which as a result of low sea levels in the region would have comprised the mainland coast. This Pleistocene landscape and the potential for indigenous artefacts to be preserved within it are discussed by Hall (1999) and the Moreton Bay Sand Extraction Study.

**Historic**

The shoreline of Moreton Bay was the first area in the Brisbane region to be settled by Europeans. Coochiemudlo Island was the site of the first landing by Matthew Flinders during his exploration of Moreton Bay and the Brisbane River. St Helena Island which was used as a prison and quarantine station at different periods was the first historical area in Queensland to be reserved as a National Park solely because of its historic ruins. Other areas settled by Europeans include Peel Island, used first as a quarantine station and then as a leper colony, Dunwich and Amity Point on North Stradbroke Island and Redcliffe on the mainland which was the site initially chosen for the penal colony before it was moved up the Brisbane River (RIS 1999).

**Tourism and Recreational Values**

Tourism and recreational values of the Moreton Bay Ramsar site predominantly relate to nature-based activities available within the Moreton Bay region. The Ramsar site includes important terrestrial and aquatic environments for tourism and recreational activities including boating, diving, spear fishing, line fishing, snorkelling, swimming, surfing, shorebird, turtle, dolphin, dugong and whale watching, bushwalking, camping, four wheel driving and sand tobogganing. In addition to the activities available, the high aesthetic and wilderness values, and indigenous and European values (discussed above) attract people to the area.

The proximity of the Moreton Bay Ramsar site to Queensland's capital city, Brisbane, highlights the importance of the site for regional residents and visitors, both for tourism and recreational purposes, and conservation and wise use of the area (i.e. management of impacts from tourism and recreation). The Bay supports a significant economic contribution from tourism and recreational activities with an estimated $500 million spent by visitors to the Moreton Bay and islands region in 2006, further contributing an estimated 5,500 jobs (EPA 2007a).

**Education and Research Activities**

The Bay and its flora and fauna have been, and continue to be, well studied. Queensland University, CSIRO and the Department of Primary Industries and Fisheries have research stations in the Moreton Bay region (although outside the boundaries of the Ramsar site). Other universities and colleges use Moreton Bay for research and education.

Numerous research programs and projects have been undertaken with respect to the Bay's habitats and important species that are documented in Section 8, References. In terms of recent research activities undertaken by State agencies, of particular note are the EPA's Queensland Turtle Conservation Project (see Limpus *et al*. 2006), recent studies of groundwater ecosystems on the Bay islands by the Department of Natural Resources and Water (see Marshall *et al.* 2006) and various research projects on Bay fisheries by the Department of Primary Industries and Fisheries.

The Brisbane City Council manages and operates the Boondall Wetlands Environment Centre on the Boondall Wetlands Reserve in western Moreton Bay which offers a range of displays and activities on the environmental and cultural heritage of the reserve for park visitors and organised groups. The mangrove boardwalk at Wynnum North is also a significant educational resource.

The Queensland Department of Education runs environmental education centres at Nudgee Beach, Moreton Bay (at Wynnum) and Jacobs Well for educating children on coastal and environmental matters. The Environmental Protection Agency has educational facilities on St Helena and Moreton Islands.

The Bay's resources and key components such as water quality are also extensively monitored. Under the Healthy Waterways Partnership, following design and input from stakeholders, the Ecosystem Health Monitoring Programme for estuarine and marine waters was implemented in 2000. The water quality and biological information obtained from this monthly monitoring program continues to the present day, allowing Bay resource managers and stakeholders to evaluate the ecosystem and community benefits of investment in protection and conservation measures. The EHMP forms the basis for the annual Report Card for the Bay which rates each of the Bay's major water bodies, rivers and catchment streams.

Other monitoring activities include extensive work by volunteers such as wader bird observations collected by the Queensland Wader Study Group and the Seagrass Watch programme undertaken by conservation groups in the region.

### 3.2.7 Policy Framework Governing the Site

The size and significance of the Moreton Bay Ramsar site is such that it is subject to a wide array of statutory and non-statutory plans and strategies that aim to manage its resources and values. A summary of the most relevant laws, plans and strategies at all relevant levels of Government is included below:

**International**

In addition to the Ramsar Convention itself, many of the values of the site that are salient to its listing as a Wetland of International Importance are also relevant to international obligations under other conventions and agreements. Some of the key instruments are:

- JAMBA - the Agreement between the Government of Australia and the Government of Japan for the protection of migratory birds in danger of extinction and their environment 1974.
- CAMBA - the Agreement between the Government of Australia and the Government of China for the protection of migratory birds in danger of extinction and their environment 1986.
- ROKAMBA – the Agreement between the Government of Australia and the Government of the Republic of Korea for the protection of migratory birds and their environment 2006.
- The Convention on the Conservation of Migratory species of Wild Animals (the Bonn Convention);
- The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78)

**National**

At the National level, the Australian Government through the Department of Environment, Water, Heritage and the Arts (DEWHA) has provided guidance with respect both preparing and using ecological character descriptions. In this context, the ECD of a wetland provides a reference for the following planning and management activities:

- development and implementation of a management plan designed to maintain the ecological character of the Ramsar site;
- the design of a monitoring program to detect change in ecological character;
- assistance in reporting to the Australian Government and the Ramsar Convention about any changes in the ecological character of Ramsar sites; and
- Environmental impact assessment of the likely impact on ecological character of proposed actions, including that required under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In relation to the last point, Ramsar sites are a key component of the matters of National Environmental Significance (NES) under which assessment and approval of controlled actions under the EPBC Act must be obtained. In practice, this is undertaken through the referral of a development proposal by a proponent to the Minister administering the Act for a determination about the likelihood of impacts to a matter of NES. For development that may affect the Moreton Bay Ramsar site, the potential for changes to the ecological character of the site (as outlined in this ECD) plays a key role in the Minister's determination of the appropriate assessment process used under the Act as well as the decision to approve a development proposal and any conditions imposed under the controlled action approval.

Of note in the context of the current study, the Moreton Bay Ramsar site is identified as generating the high number of referrals under the Act for consideration by the Minister. This is a likely reflection of the size of the site as well as the large locally resident population that is rapidly urbanising surrounding areas.

**State and SEQ Region**

There is a plethora of legislation, policies, plans and strategies that apply directly and indirectly to the conservation and wise use of the Moreton Bay Ramsar site. At the State level, legislation such as the *Integrated Planning Act 1997*, *Environmental Protection Act 1994, Fisheries Act 1994, Nature Conservation Act 1992, Coastal Protection and Management Act 1995, Water Act 2000, Vegetation Management Act 1999, Aboriginal Cultural Heritage Act 2003, Queensland Heritage Act 1992,* and their respective regulations, are applied throughout the Ramsar site. Further, the *Marine Parks Act 2004, Nature Conservation Act 1992* and *Recreation Areas Management Act 2006* are applicable in areas within the Ramsar site designated under these Acts for protection and management (e.g. as a Marine Park, National Park, Conservation Park or Recreation Area). A more substantive discussion of the applicability of these statutes to the Ramsar site is contained in BMT WBM (2008a).

Within South East Queensland (SEQ) there are additional statutory and non-statutory plans and strategies relevant to the region. Some of these plans also apply specifically to Moreton Bay. No legislation, policies, plans or strategies specifically apply to, or manage the Moreton Bay Ramsar site, although many apply to the management of aspects influencing the Ramsar values and ecological character of the site. The most relevant plans and strategies applicable to the conservation and wise use of the Ramsar site, Ramsar values and aspects of the ecological character of the site include the following:

Statutory plans, strategies and areas

- *Marine Park (Moreton Bay) Zoning Plan 1997*;
- Southeast Queensland Regional Coastal Management Plan 2006 prepared under the *Coastal Protection and Management Act 1995*;
- Protected Area Management Plans (for national parks, conservation parks and other protected areas in the region);
- Environmental Values and Water Quality Objectives under the *Environmental Protection (Water) Policy 1997*;
- *South East Queensland Regional Plan 2005*;
- Fisheries Management Plans including the East Coast Trawl and Coral Reef Fin Fish fisheries;

- Declared Fish Habitat Areas (FHAs) under the *Fisheries Act 1994*;
- Water Resource Plans prepared under the *Water Act 2000*; and
- Local Government Planning Schemes prepared under the *Integrated Planning Act 1997*.

Non-statutory plans

- SEQ Healthy Waterways Strategy – Moreton Bay Action Plan
- The Future in Balance - SEQ Catchments
- Shorebird Management Strategy – Moreton Bay

A more detailed summary and discussion of these plans, strategies and areas is contained in Appendix B.

## 3.3 Ramsar Nomination Criteria

Each site nominated under the Ramsar Convention must address some or all of the Ramsar Nomination Criteria established within the text of the Convention and amended from time to time by the Conference of Parties.

Since the Moreton Bay Ramsar site was nominated in 1993, the Nomination Criteria under the Ramsar Convention have been modified. Table 3-3 presents a comparison between the pre-1999 (as listed in the current RIS and Nomination Documentation) and the post-1999 Ramsar Nomination Criteria for identifying Wetlands of International Importance (as outlined in the Convention and National Framework document).

In the table, Nomination Criteria listed on the current Ramsar Information Sheet for Moreton Bay are underlined and italicised; noting that the Moreton Bay Ramsar site currently supports criteria 1, 2, 3, 4, 5, and 6 under the 'new' (eg. post-1999) criteria.

Criteria 7, 8 and 9 listed in Table 3-3 (which relate to criteria about fishes and wetland-dependant non-avian fauna) did not exist at the time of the nomination of the Moreton Bay Ramsar site in 1993 and as such have been evaluated in the context of the current ECD study.

The evaluation has been undertaken using the guidance and other supporting information for interpretation of the Nomination Criteria provided within the *Ramsar Handbook 14*, *Designating Ramsar sites* within the Ramsar Handbooks for the Wise Use of Wetlands 3rd Edition (published by the Ramsar Secretariat).

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**Table 3-3 Comparison of current and pre-1999 Ramsar nomination criteria**

Notes: Underlined and italicised text indicates pre-1999 nomination criteria for the Moreton Bay Ramsar site

| 'New' Criteria | Pre-1999 Criteria |
|---|---|
| **Criterion 1**: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region. | 1(a) it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region<br>*1(b) it is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region*<br>*1(c) it is a particularly good representative example of a wetland which plays a substantial hydrological, biological or ecological role in the natural functioning of an major river basin or coastal system, especially where it is located in a trans-border position*<br>1(d) it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region. |
| **Criterion 2**: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities. | *2(a) it supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species.* |
| **Criterion 3**: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region | *2(b) it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna*<br>2(d) it is of special value for one or more endemic plant or animal species or communities<br>*3(b) it regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity.* |
| **Criterion 4**: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions. | *2(c) it is of special value as the habitat of plants or animals at a critical stage of their biological cycle.* |
| **Criterion 5**: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds. | *3(a) it regularly supports 20,000 waterfowl.* |
| **Criterion 6**: A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of waterbird. | *3(c) where data on populations are available, it regularly supports 1 per cent of the individuals in a population of one species or subspecies of waterfowl.* |
| **Criterion 7**: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity. | 4(a) it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity. |
| **Criterion 8**: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. | 4(b) it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. |
| **Criterion 9**: A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species. | None. |

### 3.3.1 Justification for Listing – Criteria (1 – 6)

The justification for the listing of the Moreton Bay Ramsar site is made by a number of supporting statements in the current RIS (updated 1999) that relate back to the Nomination Criteria listed above. These have been reviewed and updated as part of the current ECD study and include the following:

**Criterion 1**

Ramsar Nomination Criterion 1 states: *A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.*

Moreton Bay is one of the largest estuarine bays in Australia enclosed by a barrier island of vegetated sand dunes.

Moreton Bay plays a substantial role in the natural functioning of a major coastal system through its protection from oceanic swells providing habitat for wetland development, receiving and channelling the flow of all rivers and creeks east of the Great Dividing Range from the McPherson Range in the south to the north of the D'Aguilar Range.

In the absence of appropriate mapping, a detailed assessment of the distribution and extent of various Ramsar wetland types is not possible at this stage (see Section 3.2.2). However, based on available information and the expert knowledge of the study team, it is known that the Moreton Bay Ramsar site contains a wide diversity of Ramsar wetland types (with up to twenty-two types represented) including several that are considered rare within the bioregion. Of particular note are the following three wetland types, all of which occur in freshwater environments, typically on sand barrier islands:

- Unforested peatland (Type U). Eighteen Mile Swamp on North Stradbroke Island contains a mosaic of unforested peatland (Type U) and forested peatland (mainly Melaleuca) (Type Xp). This wetland type is thought to be mainly resticted to offshore sand barrier islands within the biogeographic region;
- Forested peatlands (Type Xp) – see above;
- Permanent freshwater lakes (Type O). Several large, permanent freshwater lakes occur on Moreton (e.g. Lake Jabiru) and North Strabroke Island (e.g. Blue Lake, Ibis Lagoon). While Fraser Island also contains good examples of representative freshwater lakes within the biogeographic region, this habitat type is poorly represented in mainland areas within the bioregion.

**Criterion 2**

Ramsar Nomination Criterion 2 states: *A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.*

Numerous nationally and internationally threatended species occur within the site. Moreton Bay supports appreciable numbers of the nationally vulnerable green turtle *Chelonia mydas* and the endangered loggerhead turtle *Caretta caretta*. Wallum wetland habitats within the site provide habitat for the endangered Oxleyan pygmy perch *Nannoperca oxleyana*, and the vulnerable honey blue-eye *Pseudomugil mellis*, and is ranked among the top ten habitats of the IUCN listed dugong in Queensland.

Moreton Bay also supports a range of nationally threatened wetland-dependant fauna species including the wallum sedgefrog *Litoria olongburensis*, water mouse *Xeromys myoides,* and Australian painted snipe *Rostratula australis.* The internationally threatened (IUCN listed) Illidge's ant blue butterfly *Acrodipsas illidgei* also occurs in the site.

Numerous nationally vulnerable and endangered plant species exist within the Ramsar site, five of which are wetland-dependent species.

It should be noted that several other internationally and nationally marine species have been recorded in Moreton Bay, but are considered as either vagrants or do not have core habitats within the site. This includes for example whales and shark species that prefer more oceanic waters. Furthermore, hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*) and flatback (*Natator depressus*) turtles are seasonal visitors to the region, or do not have high abundances within site (Limpus *et al.* 2006). These species are therefore not considered as critical elements in the context of this ECD.

A range of state listed threatended species also occur within the site. Consistent with the National Framework, only national and international threatened species are to be considered under this nomination criteria. However, many State listed threatened species are considered as critical services in this ECD in the context of other Ramsar nomination criteria, particularly Criterion 3 (in the context of maintaining biodiversity valuyes at a regional scale), and Criteria 4-6.

The terrestrial fauna species list data sets for the South-east Queensland Bioregion and Moreton Bay presented in Appendix D were interrogated to provide a summary of threatened species for Moreton Bay. Table 3-4 provides a full listing of threatened species (wetland-dependent or otherwise). Of these species, the wetland-dependant species of conservation significance are regarded as providing critical ecosystem services in the context of the ECD.

**Table 3-4 List of threatened terrestrial fauna species known to occur in the Moreton Bay region and their primary habitat types**

| Family | Scientific Name | Common Name | NCA | EPBCA | IUCN | Habitat Types (see footnote below for codes) |
|---|---|---|---|---|---|---|
| Pteropodidae | *Pteropus poliocephalus* | grey-headed flying-fox | C | V | V | Not wetland-dependent taxa - Open forests, wet sclerophyll forests, closed forests wherever flowering trees occur. |
| Muridae | *Xeromys myoides* | false water-rat | V | V | V | H & I |
| Myobatrachidae | *Adelotus brevis* | tusked frog | V | | Near Threatened | M, N, O, Tp,Xf, & 9 |
| Myobatrachidae | *Crinia tinnula* | wallum froglet | V | | V | K, O, Tp, U, W, Xf, Xp, & 9 |
| Hylidae | *Litoria olongburensis* | wallum sedgefrog | V | V | V | K, O, Tp, Ts, & Xp |

| Family | Scientific Name | Common Name | NCA | EPBCA | IUCN | Habitat Types (see footnote below for codes) |
|---|---|---|---|---|---|---|
| Hylidae | *Litoria cooloolensis* | Cooloola sedgefrog | R | | E | O & Tp |
| Hylidae | *Litoria freycineti* | wallum rocketfrog | V | | V | O, Tp, Ts, & Xp |
| Ardeidae | *Botaurus poiciloptilus* | Australasian Bittern | | | E | Tp & Xp |
| Turnicidae | *Turnix melanogaster* | black-breasted button-quail | V | V | V | Not wetland-dependent taxa - dry closed forests (esp. semi-evergreen vine thickets) & softwood scrubs. |
| Rostratulidae | *Rostratula australis* | Australian painted snipe | V | V | | H, J, K, Tp, Ts & Xp |
| Burhinidae | *Esacus neglectus* | beach stone-curlew | V | | Near Threatened | E, G, H, K, Tp, Ts, |
| Laridae | *Sterna albifrons* | little tern | E | | Least Concern | A, E, & F |
| Lycaenidae | *Acrodipsas illidgei* | Illidge's ant blue butterfly | V | | E | I & Xp |

Where applicable, habitat types in Table 3-4 follow those listed under the current Ramsar Information Sheet (1999) for Moreton Bay, i.e.:

<u>Coastal Marine Wetland Types (11)</u>

Type A: Permanent shallow marine waters

Type B: Marine subtidal aquatic beds (seagrass beds)

Type C: Coral reefs

Type D: Rocky marine shores

Type E: Sand, shingle or pebble shores

Type F: Estuarine waters (permanent water of estuaries and estuarine systems of deltas)

Type G: Intertidal mud, sand or salt flats

Type H: Intertidal marshes (saltpan vegetation on marine clay plains, as well as saline or brackish sedgelands)

Type I: Intertidal forested wetlands

Type J: Coastal brackish/saline lagoons

Type K: Coastal freshwater lagoons (freshwater delta lagoons)

<u>Inland Wetland Types (9)</u>

Type L: Permanent inland deltas

Type M: Permanent rivers / streams / creeks

Type N: Seasonal rivers / streams / creeks

Type O: Permanent freshwater lakes (Permanent freshwater bodies over 8ha in area)

Type Q: Permanent saline / brackish / alkaline lakes

Type Tp: Permanent freshwater marshes / pools

Type Ts: Seasonal / intermittent freshwater marshes / pools on inorganic soils

Type U: Non-forested peatlands (Eighteen Mile Swamp)

Type W: Shrub-dominated wetlands (Bribie Island National Park)

Type Xf: Freshwater tree-dominated wetlands (open forests dominated by *Melaleuca quinquenervia*)

Type Xp: Forested peatlands (Eighteen Mile Swamp)

<u>Man-made Wetland Types (1)</u>

Type 9: Canals, drainage channels and ditches

**Criterion 3**

Ramsar Nomination Criterion 3 states: *A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.*

The Moreton Bay Ramsar site contains high biodiversity values at a bioregional scale. The site has a high level of habitat diversity (and associated species richness) at a bioregional scale, and includes most wetland types found in the bioregion. The site is thought to provide a refuge and source of propoagules for marine species within and external to bioregion. The site has the following biodiversity values for key wetland species groups:

- Moreton Bay supports ~275 species of macroalgae, which represents ~40% of the macroalgae species reported in Queensland (Phillips 1998). A large proportion of these species occur in the site, although this figure does include reef areas outside the boundaries of the site. Overall, tropical/subtropical species predominate (~64% of species), and several of which have their southernmost distribution limit in the Bay. The warmer waters within the Bay relative to oceanic water temperatures may provide refugia for tropical species. Temperate species represent ~15% of the species, although few species have their northern-most distribution limit in the Bay (Phillips 1998).

- The site contains seven species of seagrass (Abal *et al.* 1998), which includes all five species recorded in the bioregion by Coles *et al*. (1989), as well as *Halophila decipens*. Moreton Bay, like Hervey Bay to the north, provides optimal habitat conditions for seagrass species (i.e. large interdal babnks, high water clarity, relatively sheltered areas etc). Consequently, the site has a larger number of seagrass species compared to most riverine estuaries in the bioregion, which are typically comprised of one to three species (typically *Zostera muelleri*, together with *Halophila ovalis* and sometimes other species).

- The site supports seven species of mangrove (Abal *et al.* 1998). This represents 50% of the total number of mangrove species recorded in the south-east Queensland region (Duke 2006). The site represents the southernmost distribution limit of *Lumnitzera racemosa*. Six of the seven species recorded in Moreton Bay have been recorded in northern NSW (Duke 2006), and it is possible that the site provides a source of propagules to other areas within the bioregion.

- The site supports a rich terrestrial flora assemblage, with for example, 824 native plant species recorded from North Stradbroke Island alone (Queensland Herbarium 2005). Some flora species are thought to be restricted to the site, and therefore contribute to bioregional biodiversity.

- Moreton Bay supports ~3,225 species of marine invertebrates, although this figure also includes records from offshore reef sites outside the site (Davie and Hooper 1998). No comprehensive account of marine invertebrate diversity is available for the bioregion, although Davie and Hooper (1998) argue that the Bay:
  - has a wide diversity of habitats and constituent species in a relatively small area.
  - has many species that appear to be endemic (or undescribed);

- o lies on a biogeographic overlap zone and provides "…a refuga for both temperate and tropical species, some of which are apparently not found in neighbouring regions."

- Moreton Bay supports ~750 marine fish species (Johnson 1999). Comparisons with other estuaries is complicated by patterns in habitat selectivity and differences in habitat types. Shoalwater Bay, which has similar habitat types as Moreton Bay, contains ~413 species of estuarine and marine fish (Johnson 1999). Most other estuaries in the bioregion, which typically have less complex habitat and are generally smaller in area, would generally have lower species richness than Moreton Bay.

- The freshwater invertebrate and fish fauna of the site are compartiavely less well known. The sand barrier islands contain wallum/humic specialists (e.g. Oxlyan pymgmy perch *Nannopera oxleyana*; the zooplankter *Calamoecia tasmanica*, the dragonfly *Petalura gigantea* etc.) as well as species that have more generalist habitat requirements (Arthington and Watson 1982; Arthington 1996). The wallum/humic specialists are found in a small number of waterbodies within the bioregion, hence their presence at the site contributes greatly to bioregional biodiversity values.

- All six marine turtle species known to occur in Australian waters have been recorded in Moreton Bay (Limpus *et al.* 2006). With the exception of Hervey Bay, no other estuaries in the bioregion are known to contain this level of biodiversity.

- At least 42 species of shorebirds use intertidal habitats in the Bay, including 32 migratory species listed by JAMBA, CAMBA and ROKAMBA.

- The site contains approximately 59% of the total number of number mammal, reptile, amphibian and bird species known to occur in the SEQ bioregion (see Table 3-5). Refer to Appendix D for species lists.

**Table 3-5 Number of terrestrial fauna species in the SEQ Bioregion and in Moreton Bay**

| Taxa | SEQ Species Richness | Moreton Bay species Richness (% of SEQ species) |
|---|---|---|
| Mammals | 91 | 45 (49%) |
| Reptiles | 151 | 52 (34%) |
| Frogs | 49 | 26 (53%) |
| Birds* | 403 | 290 (72%) |
| **Total** | **694** | **413 (59%)** |

* excludes oceanic species that do not use habitats found in the site (e.g. petrels, albatross, skuas, some terns, jaegers, tropibirds etc.)

**Criterion 4**

Ramsar Nomination Criterion 4 states: *A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.*

The Ramsar site provides habitat for a range of important wetland and aquatic fauna at a critical life stage. This includes the following:

- The site is an important wintering area for migratory shorebirds.
- The site is an important breeding (nesting) area for a number of waterbirds and shorebirds. Key waterbird and shorebird species are listed in Appendix D.
- The site is an important feeding area for green and loggerhead turtles.
- The site is an important feeding and breeding area for dugong.
- The site has the most significant concentration of young and mature loggerhead turtles in Australia.
- The site represents important nursery grounds for a range of marine fish, prawns and crabs, many of which are of commercial significance.

**Criterion 5**

Ramsar nomination Criterion 5 states*: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.*

Moreton Bay can support more than 40,000 migratory shorebirds during the non-breeding season (Austral summer).

Table 3-6 is a summary of the total number of shorebird species known to occur in the South-east Queensland Bioregion and Moreton Bay (refer to Appendx D for a detailed list of species). This table shows that ten resident and 32 migratory shorebird species are regularly recorded in Moreton Bay (Thomson 1990; EPA 2005b). Note that the term shorebird is a generic term used to describe both resident and migratory species from the following families: Scolopacidae; Burhinidae; Haematopodidae; Recurvirostridae; Racanidae; Charadriidae; and Glareolidae.

**Table 3-6 Number of shorebird species in the SEQ Bioregion and in Moreton Bay**

| Category | SEQ Species Richness | Moreton Bay Species Richness |
|---|---|---|
| INBM – International non-breeding migrant | 34 | 34 |
| BR – breeding resident | 12 | 12 |
| ANBR – Australian non-breeding resident | 3 | 1 |
| PBR – possible breeding resident (though no breeding records to date) | 1 | 1 |
| **Total Species Richness** | **50** | **48** |
| V - Vagrant | 8 | 6 |

**Criterion 6**

Ramsar Nomination Criterion 6 states*: A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of waterbird.*

A total of 57 of the 66 waterbirds known from the SEQ bioregion have been recorded in Moreton Bay (see Appendix D for species list). Note that the term waterbird refers to those species found predominantly on freshwater ecosystems in Australia from the six major orders Anseriformes (ducks, geese and Black Swan), Podicipediformes (grebes), Pelecaniformes (Australian Pelican and cormorants), Ciconiiformes (herons, ibis, spoonbills and bitterns), Gruiformes (cranes, rails, crakes and gallinules), and Charadriiformes (waders and terns) (after Kingsford & Norman 2002).

The 1% species population threshold is exceeded for the following avifauna species: bar-tailed godwit *Limosa lapponica*, whimbrel *Numenius phaeopus*, Eastern curlew *Numenius madagascariensis*, terek sandpiper *Xenus cinereus*, grey-tailed tattler *Heteroscelus brevipes*, curlew sandpiper *Calidris ferruginea,* pied oystercatcher *Haematopus longirostris*, Pacific golden plover *Pluvialis fulva*, and Lesser sand plover *Charadrius mongolus* (see data in Bamford *et al.* 2008).

### 3.3.2 Justification for Listing – Criteria (7 - 9)

As part of the current study, it is recommended that criteria 7 and 8 are also supported by the Moreton Bay Ramsar site and should be included in the revision of the RIS.

While it is likely that Moreton Bay supports more than 1% of the individuals in a biogeographic population of several non-avian species (eg. Criterion 9), there is insufficient published data about populations across the biogeographic region to verify this (a stated requirement in the Ramsar Nomination Guidelines). On this basis, justification for inclusion of the site on the basis of Criterion 9 has not been recommended at this time but is discussed below for future consideration.

**Criterion 7**

Ramsar Nomination Criterion 7 states*: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages,* *species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.*

Moreton Bay contains an appreciable diversity of fish with ~750 fish species represented and over 3000 species of free living marine invertebrates (Johnson 1999).

Situated within the Moreton Tweed Marine Bioregion (IMCRA), Moreton Bay lies within a transition zone that supports both temperate and tropical fish and crustacean species. High levels of biodiversity are also supported by the unique geography and diversity of habitat types found within the site that include both nutrient-rich inshore components (made up of intertidal and shallow estuarine habitats) and more oligotrophic offshore components (made up of sandy beaches, channels, banks and bars).

Moreton Bay contains assemblages of fish that are representative of the marine and terrestrial bioregions, with at least one species with a restricted geographic distribution having core populations within the site (including Oxleyan Pygmy Perch).

**Criterion 8**

Ramsar Nomination Criterion 8 states*: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.*

Moreton Bay provides important habitats, feeding areas, dispersal and migratory pathways, and spawning sites for numerous fish species of direct and indirect fisheries significance. These fish have important fisheries resource values both within and external to the site.

Key fish species of significance include flat tailed mullet, sea mullet, fantail mullet, sand flathead, dusky flathead, tailor, spotted mackerel, golden lined whiting, eels, diver whiting, yellow finned bream and tarwhine. Significant nektobenthic crustacean species include banana, king, endeavour, tiger, school and greasy back prawns; mud, blue swimmer, red-spot, spanner and coral crabs; and Callianisidae shrimps. Other species of commercial significance include bait worms, squid, cuttlefish, rock oysters and beche-de-mer.

Many of the fish and crustacean species listed above spend their juvenile stages in shallow nearshore waters of the site, particularly around mangroves and seagrass habitats. These species also spawn in inshore waters, particularly near the surf zone and in sandy channels within the boundaries of the Ramsar site.

**Criterion 9**

Ramsar Nomination Criterion 9 states: *A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.*

Criterion 9 relates to non-avian wetland taxa including, *inter alia*, mammals, reptiles, amphibians, fish and aquatic macro-invertebrates. Some of the key non-avian wetland species within Moreton Bay that are appropriate to consider in the context of Criterion 9 would include:

- acid frogs (wallum froglet, wallum rocketfrog, wallum sedgefrog, Cooloola sedgefrog);
- water mouse;
- Illidge's ant blue butterfly;
- dugong;
- green and loggerhead turtles;
- Oxleyan pygmy perch; and
- honey blue-eye.

Furthermore, Davie and Hooper (1998) note that at least 27 marine macroinverebrate species are known only to occur in Moreton Bay. These species may be either locally endemic species (i.e. restricted to the Bay) that are either relics from more widespread habitats that have been restricted to the Moreton Bay area, or are species that may occur elsewhere outside the site but have so far remained undetected due to limited sampling effort.

In interpreting the application of Criterion 9 to these species, Ramsar Handbook 14 indicates that reliable population size limits from published sources must be included in the justification for the application of the Criterion.

Investigation of survey data for these species as part of the current study has shown such data is largely incomplete and forms an information gap. On this basis, there is not definitive data from which to determine the applicability of the Criterion. However, it is noted that expert opinion provided by various researchers to the study team as part of the study supports the view that the criterion is met by several of the species listed above. This is documented for particular species within sections 7.3 and 7.4 of this report.

# 4 SUMMARY OF CRITICAL SERVICES, COMPONENTS AND PROCESSES

## 4.1 Introduction

Section 4 of the report summarises the *critical* services/benefits, components and processes that make up the ecological character of the Ramsar site and provides the limits of acceptable change to those critical elements. The Section is set out as follows:

- Section 4.1 outlines the methodology used in the selection of the critical services/benefits, components and processes for the site;
- Section 4.2 summarises the nominated critical services and underlying critical components and processes of the Ramsar site; and
- Section 4.3 provides a summary of the limits of acceptable change developed for the site including the methodology used to derive them.

More detailed information about the critical services is presented in Section 7 of the report which provides a more complete discussion of each critical service/benefit and its underlying wetland ecosystem components and processes.

### 4.1.1 Methodology – Information Collation and Review Stage

The first step in ECD preparation outlined the National Framework document is to identify the wetland services/benefits, wetland components and wetland processes present in the Ramsar site. These key terms are defined in Section 2 of the Report and the Glossary (refer Section 9). This was initiated by undertaking a process of information collation and literature review.

As part of the information collation phase, literature and existing data relevant to the study area (whole-of-bay and catchment scale) and site were collated and reviewed. Relevant existing information was sourced from the following:

- Published scientific papers;
- Database records (EPBC, Wildnet, etc.);
- Mapping products supplied by the EPA (RE data, wetland mapping);
- Management plans, strategies and other policy documents;
- EIS and other applied studies that involved assessment of Ramsar values;

- Academic theses; and
- Grey literature from internet searches and other sources of data

Many articles, information and data sets were obtained from the EPA project team and by following up suggestions and recommendations about sources of information from the Project Steering Group and Knowledge Management Committees.

Each article of information was collated to a cursory level sufficient to determine its relevance to the study. The collected information was then reviewed to prioritise and identify information of direct relevance to the ECD.

As part of the information collation phase, key information gaps were identified on the basis of these reviews and further information was sought from the Knowledge Management Committee as part of its first meeting.

Key experts in relevant fields were also contacted and interviewed as part of the study as outlined in Section 9 and in Appendix A.

### 4.1.2 Methodology – Selection of Critical Services

Following the information collation and review phase, the study team collectively identified the potential services/benefits of the wetland. This process was based primarily upon a review of the literature and professional opinion. Wetland benefits/services were identified first as a means of facilitating the identification of the more generic wetland processes and wetland specific components (eg. wetland types and noteworthy flora and fauna species) that underpin these services.

Using the categories and list of services/benefits from the National Framework as a guide, it was apparent that the Moreton Bay Ramsar site provides a broad spectrum of services/benefits. This included: provisioning services such as provision of food in the form of fisheries and fresh water supply (through groundwater extraction), regulatory services such as erosion protection and climate regulation, cultural services such as recreational and tourism, cultural heritage, education and research and supporting ecosystem services such as biodiversity and the presence of endangered and vulnerable species.

Likewise, given the scope, areal extent and diversity of wetland environments present within the Moreton Bay Ramsar site, all wetland ecosystem processes from the National Framework were seen as occurring within the site, including a broad range of hydrological, climatic, geomorphologic, physico-chemical, biogeochemical and biological processes. It was noted that while each of these processes play a part in underpinning normal wetland functioning, many of these factors such as coastal hydrodynamics and climate operate at both regional scales and local scales.

As outlined in Section 3, a range of wetland habitat types are known to be present within the site boundaries including those designated within the coastal/marine, inland and man-made wetland categories under the Ramsar classification scheme. Within these systems, a rich diversity of wildlife exists from all the major groups of organisms (from planktonic organisms to vertebrates) which make up the key components of the wetland.

With the full range of ecosystem services/benefits, components and processes represented, there was a need to identify the most important or *critical* in the context of the Ramsar site, and the supporting critical components and processes that contribute to delivery of those services.

Following the methodology within the National Framework, the assignment of a given wetland process, component or service as *critical* was guided by the following considerations:

- The service or underlying component/process is important for supporting one or more of the Ramsar Nomination criteria under which the site was listed (refer Section 3.3); or
- The service or component/process is an important determinant of the uniqueness of the site; or
- The service or component/process may be subject to change in short to medium time frames (<100 years) and/or the change will cause potentially significant consequences (eg. change the ecological character).

To supplement these criteria, it was decided as part of the ECD process that additional consideration would be given to:

- Suggestions or recommendations regarding critical services, components or processes by Knowledge Management Committee/SEP experts (particularly where such information was documented in scientific literature) – refer Appendix A; and
- For cultural services, reference to Ramsar's 9$^{th}$ Conference, Resolution IX.21 – "Taking into account the cultural values of wetlands" – which identified the following cultural characteristics as relevant in the designation of Ramsar sites:

  *i) Sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland;*

  *ii) Sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland;*

  *iii) Sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples;*

iv) *Sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland.*

Following this internal prioritisation process, a list of draft critical services/benefits and underpinning components and processes was developed by the study team. Ecosystem components (such as habitats, species and populations) and ecosystem processes (such as hydrology) were identified as critical where such features or processes were seen as underpinning one or more nominated critical services.

The Nomination Criteria for the site were used as the primary consideration in selecting the draft critical services/benefits (principally relating to the wetland's ecological values) along with the selection of several cultural services such as site's fisheries values, the significance of the site to indigenous peoples, as well as the education and research and tourism and recreational values of the site. Evaluation of other ECD documents undertaken for large estuaries, such as the draft ECD prepared for the Great Sandy Straits and the ECD for the Coorong Lakes region in South Australia were also considered as part of the nomination process.

Using the draft list of critical services/benefits, the study team conducted a one day workshop with the Knowledge Management Committee (KMC). The primary purpose of the first KMC meeting was to undertake a parallel validation process of the study team's critical service selections with the committee of experts using a workshop to identify the key habitats of the site. This process served to confirm the identification of the critical services as well as to identify additional services, components or processes that were perceived to have been overlooked.

In general there were minimal changes to the draft critical services that were presented to the Knowledge Management Committee and the critical services/benefits presented in Section 4.2. However, the Committee provided significant assistance to the study team in identifying the key linkages between the services and the key wetland ecosystem components and processes and were able to provide guidance about the processes and components most important to maintenance of the service.

### 4.1.3 Methodology – Selection of Critical Flora and Fauna Species

The critical services/benefits presented in Section 4.2 are underpinned by the identification of several critical flora and fauna species that relate to the Nomination Criteria for the site and serve as *de-facto* indicator species for the purpose of assessing ecological character.

<u>Flora</u>

In nominating particular wetland **flora** species/communities for consideration under the critical services, the following considerations were applied –

1. Species must occur in aquatic environments (eg. macrophytes) or are otherwise considered to be wetland species; and

2. Species are listed as threatened (ie. vulnerable or endangered) at the National (threatened under EPBC Act) and/or International (i.e. IUCN) level; or

3. Communities that are classified as wetlands and designated as Endangered under the EPBC Act were considered.

Fauna

In nominating particular **fauna** species/groups for consideration under the critical services, the following considerations were applied –

1. Species must occur in aquatic or marine environments or are otherwise considered to be wetland-dependant terrestrial species (refer Glossary in Section 9 for definitions of these terms). It is acknowleged that many other terrestrial fauna (and flora) species also occur in the site that, while important to the maintaince of biodiversity values of the site, are not necessarily key wetland elements. Key threatened terrestrial species are listed in Appendix D of the ECD, and have also been considered in the context of the nomination criteria (Criterion 2 and 3). However, due to a lack of dependence on the wetland values of the site, none of these terrestrial species are viewed as critical elements in the context of this ECD report; and

2. Species should be either:

    a. designated as threatened (eg. endangered or vulnerable) at a national scale (listed as threatened under the EPBC Act) or international scale (i.e. threatened under IUCN Red List); and/or

    b. Particularly noteworthy or critical from a regional biodiversity perspective (i.e. refer to Criteria 3 or 7). This includes species that are perceived by the authors to be iconic to the site, and must also be designated as threatened under Queensland legislation (i.e. endangered or vulnerable at a State scale). In the context of this report, the key species considered here are beach stone curlew and little tern.

3. Given the boundaries of the Ramsar site are largely confined to near-shore areas, emphasis has been placed on species that use the site as core habitat, have significant population numbers and spend a large proportion of their life cycle within the site boundaries. This excludes vagrant species such as whales, sharks and some marine turtles (hawksbill, olive ridley, leatherback) that may only occur in the Ramsar site infrequently.

Based on the above, in general terms, species that are listed as migratory or marine species under the EPBC Act or listed as 'rare' under national or state species lists have not been nominated as key species under the ECD unless they otherwise meet the above criteria.

### 4.1.4 Methodology – Selection of Representative Habitat Types

The Moreton Bay Ramsar site contains marine, estuarine, palustrine, lacustrine and terrestrial biotopes. Several of these wetland habitats are considered, either individually or collectively, to represent particularly outstanding examples of near-natural ‘reference’ areas within the biogeographic region. This is important in the context of Service 2 (refer Section 4.2).

While it is acknowledged that there are numerous examples of such habitat areas within the site, for reporting purposes the study team identified six key wetland representative areas. These are:

a. Seagrass and shoals in the Eastern Banks area;

b. Intertidal flats and estuarine assemblages in the Pumicestone Passage area;

c. Mangroves and saltmarsh associated with the islands in the Southern Bay;

d. Coral communities of the Eastern Bay;

e. Freshwater wetlands (including wallum and peatlands) of Moreton and North Stradbroke Islands;

f. Ocean beaches and foredunes on Moreton Island

These wetland areas were selected on the basis that they:

- are in natural or near-natural condition (relevant to Ramsar Nomination Criterion 1);
- contain representative examples of the key habitats within the site;
- contain excellent representative examples of various wetland habitat types within the biogeographic region;
- support many or all of the ten (10) critical wetland services nominated by the ECD; and
- contain wetland habitats of recognised high conservation significance, as prescribed under legislation (protect areas) and State plans (i.e. Queensland State Coastal Plan).

The representative wetland habitat areas provide specific areas within the broader site for assessing limits of acceptable change and provide priority sites for future monitoring and research.

Further information about the representative habitat types are contained in Section 7.2 of the report.

## 4.2 Overview of Critical Services/Benefits

A graphic and summary table listing the critical wetland services/benefits, components and processes for the Moreton Bay Ramsar site are shown in Figure 4-1 and Table 4-1 respectively.

As outlined above, the ten (10) critical services/benefits have been developed principally through identification of key services/benefits that relate back to the key Ramsar Nomination Criteria for the Moreton Bay Ramsar site but also include several cultural and provisioning services that are seen as particularly important or noteworthy in the context of the benefits derived from the site.

In many cases there is a direct relationship between the critical services and wetland habitat types (such as seagrass meadows or mangrove swamps) or noteworthy fauna (endangered and vulnerable flora or fauna). In this way, many of these habitats and species are effective surrogate measures for maintenance of the wetland service and broader ecological character of the wetland.

Critical processes have been selected on the basis of their importance in underpinning the critical services/benefits and in considering the wetland habitat and noteworthy flora and fauna that make up the critical components.

It should be noted that the box model shown in Figure 4-1 does not seek to prioritise or provide any hierarchy to the processes, components and services presented; its role is simply to show the approach to categorisation of the critical elements in accordance with the guidance in the National Framework document.

The interaction of wetland services/benefits, processes and components is shown in Figure 4-2. As shown in the figure, there are three broad processes identified (climate, geomorphology and regional-scale hydrodynamic and hydrological processes) that together have shaped the topography, tidal flushing regime and other important aspects of the site. At the local habitat scale, there is a mix of physical and chemical processes as well as biological processes that control the wetland habitats and associated biota.

The interaction of the wetland components with the wetland processes yields a range of wetland benefits and services (shown in the yellow box in Figure 4-2) that are supporting (ecosystem services) and cultural (relevant to providing a social or economic benefit to humans).

Within the cultural services, two services – related to fisheries and indigenous significance – also have a provisioning aspect e.g. humans are taking and using direct products from the wetland.

Conceptual models have also been prepared for the six representative habitat types and can be found in Section 7.2 of the report. These models demonstrate the interaction between the wetland services, components and processes at a habitat scale.

Semi-quantitative and qualitative descriptions are provided of the critical components, processes and services of the site. While acknowledging that quantitative descriptions may provide more detailed information, it was the view of the study team that such an approach was not justified given most environmental parameters show great variation across a wide range of spatial (measured in meters to 100's of kilometres) and temporal (diel, diurnal, daily, seasonal, inter-annual) scales, and it is therefore often difficult to provide meaningful empirical data without fully explaining the context of this variability. Furthermore, with few exceptions, quantitative data are typically unavailable for most species and environmental parameters, which could lead to biases towards those attributes that are more easily or intensively studied. Consequently, the reader is referred to the original data sources (cited in this report) that have been used to describe the critical components, processes and services.

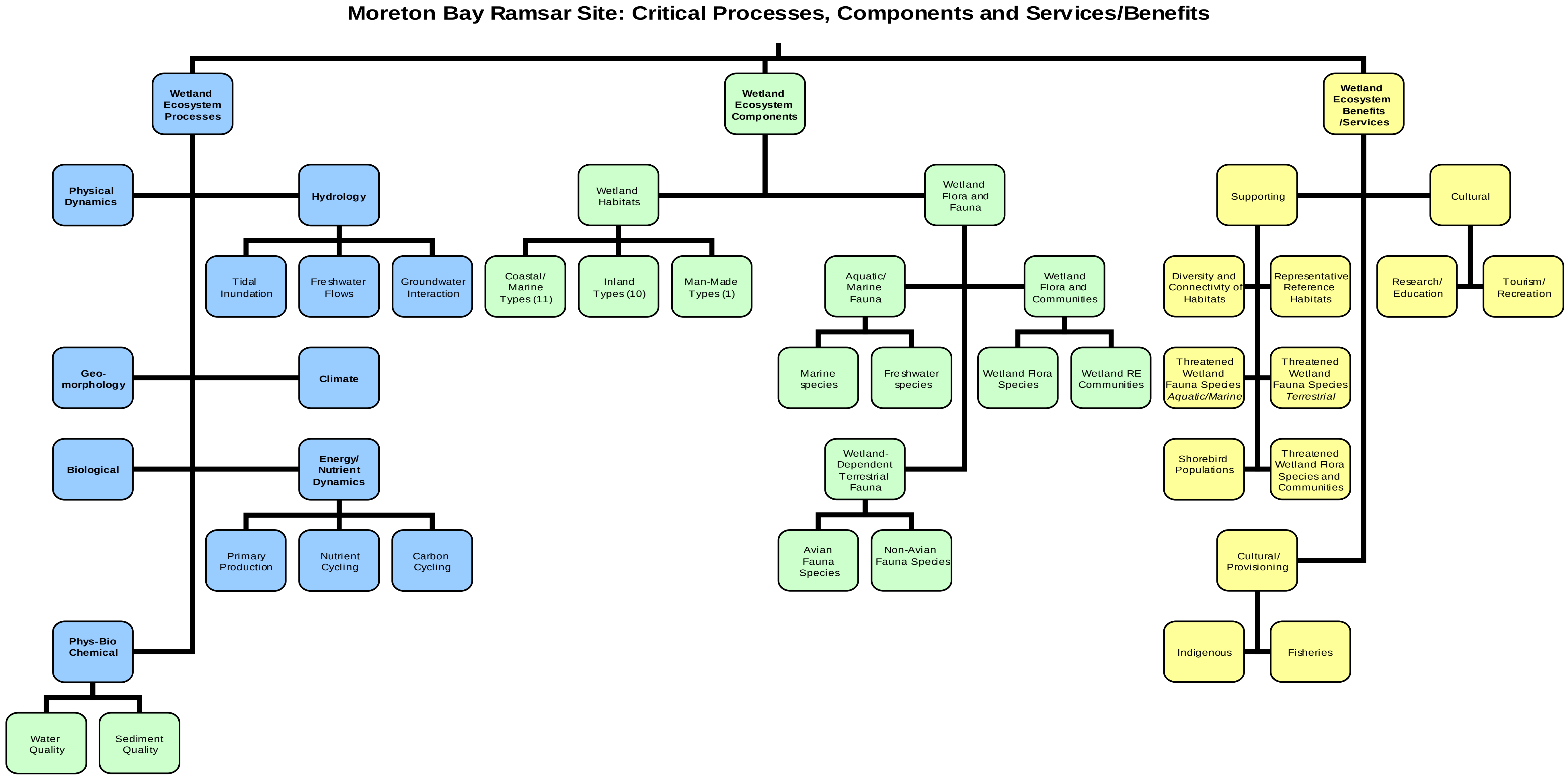


**Figure 4-1** Graphical Depiction of Critical Services/Benefits, Components and Processes

**Table 4-1 Summary of Critical Services/Benefits, Components and Processes**

| Critical Service/Benefit | Nomination Criteria and Service Type | Underlying Critical Components | Underlying Critical Processes[3] |
|---|---|---|---|
| **S1.** Moreton Bay Ramsar site contains a **diversity** of wetland habitat types that are **representative** of a major coastal wetland aggregation and in many areas show a high degree of **connectivity** between habitat types. | Criterion 1<br><br>*Supporting* | Across the site there are 22 Ramsar Wetland types represented<br><br>Of these:<br>• 11 are classified as coastal/marine<br>• 10 are classified as inland waters<br>• 1 is classified as man-made<br><br>Several habitat types are highly localised (eg. rare) in the context of the bioregion and within the site itself including Type U – non-forested peatlands and Type O – permanent freshwater lakes. | Broad-scale processes including:<br>• **Physical Coastal Processes.** Hydrodynamic controls on habitats through tides, currents, erosion and accretion<br>• **Hydrology.** Patterns of tidal inundation and freshwater flows to wetland systems<br>• **Groundwater.** For those wetlands influenced by groundwater interaction, the level and quality of the groundwater table<br>• **Energy and Nutrient Dynamics.** Primary productivity and the natural functioning of carbon and nutrient cycling processes<br>• **Biological Processes.** Important biological processes such as growth, reproduction, recruitment, migration and dispersal<br>• **Water Quality.** Water quality that provides aquatic ecosystem values within wetland habitats<br>• **Climate.** Patterns of temperature, rainfall and evaporation<br>• **Geomorphology**. Key geomorphologic/topographic features of the site |

| Critical Service/Benefit | Nomination Criteria and Service Type | Critical Habitat Component (Reference site in parenthesis) | Underlying Critical Processes |
|---|---|---|---|
| **S2.** Moreton Bay Ramsar site contains several critical **wetland habitat types**. | Criterion 1<br><br>*Supporting* | S2A Seagrass and shoals (Eastern Banks Area) | • **Physical Coastal Processes**. Natural coastal processes and hydrodynamics such as current, waves, erosion and accretion (eg. hydrodynamic controls on the topography of the habitat)<br>• **Water Quality**. Particularly, light penetration, salinity, turbidity, suspended solids, and nutrients<br>• **Energy and Nutrient Dynamics.** Primary productivity and the functioning of carbon and nutrient cycling processes<br>• **Biological Processes**. Biological processes that maintain and control habitat condition, including plant growth and reproduction, and grazing |

[3] Note that while there are many ecosystem processes that apply, the dot points listed are those considered to be the most important/critical to the maintenance of the critical components and critical service/benefit

| | | | |
|---|---|---|---|
| Reference sites have been selected within these critical habitat types that are **in a near natural state** and are **representative** of the habitat type within the broader biogeographic region. | | S2B Tidal Flats and estuarine assemblages (Pumicestone Passage) | • **Hydrology.** Natural patterns of tidal inundation and freshwater flows<br>• **Physical Coastal Processes**. Natural coastal processes and availability of habitat (eg. accretion and erosion of key intertidal habitats), as well as tidal and current velocity<br>• **Water and Sediment Quality**. Particularly, suspended solids, nutrients, toxicants, and salinity<br>• **Biological processes**. Biological processes that maintain and control habitat condition, including grazing, plant growth and reproduction. |
| | | S2C Mangroves and saltmarsh (Southern Bay) | • **Hydrology.** Natural patterns of tidal inundation and freshwater flows to wetland systems<br>• **Energy and Nutrient Dynamics.** Primary productivity and the functioning of carbon and nutrient cycling processes<br>• **Physical Coastal Processes**. Natural coastal processes and availability of habitat (eg. accretion and erosion of key intertidal habitats), as well as tidal and current velocity<br>• **Biological Processes**. Biological processes that maintain and control habitat condition, including grazing, plant growth and reproduction.<br>• **Sea level rise**. Controls on mangrove colonisation into saltmarsh areas in response to sea level rises. |
| | | S2D Coral Communities (Eastern Bay) | • **Physical Coastal Processes**. Natural coastal processes and hydrodynamics such as current, waves, erosion and accretion (eg. hydrodynamic controls on the topography/morphology of the habitat such as depth)<br>• **Water Quality.** Particularly light penetration, salinity, turbidity, temperature, suspended solids, nutrients, and toxicants<br>• **Energy and Nutrient Dynamics.** Primary productivity and the functioning of carbon and nutrient cycling processes are maintained<br>• **Biological Processes**. Maintenance of essential biological processes that maintain and control habitat condition, including grazing, and plant growth and reproduction. and predation |
| | | S2E Wallum and peatland freshwater wetlands (Bay Islands) | • **Water Quality.** Particularly pH, nutrients and dissolved oxygen<br>• **Groundwater.** Water depth and groundwater interaction in lakes, bogs and creeks and groundwater interactions with surface water<br>• **Climate.** Precipitation and evaporation rates will determine supply and water levels in these environments<br>• **Geomorphology.** Topography of these features (eg. depth) is critical to their long term condition.<br>• **Fire Regime.** Natural fire regime can control extent and condition in relation to these island wetlands |
| | | S2F Ocean Beaches and foredunes (Moreton Island) | • **Physical Coastal Processes**. Natural coastal processes and hydrodynamics such as current, waves, erosion and accretion (eg. hydrodynamic controls on the morphology of the habitat)<br>• **Wind-Driven Processes.** Particularly as it affects fine sediment erosion and deposition processes.<br>• **Biological Processes**. Structural habitat and vegetation cover particularly in dune areas will affect nesting habitat. |

| Critical Service/Benefit | Nomination Criteria and Service Type | Underlying Critical Components | | Underlying Critical Processes |
|---|---|---|---|---|
| | | **Key Wetland Habitat** | **Noteworthy Flora and Fauna Species** | |
| **S3.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered marine/aquatic fauna | Criterion 2<br>Criterion 4<br><br>*Supporting* | Seagrass, reefs, nearshore open waters and rivers, offshore coastal environments | Dugongs, green, loggerhead, turtles | See S1 and S2A above |
| | | Dune lakes and creeks on sand islands<br>Wallum habitats adjacent to Pumicestone Passage | Oxleyan pygmy perch<br>Honey blue-eye (mainland only) | See S1 and S2E above |
| **S4.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered wetland–dependant terrestrial fauna species | Criterion 2<br>Criterion 4<br><br>*Supporting* | Flats (sand, mud, and bars)<br>Sandy Beaches<br>Mangroves and Saltmarsh | Little tern<br>Beach stone-curlew<br>Water mouse<br>Illidge's ant blue butterfly | See S1 and See 2B above |
| | | Wallum habitats adjacent to Pumicestone Passage and on the sand islands | Wallum sedgefrog; wallum rocketfrog; wallum froglet; Cooloola sedgefrog;<br>Australian painted snipe<br>Australasian bittern | See S1 and S2E above |
| **S5.** Moreton Bay Ramsar site supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems | Criterion 2<br>Criterion 4<br><br>*Supporting* | Key Ramsar wetland types for wetland flora and communities include:<br>• Intertidal forested wetlands (Type I)<br>• Permanent streams and creeks (Type M)<br>• Freshwater marshes and pools (Types Tp and Ts)<br>• Freshwater tree-dominated wetlands (Type Xf). | Several vulnerable and endangered wetland flora species have been identified within the Ramsar site. These include:<br>• Swamp Daisy<br>• Knotweed<br>• Lesser Swamp Orchid<br>• Yellow Swamp Orchid<br>• Swamp Orchid | See S1 and S2E above plus:<br>• **Geomorphology.** Stabilisation of substrate (vegetation cover, maintenance of natural sand/sediment transport patterns) important for retention of soils<br>• **Biological processes.** Growth, reproduction and maintenance for population viability of key plant species and communities |
| **S6.** Moreton Bay Ramsar site supports significant populations (more than 20 000 in total and over 1% of the population size of particular populations of shorebirds | Criterion 3, 5, 6<br><br>*Supporting* | Intertidal flats (sand, mud, and bars) +/-<br>Seagrass beds<br>Sandy Beaches<br>Coral rubble on islands (Eastern Bay)<br>Sparsely vegetation salt marsh and freshwater marshes (Western Bay) | Migratory Waterbirds (>20 000 and up to 50 000)<br>Species exceeding the 1% criterion are as follows: bar-tailed godwit, whimbrel, Eastern curlew, terek sandpiper, grey-tailed tattler, curlew sandpiper, pied oystercatcher, Pacific | Broad-Scale Processes – See S1<br><br>See S2A, S2B, S2C, S2F as key shorebird habitat areas |

| | | Underlying Critical Components | | |
|---|---|---|---|---|
| | | | golden plover, and lesser sand plover. | |

| Critical Service/Benefit | Nomination Criteria and Service Type | Underlying Critical Components | | Underlying Critical Processes |
|---|---|---|---|---|
| | | **Key Wetland Habitat** | **Noteworthy Flora and Fauna Species** | |
| **S7.** The tidal fish habitats and fish and invertebrate populations of the Moreton Bay Ramsar site support valuable recreational and commercial fishing activities | Criterion 7 and 8<br><br>*Cultural and Provisioning* | Mangroves<br>Saltmarsh<br>Intertidal flats<br>Supratidal channels and flats<br>Seagrass and algal beds<br>Coral and Rocky Reefs<br>Shallow surf bars and banks<br>Open expanses of shallow oceanic waters | Bream, flathead, whiting, luderick, mullet, tailor, mackerel, sharks, baitfish, eels, and pink snapper finfish<br><br>King, tiger, endeavour, banana, greasyback and school prawns<br><br>Blue swimmer, mud, red spot, spanner and coral crabs and Callianasid shrimp (yabbies)<br><br>Squid, cuttlefish, gastropods, rock oysters, bivalves and beche-de-mer. | Broad-Scale Processes – See S1<br><br>See S2 for important fish habitats (eg. nursery, spawning, etc.) |
| **S8.** Moreton Bay Ramsar site has important cultural values and significance to indigenous peoples | Ramsar Cultural Criteria<br><br>*Cultural and Provisioning* | All ~ acknowledging many traditional owner groups in the SEQ region will have close association/regularly use wetland resources within particular areas such as the Bay Islands and Southern Bay region. | Culturally important species (eg. wetland fauna species with spiritual importance and/or targeted as part of traditional fishing and hunting activities; wetland flora species with particular traditional food or medicinal significance) | Broad-Scale Processes – See S1 |
| **S9.** Moreton Bay Ramsar site is an important site for research and education | N/A<br><br>*Cultural* | All ~ noting that several of the key habitat types identified above have been subject to long term research and education activities | All ~ noting that several of the noteworthy species of conservation significance identified above have been subject to long term research and education activities | Broad-Scale Processes – See S1 |
| **S10.** The Moreton Bay Ramsar site provides and supports significant tourism and recreational uses in the Region | N/A<br><br>*Cultural* | All ~ With specific importance placed on:<br>• Marine and estuarine waters;<br>• Sandy beaches and dunes; and<br>• Freshwater lakes | All ~ noting that some species of specific tourism interest such as whales that while associated with the Bay, rarely occur within the Ramsar site. | Broad-Scale Processes – See S1 |

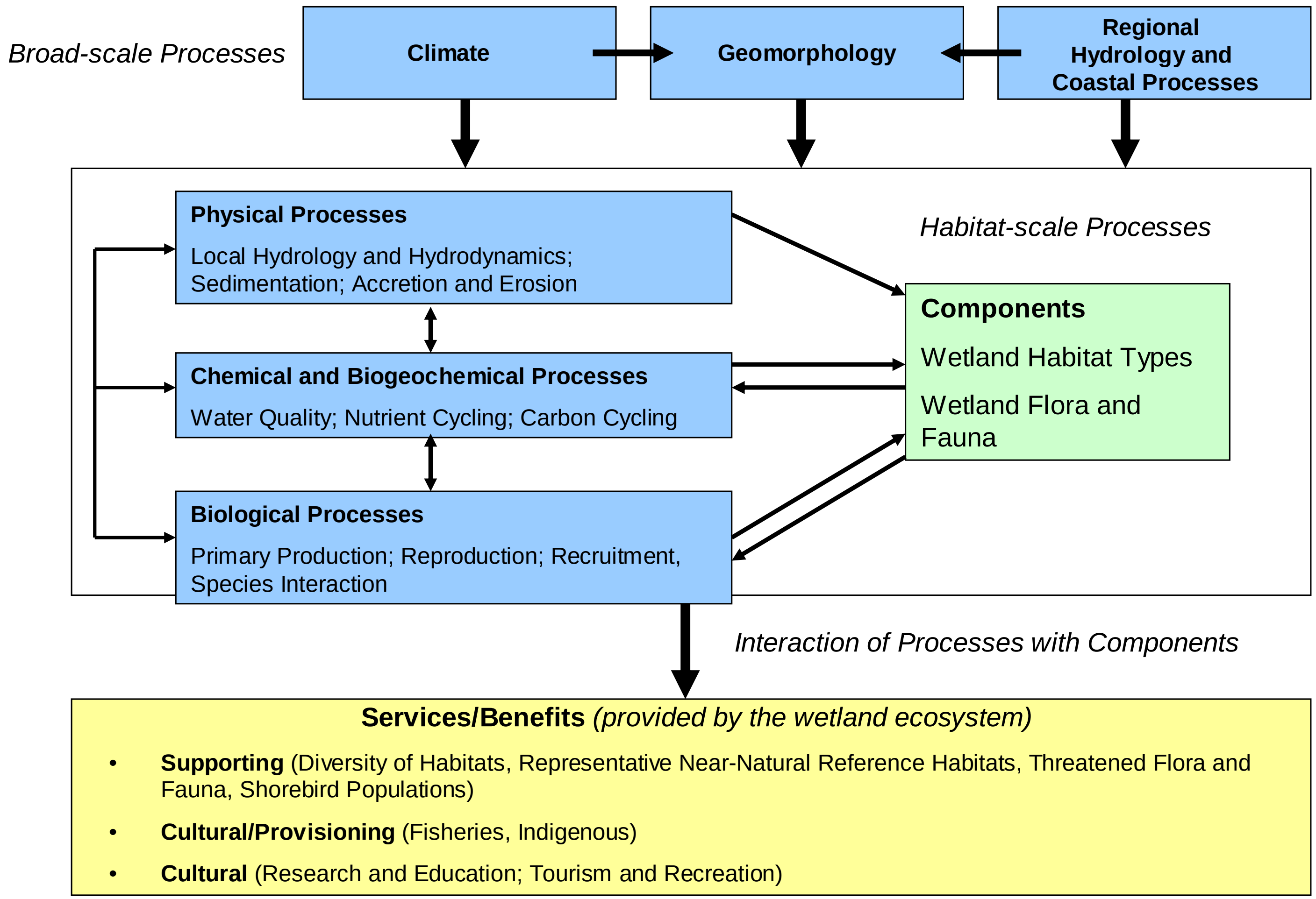


**Figure 4-2 Conceptual Model Showing Interaction of Critical Elements**

## 4.3 Overview of Limits of Acceptable Change

A key requirement of the ECD is to define the limits of acceptable change (LACs) for the critical services/benefits, components and processes of the wetland.

The approach taken for the identification of LAC's for Moreton Bay has been to outline the following:

- to align the limits of acceptable change defined under this ECD with the Ramsar Nomination Criteria under which the site has been listed under the Convention;
- to provide a qualitative description of what characterises an unacceptable change to ecological character under the relevant nomination criterion based on the critical services, components and processes;
- to identify 'interim' limits of acceptable change - where there is insufficient data to set a limit of acceptable change with confidence - based on current knowledge, data and published research about underlying critical components (habitats and species) and underlying critical processes (wetland ecosystem processes such as water quality, hydrological processes and similar).

This approach is described graphically in Figure 4-3.

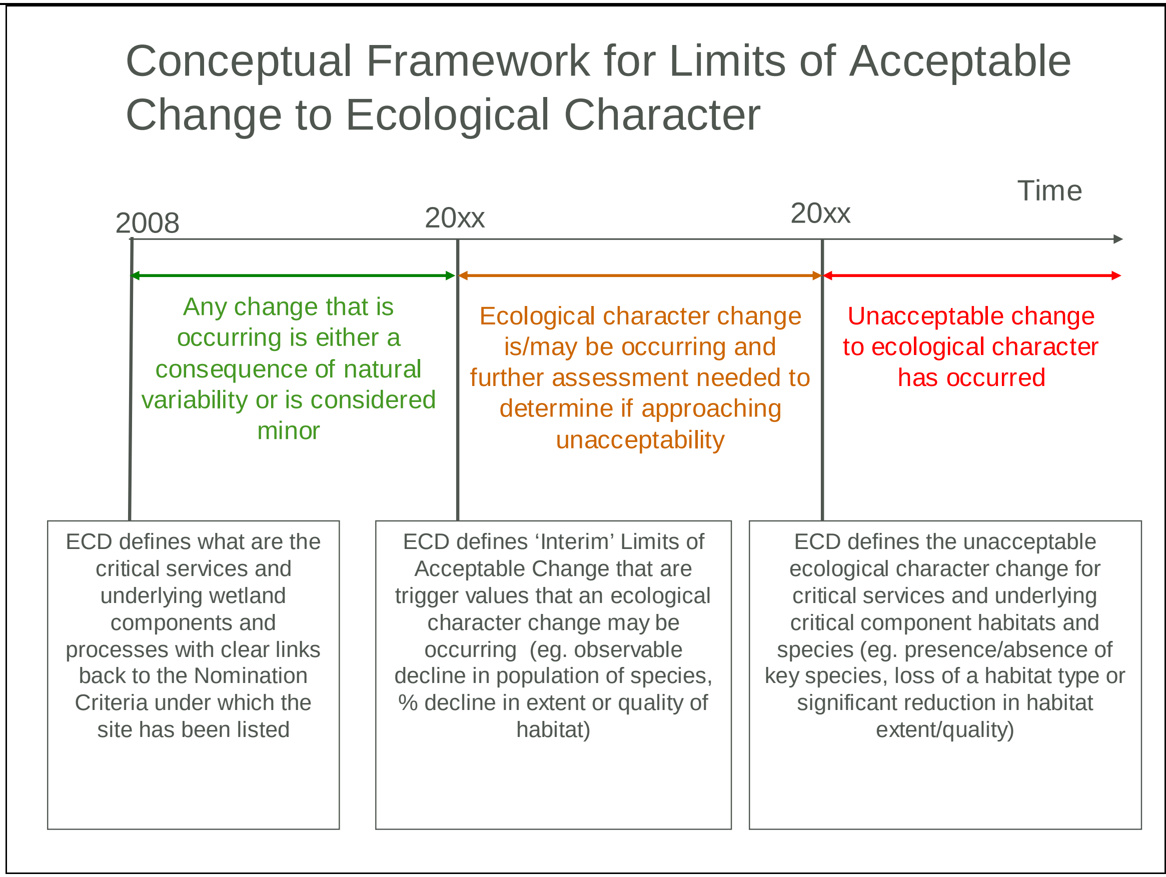


**Figure 4-3 Conceptual Framework for Limits of Acceptable Change to Ecological Character**

Consistent with the above, in general terms, LAC's outlined in this ECD should be interpreted and applied as follows:

- An unacceptable change to ecological character will have been deemed to occur where one (or more) of the Ramsar Nomination Criteria under which the site has been nominated no longer apply or where limits of acceptable change have been exceeded (see dot point below);
- Limits of acceptable change listed in the ECD that have a direct relationship back to ecological character include for example: the continued presence or absence of particular vulnerable or endangered species listed in the ECD, the reduction below a minimum population number for key

species, or a reduction in the overall abundance of populations or groups such as the requirement for at least 20 000 over-wintering avifauna under Ramsar Criterion 5;

- In most cases though, there will be one or more indicators of *potential* change to ecological character based on a key attribute, control or stressor on a habitat, species or population which serve as 'interim' limits of acceptable change. Observation or exceedance of an interim limit of acceptable change does not necessarily represent a significant change to ecological character of the site is occurring. Instead, exceedance of the interim limits of acceptable change provides a management trigger for further evaluation to determine if the change is characteristic of an unacceptable change or alternatively, to further evaluate if the change is the likely consequence of the broad natural variability of the site.

Interim limits of acceptable change also provide guidance to whether or not an action is or is likely to have a 'significant impact' on the ecological character of the Ramsar site in the context of EPBC Act assessments. Using the criteria presented in EPBC Act Policy Statement 1.1 – *Significant Impact Guidelines* (DEWHA 2006) particular issues addressed in the 'interim limits' of the ECD that are relevant to EPBC assessments include:

- identification of changes to wetland extent that may affect ecological character;
- identification of changes to the hydrological regime of the wetland that may affect ecological character;
- identification of the key habitats and lifecycles of important wetland flora and fauna within the site;
- identification of changes to water quality of the wetland that may affect ecological character; and
- presence of invasive species that may be harmful to ecological character

In this context, section 4.3.2 provides the limits of acceptable change identified for the Moreton Bay Ramsar site, preceded by the methodology used to derive them in section 4.3.1.

### 4.3.1 Derivation of Limits of Acceptable Change

Almost all Limits of Acceptable Change (LAC) outlined in this report are considered as interim limits, in recognition of the lack of empirical data describing ecological responses of biota to key regulating processes or controls. Wherever possible, the LAC have been based on existing benchmarks or guideline values used in other programs that have the key aim of protecting environmental values of relevance to this ECD. The following provides a rationale for the LAC for the selected critical components, services and processes.

**Water Quality Indicators**

By default, sub-regional guideline values outlined in Queensland Water Quality Guidelines (EPA 2006) have been adopted as interim LAC. The methodology to be followed to assess compliance should also be consistent with the approach outlined in EPA (2006) guidelines for assessing compliance in HEV areas.

It is recognised that there are available data describing the tolerance limits of some of the critical species identified in this ECD. These are:

- seagrasses (*Zostera muelleri, Halophila ovalis*), based on published critical threshold values including (but not limited to) values summarised by Erftemeijer and Lewis (2006);
- corals. This is based on studies in GBR, which demonstrate a threshold value that may lead to light limitation, and hence sub-lethal photo-physiological stress for *Symbiodinium* hosted by *Pocillopora damicornis* (Cooper *et al.* 2008). However, it should be noted that this species is not common in Moreton Bay (Johnson and Neil 1998a), and case studies for local species are lacking.
- reference data at which key aquatic species have been recorded (i.e. Oxleyan pygmy perch, honey blue-eye, wallum froglets etc.). While this may not necessarily represent the actual tolerance limits of these data, water quality conditions approaching or beyond the range should trigger management action to determine the causes and consequences of these changes.

**Flow Regimes**

By default, the mandatory Environmental Flow Objectives (EFOs) outlined in Water Resource Plans (WRP), as prescribed under the Queensland *Water Act 2000*, have been adopted here as the interim LAC. Within the context of water resource planning, mandatory EFOs are defined as flow objectives for the protection of the health of natural ecosystems for the achievement of ecological outcomes. These EFOs have therefore been developed to protect downstream ecosystem values, which is consistent with the wise use paradigm of Ramsar wetlands.

In this ECD, where freshwater flows are known or likely to represent a key controlling process for a particular ecosystems service, mandatory EFOs have been adopted as default interim triggers. Where mandatory EFOs are not met as a result of water resource activities, then further consideration needs to given to whether measurable impacts are known or are likely to occur to the service, and management actions may need to be implemented to mitigate these impacts.

According to the WRP, mandatory EFOs must be met at a number of critical sites, or nodes, within the river system. Several of these nodes occur within or directly adjacent to the Ramsar site, and have been adopted here to determine potential impacts to the site. These are listed in Table 4-2 below. Note that on 26 July 2007, the Minister for Natural Resources and Water announced his intention to amend the Logan Basin WRP to include water in a watercourse, lake, wetland, subartesian aquifer or spring in the Southern Moreton Bay Islands area. The revised Logan Basin WRP is likely to include additional EFOs of direct relevance to this ECD, particularly as it relates to water resources on North Stradbroke Island. It is recommended that the revised WRP be reviewed to assess implications of this ECD.

**Table 4-2 Nodes and Mandatory EFOs adopted as interim LAC**

| Water Resource Plan | Mandatory EFO | Node | Node Location |
|---|---|---|---|
| Water Resource (Moreton) Plan 2007 | See Schedule 7 of WRP | A | Pumicestone Creeks at end of system (AMTD 0.0km) |
| | | B | Caboolture River at end of system (AMTD 0.0km) |
| | | C | Pine River at end of system (AMTD 0.0km) |
| | | E | Brisbane River end of system (AMTD 0.0km) |
| Water Resource (Logan Basin) Plan 2007 | See Schedule 5 of WRP | G | Logan River at AMTD 0.0km |
| Water Resource (Gold Coast) Plan 2006 | See Schedule 5 of WRP | A | Coomera River at end of system (AMTD 0.0km) |
| | | N/A | Pimpama River |

Given the current absence of EFOs for North Stradbroke Island wetland habitats, several interim trigger values were established. These interim trigger values were specifically used to protect habitat of threatened fish species, i.e. Oxleyan pygmy perch (OPP) *Nannoperca oxleyana*. Because this species forms genetically discrete populations with no interchange over the last few millennia, populations could become locally extinct if its waterbody completely dries and there is no adjoining refugia. This is a particular risk for the Little Canalpin Creek, given the small size of this waterway. Complete drying of a known habitat would result in local extinction of a genetically distinct population, and is considered to represent a change to ecological character (specifically the intent of criterion 9). Based on baseline monitoring undertaken in Little Canalpin Creek, it is known that OPP can occur in waters ~0.2 m water depth, and this may represent a useful start to developing a LAC for this location. It is known that deeper waters are used by OPP at other locations, and for this reason there is a need to develop site-specific LACs for this parameter.

It is also known that OPP prefers relatively quiescent waters, hence an increase in flow velocities above background may also result in impacts to this species. There are insufficient data to assess specific tolerances of OPP to increased flow velocities. OPP has been recorded in water velocities up to between 0.21 to 0.3 m/second (Pusey *et al.* 2004), which Cotterell (1998) suggests is likely to allow passage of all species of native fishes. It is recommended as in interim measure that flow velocities >0.1 m/second represent a preliminary trigger for management action. There is also a need to collect baseline data to determine reference conditions, and on the basis of this information, refining this interim LAC.

**Tidal Hydraulics**

Background/reference values for various tidal hydraulics indicators should form the basis of this LAC. If values fall outside these reference values (i.e. conditions outside background variability), there may be a change to species, communities or habitats, which may in exceptional circumstances lead to a change in ecological character, as defined by the ten (10) critical services/benefits outlined in this ECD.

It is very difficult to provide a complete list of LAC for tidal hydraulics indicators, as these values will vary from place to place, as well as over time in response in changes in tidal phase and meteorological conditions. It is also noted that while a change in conditions may occur as a result of a particular activity, these changes may not necessarily be ecologically meaningful, or lead to changes to ecological character.

In the interim, it is recommended that:

- The Moreton Bay Partnership Hydraulic Model (or its future replacement) be used to establish background/reference hydraulic (and associated sediment dynamics) conditions (based on a 2008 model configuration) of the site;
- Modelling be used to assess the potential hydraulic impacts of the development under consideration;
- There should be no measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater above background such that it results in a measurable, medium-term (>2 to 5 years) flow-on effects to key species, communities or habitat at this spatial scale.

In this context, it is strongly advised that there is a need to further refine these limits before they are applied in assessing impacts to ecological character.

**Flora and Habitat Extent**

It is difficult to set LACs for changes in habitat extent for several reasons:

- The area of some habitat types is variable over time, hence it is difficult to determine ‘baseline’ conditions for these habitats;

- Empirical relationships between habitat extent and flora and fauna abundance/ richness etc. have not been established, hence it is not generally possible at this stage to make quantitative predictions of the responses of most key species to habitat changes;

- It is known that different habitat patches with similar size and structural characteristics can have different fauna habitat values. For example, studies elsewhere demonstrate that particular patches of seagrass can contain more diverse or abundant fish assemblages than nearby, structurally similar patches. The reasons for why different habitat patches are more or less valuable to fauna are not well understood, which further hinders the development of generalised habitat area : fauna assemblage models;

- At the whole-of-site scale, habitat loss associated with a particular development proposal is often small relative to the total available area of habitat. Therefore, at a whole-of-site scale, habitat loss is often a result of incremental or cumulative changes associated with multiple developments.

There is however a need to establish interim LACs describing changes in habitat extent which, if triggered, will lead to a management response. There are two components required to derive a LAC:

1. there is a need to develop a numerical habitat-extent based trigger value;

2. there is a need to consider whether the changes in extent are ecologically meaningful in the context of the critical services/benefits.

In terms of the first component, consistent with approaches used elsewhere, interim LACs are based on the total area of habitat lost relative to a particular benchmark (i.e. percentage of the total extent of habitat lost). Studies elsewhere usually set habitat loss LACs of 0% to 10%, depending on the known perceived values of the habitat. Based on this, the following trigger values have been developed for this ECD:

- In the context of vegetated and unvegetated marine habitats, there should not be a >10% change in marine habitat extent, relative to the total area of available habitat within Moreton Bay, and also relative to natural background temporal variability, in the medium term (>2-5 years);

- For intertidal habitats, there should not be a >10% change in the total area of unvegetated habitat and the extent of habitat within the following tidal zones: Mean High Water (MHW) and Mean Sea Level (MSL); MSL and Mean Low Water (MLW); and MLW and Lowest Astronomical Tide (LAT), in the medium term (>2-5 years);

- For critical terrestrial and aquatic habitats for threatened species, >5-10% change in extent (outside the bounds of natural variability) should trigger management action.

In terms of the second component, there is also a need to take into account natural temporal variability in habitat extent, and if changes in extent are ecologically meaningful in the context of the key services. For the purpose of this assessment, two spatial scales have been delineated: (i) Regional scale, and (ii) local (measured in kilometres) scales. The regional scale considers the impacts of a habitat loss to the overall population size and conservation status of particular species. The local scale considers the significance of impacts within the site.

At broad (regional or greater) spatial scales, there should be no net change in extent and condition of a particular habitat type, relative to natural background temporal variability, such that it results in a measurable, medium-term (>2 to 5 years) flow-on effect to the declared population status (as defined under Commonwealth or State legislation) of threatened species or communities. This means that there should be no change in habitat extent such that it results in species or communities having a revised conservation status under legislation (i.e. downgrade of conservation status from rare to vulnerable, or vulnerable to endangered etc.).

It is also recognised that there is a need to establish a more conservative interim LAC to capture local scale level impacts (i.e. impacts to values within the site). It is recognised that the definition of “local-scale” may vary depending on the distribution and home-range of different species. However, for the purposes of this assessment, local scale change is defined as a change in a particular pattern or process that is measurable at spatial scales of kilometres. For example, a change in a community measure (e.g. the abundance of a plant or an animal, the diversity etc.), that is either predicted (in the context of an impact assessment study) or measured (in the context of monitoring) 1.2 km from a particular project area would be considered unacceptable. In contrast, where community structure is within the range of background variability <600 m from a particular project area, this is not considered as an unacceptable change (unless the change is measurable at the greater than regional scale discussed above, i.e. change in conservation status).

It is important to note that for most habitat types, natural temporal variability in the extent of habitats is not well known. This is a key information gap that needs attention.

**Threatened and Significant Fauna Abundance**

As an interim measure and based on standardised sampling methodology and effort, it is suggested that the following represent triggers for management intervention:

- Significant decline in the numbers of the four acid frog species for important populations on North Stradbroke and Moreton Islands;
- Significant decline in the numbers of little tern over five years as determined at key roost sites (e.g. northern Pumicestone Passage; South Stradbroke Island);
- Lack of observation of Beach stone-curlew in any three year period over five years within the following areas: Pumicestone Passage (Toorbul north to Bells Creek); Bulwer to North Point (Cape Moreton); Cape Cliff (Cape Moreton) to Eagers Creek; Little Sandhills to Mirapool Lagoon; Amity to

Point Lookout; Peel Island; Jumpinpin (includes southern end tip of North Stradbroke Island and associated mangrove islands); western side of South Stradbroke Island;

- Greater than 20% reduction in the number of active/recently active water mouse nests or greater than 15% reduction in usage of any one of the diversity of nest types used (following Van Dyck and Gynther 2003) over five years for important populations associated with North Stradbroke Island, southern Moreton Bay (e.g. Macleay Island, Coomera & Pimpama Rivers, South Stradbroke Island) and Pumicestone Passage (e.g. Bribie Island, Donnybrook); and

- Loss or otherwise significant reductions in the known populations of Oxleyan pygmy perch and Honey blue-eye.

**Habitat Condition Indicators**

For habitat condition, interim LAC used in the study are as follows:

- Sedimentation on coral reefs. Sedimentation should not exceed background variability and lead to measurable impacts to coral communities.

- Emergent macrophyte cover. Oxleyan pygmy perch and honey blue-eye are both found in structurally complex habitat, with bank undercutting and/or 60-80% aquatic plant cover (typically sedges). Should this habitat feature be lost then impacts to fish could occur. An interim limit of >50% cover of emergent macrophytes has been set. It is recognised that some sites may have naturally lower emergent macrophyte cover, but still represent an important habitat. In such cases, adopt: 20$^{th}$, 50$^{th}$ & 80$^{th}$ percentile values of reference site conditions in which population has been recorded. The 75$^{th}$ confidence limit should not be less than these values.

**Ecosystem Condition Biological Indicators**

Several condition indicators based on fauna provide a basis for defining the following interim LAC:

- Seagrass depth range (SDR). SDR guideline values outlined in the Queensland Water Quality Guidelines (EPA 2006) for various sub-areas within the Bay have been adopted.

- Coral community structure. The EHMP has adopted coral community structure as a measure of ecosystem condition. Coral community structure is also directly relevant to Service 2 and to a lesser extent service 1 in this ECD. A change in coral community structure, such that key processes, functions and attributes are lost or modified, would be considered an unacceptable change.

- Coral bleaching. Coral bleaching occurs when hard coral reject their symbiotic zooxanthellae, which typically occurs under stressful conditions. An increase incidence in bleaching (above background variability), such that it results in significant long-term coral mortality, would be considered an unacceptable change in the context of changes to Services 1 and 2. There is a need to collect further reference data to assess this LAC.

- Crab burrow densities. Counts of crab burrows is a potential non-destructive, rapid assessment technique for assessing potential changes in crab abundances, which may be linked to changes in ecosystem condition. Crabs also represent an important food resource for fish and some wader birds, and represent keystone species in mangrove forests. There is a need to develop methods and limits of acceptable change for this indicator.

- Spionidae and Capitellidae worm abundance. These taxa may increase in abundance in response to organic enrichment, or decrease in abundance in response to increase toxicant loads. Polychaete abundances can also exert an influence on waterbird abundance. High range and low range limits are therefore proposed. The high range is based on ANZECC/ ARMCANZ (2000) value of >1000 individuals per $m^2$. A low range guideline would need to be developed. This method and LAC should be further developed based on *Method 8 Density of Capitellid Worms* in ANZECC/ARMCANZ (2000).

- Eastern Gambusia abundance. Eastern Gambusia represents a pressure of native fish and frogs. The presence of Eastern Gambusia in critical habitat of sensitive species should be a matter of management concern. In the context of this ECD presence of Eastern Gambusia in Little Canalpin Creek would represent a trigger for management concern given the limited area of this habitat, and the absence of refugia (i.e. deeper waters) for OPP to avoid interactions with Eastern Gambusia.

### 4.3.2 Summary of Limits of Acceptable Change

Table 4-3 below lists the Nomination Criteria for the Moreton Bay Ramsar site (column 1), qualitative indicators that describe unacceptable changes to ecological character (column 2) and more detailed indicators that have been developed as ‘interim’ limits of acceptable change to indicate that ecological change for the criteria may be affected or occuring (column 3). As mentioned previously, these ‘interim’ limits of acceptable change in column 3 have been developed to assist the site manager to identify potentially significant changes to ecological character on the site prior to an unacceptable change occurring.

In this context, observation or exceedance of an interim limit of acceptable change (column 3) does not necessarily represent a change to ecological character of the site. Instead, exceedance of the interim indicator provides a management trigger for further evaluation to determine if the change is characteristic of an unacceptable change to ecological character or alternatively, to further evaluate if the change is the likely consequence of the broad natural variability of the site.

Table 4-4 and 4-5 underpin Table 4-3 and are specific to the identification of natural variability and limits of acceptable change for particular critical wetland habitats and species nominated within the critical services/benefits of the ECD. Specifically, these tables outline the key attributes (eg. wetland ecosystem processes) that underpin the ecological condition of these habitats and species which are fundamental to the maintenance of critical services and overall ecological character of the site. Cross-references are supplied in the table, particularly to show where a particular habitat or species has relevance to one or more of the ten (10) critical services. The detailed discussion of critical services within Section 7 of the report provides further information to support these tables.

Limits of acceptable change have not been identified for the broader cultural and provisioning services identified in the ECD such as fisheries values (S7), indigenous significance (S8), research and education (S9) and tourism and recreational uses (S10). This is generally due to a lack of quantitative or comparable data sets. Also, in general, the extent to which these cultural services continue over time will depend on the maintenance of the other critical services and underlying ecosystem components and processes.

Notwithstanding, qualitative analysis of the key threats, information gaps and monitoring needs concerning these cultural services (and their maintenance) are identified and discussed in Section 7 as part of the detailed description.

**Table 4-3 Summary of Limits of Acceptable Change**

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| **Criterion 1**: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region. | Criterion 1 is based on the site containing at least one particularly notable wetland habitat type, and this wetland type is maintained in natural or near-natural condition.<br>**Wetland Types and Extent**<br>The ECD/RIS list twenty-two (22) wetland types within the site (using the Ramsar Classification Methodology). An unacceptable change will have occurred if it can be demonstrated that one or more of these wetland types have been lost.<br>**Wetland Condition**<br>A change in natural or near-natural condition at one of the six (6) reference sites[4] or more broadly across that habitat type at a whole-of-site scale are defined as follows**:**<br>• **Seagrass meadow** cover and extent has declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Eastern Bay) or has resulted in | **Habitat Extent**<br>At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, communities or habitat at this spatial scale.<br>**Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4 |

[4] These representative habitat types and locations have been selected on the basis of their role in ecosystem functioning across the site and are important habitats for threatened species, communities and populations that are relevant to other Criteria in the table.

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| | measurable changes to the local population status of dugongs and green turtles, or fisheries stocks (all seagrass areas);<br>• **Unvegetated intertidal flats** and associated microphytobenthos and marine fauna community structure has changed to such levels that it in the medium to long-term (>5 years), can no longer be considered to be in pristine or near-pristine condition (Pumicestone Passage) or has resulted in measurable changes to avifauna populations or fisheries stocks (all tidal flat areas);<br>• **Mangrove and saltmarsh** habitat extent and community structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered to be in pristine or near-pristine condition (Southern Bay) or has resulted in measurable changes to avifauna populations or fisheries stocks (all mangrove and saltmarsh areas);<br>• **Coral community** and reef habitat structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered to be in pristine or near-pristine condition (Eastern Bay coral communities) or has resulted in measurable changes to the extent or condition of the habitat (eg. coral dominated reefs algal dominated);<br>• **Freshwater wallum** wetland **/peatland** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (North Stradbroke or Moreton Islands) or has resulted in measurable changes to the local population status of threatened flora and fauna species or communities (see Criterion 2 below);<br>• **Ocean beach and foredune** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Moreton Island) or has resulted in measurable changes to the local population status of avifauna or nesting usage by avifauna and marine turtles (all ocean beaches and foredune areas). | |
| **Criterion 2**: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities. | Criterion 2 is based on the site containing at least one vulnerable or endangered species or threatened ecological community. The ECD/RIS lists several species/communities within the site that meet this criterion which include:<br>• Marine Species - dugongs, green and loggerhead turtles<br>• Freshwater Fish - Oxleyan pygmy perch and honey blue eye<br>• Avifauna - little tern, beach stone-curlew, painted snipe, Australasian bittern<br>• Wetland-dependant non-avian fauna - Illidge's ant blue butterfly, acid frogs and water mouse<br>• Nationally Endangered wetland flora species including several swamp orchids, knotweed and swamp daisy<br><br>An unacceptable change will have occurred if it can be demonstrated that one or more of these threatened species or threatened communities is lost within the site. | **Species/Populations**<br>Detectable decline in local abundance/population of the key species.<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| | In particular, a change to character would be demonstrated if the following were to occur:<br>• The wetland becomes unsuitable as habitat for one or more threatened species or community listed in this ECD; or<br>• Threatened animal and plant species identified in the ECD no longer occur at the site. | |
| **Criterion 3**: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region | Criterion 3 is based on the site containing a large proportion of species that are not well represented in the wider region. An unacceptable change will have occurred if it can be demonstrated that there has been a reduction in the number of species occurring within the site, and that this has resulted in a loss in biodiversity within the bio-region.<br>In this context, a change to character would be demonstrated if the following were to occur:<br>• Habitats have become unsuitable for wetland flora or fauna species or populations listed in the critical services of this ECD (see Criterion 2)<br>• Noteworthy animal and plant species identified in the ECD are no longer present (see Criterion 2)<br>• Populations of noteworthy species (see Criterion 2 above) no longer recorded in previous abundances (i.e. possible loss of genetic diversity)<br>• Overall vertebrate fauna biodiversity is measurably and significantly reduced | **Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4<br>**Species/Populations**<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |
| **Criterion 4**: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions. | Criterion 4 is based on the site representing critical refugia for any species, and the site maintaining critical life-cycle processes for any species.<br>An unacceptable change will have occurred if it can be demonstrated that the site no longer provides a refugia function for important flora and fauna species (see Criterion 2) or if critical life-cycle processes are no longer being supported.<br>The following are considered to represent the key critical life-cycle functions in the Moreton Bay Ramsar site -<br>• Feeding and nesting habitat for green and loggerhead turtles that could impact the local population<br>• Feeding and breeding habitat for dugong that could impact the local population<br>• Refuge habitat for freshwater fish of conservation significance that could impact the local population<br>• Roosting habitat for migratory waterbirds that could impact the local population<br>• Critical overwintering habitat and a flyway staging area (both northern and southern migration routes) for migratory waterbirds | **Habitat Condition**<br>See Wetland Habitat Ecosystem Process Indicators – Table 4-4<br>**Species/Populations**<br>See Wetland Species Ecosystem Process Indicators – Table 4-5 |
| **Criterion 5**: A wetland should be considered internationally | An unacceptable change will have occurred if the site no longer supports the required abundance of waterbirds under this Criterion | That the total number of waterbirds at the site always exceeds 20,000 individuals |

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| important if it regularly supports 20,000 or more waterbirds. | | Greater than 10% reduction in over a 10 year period of numbers of bar-tailed godwit, Eastern curlew, or Pacific golden plover which are surrogates for assessing shorebird abundance generally. |
| **Criterion 6**: A wetland should be considered internationally important if it regularly supports 1 per cent of the individuals in a population of one species or subspecies of waterbird. | An unacceptable change will have occurred if the site no longer supports the 1% of individuals of populations for the key species in the ECD which are:<br>• bar-tailed godwit<br>• whimbrel<br>• Eastern curlew<br>• terek sandpiper<br>• grey-tailed tattler<br>• curlew sandpiper<br>• pied oystercatcher<br>• Pacific golden plover<br>• lesser sand plover | Greater than 20% reduction in any three year period over five years for any of the eight migratory shorebird species (which exceed the 1% threshold). |
| **Criterion 7**: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity. | Long term impacts on the sustainability of populations of important commercial and recreational species that occur within the site (or in adjacent areas of the Bay) including:<br>• bream, flathead, whiting, luderick, mullet, tailor, mackerel, sharks, baitfish, eels, pink snapper and other key finfish species;<br>• king, tiger, endeavour, banana, greasyback and school prawns;<br>• blue swimmer, mud, red spot, spanner and coral crabs and Callianasid shrimp (yabbies);<br>• squid, cuttlefish, gastropods, rock oysters, bivalves and *beche-de-mer*. | A long-term loss of fish/shellfish stocks, which results in the reduction in the sustainability of key Bay fisheries, should be considered a trigger for assessing potential changes to ecological character. |
| **Criterion 8**: A wetland should be considered internationally | Medium to long-term (>5 years) reduction in the extent or condition of wetlands or other areas and a corresponding measurable impact on important spawning, nursery or migration pathways | At a local scale, >10% change in habitat extent, relative to natural background |

| Nomination Criterion | Definition of an unacceptable change to ecological character | Indicators that ecological character may be affected (eg. interim limits of acceptable change) |
|---|---|---|
| important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. | for fisheries. | variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, life-stages, communities or habitat at this spatial scale.<br><br>In assessing this interim LAC, attention should be given to assessing changes in the extent of mangroves, saltmarsh, seagrass and tidal flat environments, which represent key nursery habitats to many commercially important species within the site. |

**Table 4-4 Summary of Natural Variability and LAC – Critical Habitats**

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| **Seagrass** | See 'Natural Variability' column | See below<br>Turbidity/light | Variable across site. Refer to EHMP data. | n/d | *H. ovalis*:<br>H90. Min. light requirement = 16% SI [P,Q]<br>H91. Duration = >30 days at 0% SI [P,S]<br>*Z. muelleri*:<br>H92. Duration = >30 days at 5% SI [P,Q]<br>H93. Critical thresholds = >30% SI [Q,R,]; 0.9 Kd ($m^{-1}$) [P,R]; 10 mg/L [P,R]<br>H94. If site values exceed levels in H1 to H4, use default baseline turbidity values at seagrass sites as default trigger values (see SDR sites below) [J] | S1, S2, S3, S6, S8 |
| | | Seagrass depth limit/range (SDR) | | n/d | Medium term (>5 years) median SDR value should not fall below the following interim default SDR values [N]:<br>H95. Pumicestone Passage HEV = -0.8 m | |
| | | | | | H96. Pumicestone Passage SMD = -1.2 m | |
| | | | | | H97. Deception Bay North SMD = -3m | |
| | | | | | H98. Waterloo Bay HEV = -1.9m | |
| | | | | | H99. Central Bay HEV/ SMD = -2.2m | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | | | | H100. Eastern Bay HEV = -3.5m<br>H101. Eastern Bay SMD = -2.2m<br>H102. Southern Bay HEV/ SMD = -1.3m | |
| | | Long-term change in tidal hydraulics and sedimentation patterns (short to medium term) | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008)[A]. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H103. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater above background [B]. | |
| **Unvegetated tidal flats** | Pumicestone Passage, Waterloo Bay, Bramble Bay, Eastern Banks. | Freshwater flows | Waterway-specific & highly variable over time. Baseline hydraulic conditions as per 'Existing-case' scenarios in Moreton WRP. | n/d<br><br>Quantitative environmental flow requirements of key local species and habitats unknown | H104. As a minimum, compliance with EFOs outlined in Moreton WRP for Nodes A-E | S1, S2, S3, S4, S6, S8 |
| | | Tidal hydraulics & sedimentation patterns (short to medium term) | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008) [A]. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H105. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater above background [B] | |
| | | Long term (>50 years) changes to tidal inundation and sediment dynamics patterns & processes due to sea level rise | -0.22 mm/year change over last 26 years of data collection [C] | n/d<br><br>Impacts dependent on sedimentation rate relative to sea level rise | H106. A change in frequency, duration & magnitude of tidal inundation between:<br>• MHW and MSL;<br>• MSL and MLW<br>• MLW and LAT<br>• Such that it results in >10% change (above background) in the extent of unvegetated habitat at these levels, and results in [B]. | |
| | | Spionidae and Capitellidae worm densities, and sediment TOC, as indicators of organic enrichment | Highly variable in space and time | n/d | Using methods as per ANZECC, assess whether the following are exceeded:<br>H107. Interim high range – Capitellidae or Spionidae densities >1000 individuals per $m^2$<br>H108. Interim low range – n/d | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | Crab burrow densities. This is a potential non-destructive, rapid assessment technique for assessing potential changes in crab abundances, which may be linked to changes in ecosystem condition [U] | | | n/d.<br>H109. There is a need to investigate (i) whether robust and cost-effective methods can be developed, and if so (ii) proceed to establish threshold criteria based on sampling of appropriate indicator species at a range of references sites. | |
| **Mangroves and Saltmarsh** | Southern Bay<br>Pumicestone Passage<br>Western Bay | Freshwater flows | H110. As a minimum, compliance with EFOs outlined in Moreton WRP for Nodes A-E (see also H15) plus nodes outlined in Logan WRP (Note G) and Gold Coast (Note A) WRPs. This should be assessed using SunWater IQQM models. | | | S1, S2, S7, S8 |
| | | Tidal hydraulics | H111. Refer to unvegetated flats, i.e. H16 | | | |
| | | Tidal inundation patterns | H112. Refer to unvegetated flats, i.e. H17 | | | |
| | | Crab burrow densities | n/d | n/d | H113. n/d. Refer to H20 | |
| | | Mangrove die-back extent and hypersaline areas | n/d | n/d | H114. n/d. There is a need to map the distribution and extent of mangrove die-back (aerial photography & ground-truthing) to establish existing conditions. Monitoring should be undertaken on a 5 year basis.<br><br>H115. Salinity should not be > 40-50 g/L (low tide) to reduce the risk of impacts to mangrove health[V].<br>H116. Where ambient salinity exceeds levels in H26, & mangroves and saltmarsh are demonstrated to be in good condition, derive local trigger values based on ambient/background data. [J] | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Coral Communities (Eastern Bay)** | Central and Eastern Bay – Myora, Peel Island, etc | Turbidity | <1, 1, 1 NTU [E] | n/d.<br><br>Tolerance limits of most local species are largely unknown. | H117. Long-term (>5 day) average turbidity should not exceed >3 NTU [H]<br>H118. Use default baseline conditions at coral reef sites as default interim trigger values for turbidity & other attributes [J] | S1, S2, S3, S8 |
| | | pH | 8.2, 8.3, 8.4 [E] | | | |
| | | TN | 100, 120, 160 μg/L [E] | | | |
| | | TP | 5, 9, 12 μg/L [E] | | | |
| | | Water temperature | 12.5° to 32°C (Reef flat); 16 to 28°C (Moreton Bay surface waters [F] | | | |
| | | Sedimentation rates (mg/cm$^2$/day) [G] | Peel Is = 2 to 32<br>Myora = 5.9 to 16.1 | n/d<br>Tolerance limits are:<br>• highly species-specific.<br>• not available for local species<br>• dependent on duration & frequency of exposure to sedimentation<br><br>Available baseline sedimentation data has limited temporal coverage (1 year). | H119. Sedimentation should not exceed background variability and lead to measurable impacts to coral communities [K] | |
| | | Coral bleaching frequency & extent | n/d<br>Incidence of coral bleaching is not reported in EHMP. | n/d | H120. The frequency & duration of bleaching events should not increase to such levels where measurable impacts to coral communities occur [K] | |
| | | Reef community structure (cover of numerically dominant taxa) | Site specific, and variable in time for some macrophyte species. Refer to EHMP (2006) data for a description of baseline conditions. | n/d | H121. >5% loss in hard and/or soft coral cover > background temporal variability [L] | |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| **Wallum freshwater wetlands** | Bay Islands Pumicestone Passage | Groundwater hydrology | Waterway-specific & highly variable over time. Baseline hydraulic conditions as per 'Existing-case' scenarios in Logan WRP (& underlying modelling). | n/d | H122. As a minimum, compliance with EFOs outlined in future draft Logan WRP (North Stradbroke Island) [M]<br>H123. No changes in water levels at Blue Lake, or the Blue Lake Overflow discharge channel, such that a detectable community or ecosystem change occurs [B] | S1, S2, S4, S5, S7 |
| | | Invertebrates | 20th percentile:<br>Taxa richness = 12<br>PET richness = 2<br>SIGNAL = 3.32 | n/d | H124. No change in water quality or invertebrate biotic indices, outside the bounds of natural variability. Note that water quality and biotic indices show great change among different waterbodies, hence there is a need to derive local trigger values based on ambient/background data. [J] | |
| | | pH [I] | Blue L. = 4.9 to 5.2<br>Brown L. = 4.6 to 5.0 | | | |
| | | EC (µS/cm) [I] | Blue L. = 90<br>Brown L.= 90 | | | |
| | | Secchi (m) [I] | Blue L. = 4.9 to 6.9<br>Brown L. = 0.7 | | | |
| | | DO (% saturation) [I] | Blue L. = 86 to 95<br>Brown L. = 90 to 99 | | | |
| | | Chlorophyll a (µg/L) [I] | Blue L. = 0.6 to 2.4<br>Brown L. = 14 | | | |
| | | TP (µg/L) [I] | Blue L. = 2 to 6<br>Brown L. = 15 | | | |
| | | Water Temp (deg C) [I] | Blue L. = 19 to 26<br>Brown L. = 19 to 26 | | | |
| | | Turbidity (NTU) [I] | Blue L. = <1 to 1<br>Brown L. = 9 | | | |
| | | Ammonia (µg/L) [I] | Blue L. = 2 to 7<br>Brown L. = 9 | | | |
| | | Total N (µg/L) [I] | Blue L. = 90 to 130<br>Brown L. = 500 | | | |
| | | NOX (µg/L) [I] | Blue L. = 6 to 37<br>Brown L. = 3 | | | |
| **Ocean beaches and foredunes** | High-energy beaches and foredunes of Bribie, Moreton and North and South Stradbroke Islands | Long-term change in tidal hydraulics and sedimentation patterns (short to medium term) leading to change in beach morphology | Highly site-specific. Adopt appropriate metrics (e.g. % exceedance values) output from Moreton Bay regional hydraulics model (existing-case 2008)[A] or long term aerial photograph analysis. | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H125. No measurable medium term (>5 years) change to hydraulic, wave &/or sedimentation patterns at spatial scales measured in km or greater, relative to background [B]. | S1, S2, S3, S4, S7 |

| Critical Habitat Type | Key Locations | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|
| | | Groundwater inflows | Highly site-specific. Groundwater flows bring nutrients into the beach system and into the swash zone and control invertebrate and nearshore phytoplankton communities | n/d<br><br>No specific information on locally relevant keystone species.<br><br>Tolerances likely to vary depending on magnitude, duration & frequency of change. | H126. No measurable medium term (>5 years) change to groundwater supply/flows into beach systems relative to background [B]. | |
| | | Density of *Pipis* or other indicator species linked to changes in ecosystem condition | Highly variable in space and time | n/d | H127. There is a need to establish threshold criteria based on sampling of appropriate indicator species at a range of references sites. Refer to H20. | |

**Table 4-5 Summary of Natural Variability and LAC – Critical Species**

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| Oxleyan pygmy perch | Bay Islands, Pumicestone Passage | No long-term reduction in population densities of Oxleyan pygmy perch in waterbodies, outside the range of natural variability.<br><br>No reduction in the total number of waterbodies inhabited by Oxleyan pygmy perch within the site. | pH | 4.2 to 7.2 [A] | n/d<br><br>No experimental determination of physiological tolerances<br><br>All information on habitat preferences based on environmental conditions in which this species has been recorded | H128. Long term average should not >6.5<br>H129. If above this value, adopt 20th, 50th & 80th percentile values of reference site conditions in which population has been recorded. The 75th confidence limit should not be > these values. | S1, S2, S3 |
| | | | Dissolved Oxygen | > 2 mg/L [B] | | H130. Long-term median should not be <5 mg/L. If above this value, then adopt percentile values described in H40 | |
| | | | Turbidity | Clear, tannin stained waters (1 to 300 NTU) [A, B] | | H131. Long-term median should not > 1 NTU. If above this value, then adopt percentile values described in H40 | |
| | | | EC/Salinity | <330 μS/cm [A] | | H132. Long term average should not exceed 300 μS/cm. If above this value, then adopt percentile values described in H40 | |
| | | | Water levels | 0.2[A, B] to 5[C] m, depending on water body characteristics. Mean weighted depth of captures = 0.63 m [A], whereas OPP Recovery Plan indicates most OPP captures in 0.3 to 0.4 m depth range [F]. | | H133. n/d. Trigger value may vary depending on particular requirements and local habitat conditions, i.e. avoidance of competition with eastern Gambusia or maintenance of fish passage. Local trigger values therefore need to be developed, although water depths <0.2 m unlikely to allow maintenance of OPP populations.<br>H134. Drying. Where adjoining permanent refugia is absent, drying of a known habitat will cause local extinction at the site. | |
| | | | Groundwater hydrology | Low flow <0.3 m/sec [A] | | H135. Flow <0.1 m/second. If >, then If above this value, then adopt percentile values described in H40 | |
| | | | Emergent macrophyte cover and undercut banks | 60-80% emergent macrophyte cover (typically sedges), undercut banks, woody debris & root masses. | | H136. >50% reduction in emergent vegetation cover, above background variability, such that it results in such that it results in a measurable, short-term (1-5 years) flow-on effects to OPP populations and/or key ecosystem functions. | |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Eastern Gambusia in freshwater reaches of Little Canalpin Ck.** | Absent in freshwater reaches, but found in lower estuarine/brackish environs | n/d | H137. Presence of Eastern Gambusia in Little Canalpin Creek represents a trigger for further investigation of viability of this sub-population. | |
| | | | Oxleyan pygmy perch abundance | This species has low population densities, hence empirical limits are difficult to set. On North Stradbroke Is., average CPUE is typically 0-0.6 individuals/trap /hour*. | n/d | H138. No fish recorded during >5 sampling events, using various combinations of sampling methods (e.g. box traps, electro-fishing and seine netting), should trigger further investigations of whether waterbody continues to provide suitable OPP habitat, and the identification of drivers for change. | |
| Honey blue-eye | Pumicestone Passage | No long-term reduction in population densities of honey blue-eye in waterbodies, outside the range of natural variability.<br><br>No reduction in the total number of waterbodies inhabited by honey blue-eye within the site. | pH | 4.4 to 6.8 [A] | n/d<br><br>No experimental determination of physiological tolerances<br><br>All information on habitat preferences based on environmental conditions in which this species has been recorded | H139. Long term median should not be >6.5, or if above this value:<br>H140. Adopt 20th, 50th & 80th percentile values of reference site conditions as described in H40 | S1, S2, S3 |
| | | | Dissolved Oxygen | > 6.8 mg/L [A] | | H141. Long-term median should not be <5 mg/L.<br>H142. If background above this value, then adopt percentile values described in H40 | |
| | | | Turbidity | Clear, tannin stained waters (<17 NTU) [A] | | H143. Long-term median should not > 1 NTU.<br>H144. If background above this value, then adopt percentile values described in H40 | |
| | | | EC/Salinity | <900 μS/cm [A] | | H145. Long term median should not exceed 700 μS/cm.<br>H146. If background above this value, then adopt percentile values described in H40 | |
| | | | Water levels | n/d | | H147. n/d. Trigger value may vary depending on particular requirements, i.e. avoidance of competition with eastern Gambusia or maintenance of fish passage. Local trigger values need to be developed.<br>H148. Drying. Where adjoining permanent refugia is absent, drying of a known habitat will cause local extinction at the site. | |
| | | | Groundwater hydrology | Low flow <0.3 m/sec [A] | | H149. Median flow velocity <0.1 m/second.<br>H150. If background above H22, then adopt percentile values using approach described in H40 | |

| **Critical Species/ Community Type** | **Key Locations** | **Description of unacceptable adverse ecological change(s) to this species** | **Key Attributes and Controls** | **Natural Variability of the Habitat (Ecological Character Maintained)** | **Specific (quantitative) limits for unacceptable changes (LAC)** | **Interim Trigger (if n/d in specific column)** | **Related Critical Services** |
|---|---|---|---|---|---|---|---|
| | | | Emergent macrophyte cover and undercut banks | High aquatic plant cover, typically sedges [A] | | H151. >50% reduction in emergent vegetation cover, above background variability, such that it results in such that it results in a measurable, short-term (1-5 years) flow-on effects to Honey Blue-eye populations and/or key ecosystem functions.. | |
| | | | Honey blue-eye abundance | This species typically has low population densities [A], hence empirical limits are difficult to set. | n/d | H152. No fish recorded during >5 sampling events, using various combinations of sampling methods (e.g. box traps, electro-fishing and seine netting), should trigger further investigations of whether waterbody continues to provide suitable habitat, and the identification of drivers for change. | |
| Dugong | Eastern Bay<br>Pumicestone Passage<br>Southern Bay | Detectable decline in local abundance of dugong outside the range of natural variability | Turbidity, nutrients and chlorophyll *a* | Refer to seagrass indicators in Habitat Table 4-4 | | | S1, S2, S3, S9 |
| | | | Seagrass depth limit (and extent) | Refer to seagrass in Habitat Table 4-4 | | | |
| | | | Dugong population densities | 503 ± 63 (S.E) (July) to 1019 ± 166 (S.E) (December) individuals in 1995 (Lanyon 2003) [D]. Recent population modelling suggests local population size of ~970 ±75 animals [E]. | n/d | H153. A decline in dugong abundance to <800 individuals for 2-3 successive years may represent a trigger for further investigation. Note however that these figures should be considered as indicative only, as there is insufficient available information on the population dynamics and genetics of dugongs to develop a reliable interim trigger value. | |
| Marine Turtles: green turtle loggerhead turtle | Eastern Bay<br>Pumicestone Passage<br>Southern Bay | Detectable decline in green and loggerhead turtles outside the range of natural variability | Turbidity, nutrients & chlorophyll *a* | Refer to seagrass indicators in Habitat Table 4-4 | | | S1, S2, S3, S9 |
| | | | Seagrass depth limit (and extent) | Refer to seagrass in Habitat Table 4-4 | | | |
| | | | Green and loggerhead turtle population dynamics & breeding readiness | n/d | n/d | H154. n/d. Insufficient available information on the population dynamics, growth rates and breeding readiness of turtles to develop a reliable interim trigger value. | |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| Wallum Acid Frogs | Wallum habitats on Bay Islands and Pumicestone Passage | Significant population declines outside the range of natural variability in either of the four acid frog species | Water quality:<br>• non-turbid<br>• tannin-stained<br>• oligotrophic (low nutrient)<br>• naturally acidic | pH 3.0-5.5 as derived from dissolved organic acids leached from humus). | n/d | H155. Significant decline in the numbers of the four acid frog species for important populations on North Stradbroke and Moreton Islands. | S4 |
| | | | Absence of predatory fish | n/d | n/d | H156. Presence of Eastern Gambusia may represent a threat to local populations | S4 |
| | | | Wallum wetland vegetation | n/d | n/d | H157. Greater than 5% reduction over five years of wallum wetland vegetation cover. | S4 |
| | | | Ground water hydrology and freshwater flows | n/d | n/d | H158. No long-term change in groundwater hydrology such that it causes alterations to water quality, water levels and wetland flora and fauna, outside the bounds of natural variation. | S4 |
| Beach stone-curlew | Outer Bay islands, Pumicestone Passage, mangrove habitats of southern Moreton Bay. | Significant declines in key habitat areas | Mangroves and associated intertidal flats (roost and feeding); sandy beaches (feeding), foredunes (breeding sites) | n/d | n/d | H159. Lack of observation of beach stone-curlew in any three year period over five years within the following areas: Pumicestone Passage (Toorbul north to Bells Creek); Bulwer to North Point (Cape Moreton); Cape Cliff (Cape Moreton) to Eagers Creek; Little Sandhills to Mirapool Lagoon; Amity to Point Lookout; Peel Island; Jumpinpin (includes southern end tip of North Stradbroke Island and associated mangrove islands); western side of South Stradbroke Island. | S4 |
| Water mouse | Pumicestone Passage, North Stradbroke Island, Southern Moreton Bay (e.g. Steiglitz, Jacobs Well, Pimpama River Conservation Area, Coomera River, & South Stradbroke Island). | Significant declines in the usage of nests and the diversity of nest types used. | Relatively large areas of intertidal flats in association with mangroves (feeding), marine intertidal invertebrate prey, supralittoral wetlands, including salt marsh and sedgelands (nesting sites) | n/d | n/d | H160. Greater than 20% reduction in the number of active/recently active water mouse nests or greater than 15% reduction in usage of any one of the diversity of nest types used (following Van Dyck and Gynther 2003) over five years for important populations associated with North Stradbroke Island, southern Moreton Bay (e.g. Macleay Island, Coomera & Pimpama Rivers, South Stradbroke Island) and Pumicestone Passage (e.g. Bribie Island, Donnybrook). | S4 |
| | | | Tidal conditions | n/d | n/d | H161. Any detectable long-term change to tidal regimes at spatial scales >5 km. | S4 |
| Australian painted | Freshwater swamps | Lack of | Densely | n/d | n/d | H162. Loss of more than 20% of the extent of | S4 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| snipe | of outer Bay islands (e.g. 18 Mile Swamp). | records for any 10 year period. | vegetated permanent of seasonal wetlands | | | vegetated freshwater wetland habitat. | |
| Australasian Bittern | Freshwater swamps of outer Bay islands (e.g. 18 Mile Swamp). | Lack of records for any 10 year period. | Densely vegetated permanent of seasonal wetlands | n/d | n/d | H163. Loss of more than 20% of the extent of vegetated freshwater wetland habitat. | S4 |
| Little Tern | Open waters of Bay, Caloundra sandbanks, beaches & sand spits of outer Bay islands, South Stradbroke Island. | Significant decline in abundance, outside the range of natural variability. | Nearshore and offshore open waters and rivers; water quality sufficient to support abundance of surface active baitfish; high-tide roost sites. | n/d | n/d | H164. Significant decline in the numbers of Little Tern, outside the range of natural variability, over five years as determined at key roost sites (e.g. northern Pumicestone Passage; South Stradbroke Island). | S4 |
| Illidge's ant blue butterfly | Mangrove communities of Redland Bay, Hays Inlet, Fisherman Islands, outer Bay islands, and Coomera Island | Lack of records for any three year period. | Large areas of mangroves with mature trees bearing senescing limbs and dead branchlets which support the *Crematogaster* sp. ant; also adjacent supralittoral forests. | n/d | n/d | H165. Greater than 10% reduction over five years of mangrove cover and associated intertidal habitats. | S4 |
| Migratory Shorebirds | Intertidal sand/mud flats, rocky shores and mangrove communities throughout the site, intertidal areas of coarse rubble associated with central bay islands | Decline in shorebird abundance and species diversity. | Diversity and abundance of epi/infauna of the intertidal flats; diversity of disturbance-free high tide roost spatially proximate to | n/d | n/d | H166. Greater than 10% reduction over five years of any one of the following components – mangrove cover and associated intertidal habitats; and supralittoral salt marsh habitats.<br>H167. Any detectable long-term change to tidal regimes at spatial scales >5 km.<br>H168. No long-term reduction in water quality and ecosystem condition in the estuarine sections of each major catchment area (as determined through | S6 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | (Mud, St. Helena and Green islands) and western shores (Wellington Point and Redcliffe Peninsula), high tide roost sites throughout the site (natural and artificial). | | suitable feeding grounds. | | | the EHMP).<br>H169. Greater than 10% reduction in over a 10 year period of numbers of bar-tailed godwit, Eastern curlew, or Pacific golden plover which are surrogates for assessing shorebird abundance generally.<br>H170. Greater than 20% reduction in the in any three year period over five years for any of the eight migratory shorebird species (which exceed the 1% threshold). | |
| Threatened Flora Communities: Endangered and Of Concern Regional Ecosystems | Bribie Island, Moreton Island, Southern Moreton Bay Islands, Southern Bay | Detectable decline in extent of Regional Ecosystems.<br><br>Loss of sensitive plant species and change to alternate community type.<br><br>(Loss of dependent fauna). | Groundwater hydrology | Waterway-specific and variable over time. | n/d<br><br>Quantitative groundwater requirements of ecosystems unknown. | H171. No significant reductions in water table depth, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br>H172.<br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| | | | Fire regimes | Variable over time and between different vegetation types. | n/d<br><br>Specific fire regime requirements of ecosystems unknown. | H173. No significant changes in fire frequency or intensity, relative to background variability, such that it results in such that it results in a measurable, medium-term (>5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>No significant changes in fire frequency or intensity such that ecological integrity of ecosystems is not maintained. Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Geomorphology:<br>• Erosion<br>• Sedimentation<br>• Soil type | Erosion and sedimentation variable over time. Soil type not variable over relevant time scale. | | H174. No significant changes in erosion or sedimentation processes, or changes to soil characteristics, relative to background variability, such that it results in such that it results in a measurable, medium-term (>2 to 5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| Vulnerable and Endangered wetland plants:<br>*A. baueri*<br>*M. triglochinoides*<br>*O. hygrophila*<br>*P. elatior*<br>*P. australis*<br>*P. bernaysii*<br>*P. tancarvilleae*<br>*T. confluens* | Bay Islands: swamps, lakes and waterways | Detectable decline in local abundances of plant species. | Groundwater hydrology | Waterway-specific and variable over time. | n/d<br><br>Quantitative groundwater requirements of flora species unknown. | H175. No significant reductions in water table depth, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | S5 |
| | | | Water Quality:<br>• Toxicants<br>• Nutrients<br>• Turbidity<br>• Salinity, pH | Waterway-specific and variable over time. | n/d<br><br>No experimental determination of flora species water quality tolerances. | H176. No change in water quality indices outside bounds of natural variability. Adopt 20th, 50th & 80th percentile values of reference site conditions in which population has been recorded. The 75th confidence limit should not be > these values.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, species should continue to exist at current conservation status. | S5 |

| Critical Species/ Community Type | Key Locations | Description of unacceptable adverse ecological change(s) to this species | Key Attributes and Controls | Natural Variability of the Habitat (Ecological Character Maintained) | Specific (quantitative) limits for unacceptable changes (LAC) | Interim Trigger (if n/d in specific column) | Related Critical Services |
|---|---|---|---|---|---|---|---|
| | | | Freshwater flows and inundation | Waterway-specific and variable over time. | n/d<br><br>No quantification of frequency, duration and extent of freshwater inundation requirements for flora species. | H177. No significant reductions in flow regimes, relative to background variability, such that it results in such that it results in a measurable, medium-term (> 5 years) flow-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, species should continue to exist at current conservation status. | S5 |
| | | | Geomorphology:<br>• Erosion<br>• Sedimentation<br>• Soil type | Erosion and sedimentation variable over time. Soil type not variable over relevant time scale. | n/d<br><br>No quantification of geomorphologic requirements of flora species. | H178. No significant changes in erosion or sedimentation processes, or changes to soil characteristics, relative to background variability, such that it results in such that it results in a measurable, medium-term (>2 to 5 years) low-on effects to key species, communities, habitats and/or key ecosystem functions at spatial scales measured in hectares or greater.<br><br>Specific limits cannot be quantified with current knowledge – but as an interim trigger, communities should continue to exist at current conservation status. | |

# 5 CHANGES TO ECOLOGICAL CHARACTER AND THREATS

## 5.1 Changes to Ecological Character

### 5.1.1 Changes/Impacts Observed Since Nomination

The National Framework requires ECD studies to assess the extent to which the ecological character of the wetland has changed, with a specific point of reference or baseline from the date of nomination into the Ramsar List of Wetlands of International Importance.

Following a review of scientific literature and planning documents relevant to the Moreton Bay Ramsar site, the study team engaged the Steering Committee and Knowledge Management Committee members about their views regarding potential changes to ecological character that have occurred since listing of the site in 1993. In particular, the study team sought advice about impacts to those aspects of the site nominated as critical services/benefits and underlying components and processes as outlined in the previous sections of this report.

In general terms, the literature reviewed and experts have not identified any significant or overarching changes during this fifteen year period but recognise that a number of long term threats are having an incremental and cumulative effect on ecological character. Likewise, no views were expressed from the information sources reviewed or from the committee members to merit consideration that the ecological character of the site had significantly diminished with respect to the critical services/benefits outlined in this study.

Some of the issues that were raised in the context of perceived impacts and potential changes to ecological character of the Ramsar site were as follows (not reported in any order):

- Increased occurrence and severity of *Lyngbya* blooms in southern Deception Bay and the Eastern Banks;
- Localised die-off of seagrass communities in Deception Bay (resulting from increased turbidity caused by fine sediment re-suspension) and in the Broadwater (resulting from changes to hydrodynamics and habitat modification as a result of the construction of the Gold Coast Seaway opening) and in some cases, the corresponding replacement of these habitats with macroalgal communities (eg. *Caulerpa* sp.). Abal *et al.* (2005) provides a quantitative measure of change to seagrass abundance for the whole Bay (not just the Ramsar site), noting that there have been significant declines in abundance of seagrass over time measured in a time frame between 1987 and 1997/2000, with a net change of - 2219 ha in the Northern area of the Bay and - 84 ha in the Southern area (note that these figures account for seagrass additions);
- Localised die-back of mangrove communities (eg. Southern Bay, Brisbane River delta area) from a range of natural and potentially anthropogenic causes;
- Loss/reduction of saltmarsh areas since 2003 (estimated 2500 ha) due to a combination of development pressure and sea level rise leading to subsequent colonisation of saltmarsh areas by mangroves in the Western and Southern Bay areas (Hegerl and Tarte, pers. comm. 2008);
- Observed fluctuations in dugong and turtle populations suspected to be from a range of natural and anthropogenic causes;

- Observed decreases in the number of visiting migratory waterbirds (noting that this is likely related to a variety of off-site circumstances such as changes to extent of habitat and condition of habitats throughout the Flyway);
- Increased pressure on wetland values through increased visitation and use of the site (such as the bay island National Parks);
- Groundwater extraction for domestic water supply and associated impacts on Eighteen Mile Swamp on North Stradbroke Island (including the increased susceptibility of the peatlands to irreversible impacts from fire);
- Wetland habitat modification (principally of adjacent wetland areas outside the site) and direct fishing effort resulting in impacts on commercial and recreational fisheries (see threats section below); and
- Changes in the location and an overall reduction in the quality of shorebird roosting sites in the Western and Southern Bay (principally mainland habitats) as a result of habitat loss, modification and increases in frequency of disturbance.

From this list of impacts observed over the period from 1993 - 2008, the following six impacts are seen as having the greatest significance in the context of the critical services/benefits and therefore, implications for future ecological character:

**Use and quality of habitat for migratory waterbirds**

While difficult to quantify without more complete data sets, there is a general view by professional and amateur ornithologists and regular observers that there have been observed decreases in the number of visiting migratory waterbirds to the site (R. Jaensch, pers. comm.. 2008). As outlined above, this is likely to be the result of multiple stressors off and on site. Off-site impacts that are likely contributing to this decline are the quality and availability of habitat in other nations along the Australasian Flyway as well as the condition of Australia's inland wetland habitats. See Nebel *et al.* (2008) for a discussion on long term survey results which show a consistent declines in waterbird abundance. On-site changes in the location and an overall reduction in the quality of bird roosting sites in the Western and Southern Bay (principally mainland habitats) as a result of habitat loss, modification and increases in frequency of disturbance are also likely contributing factors.

**Seagrass loss in Deception Bay and Southern Bay**

Large-scale seagrass dieback in southern and eastern Deception Bay in recent years has resulted in the loss of a significant area of *Zostera* as well as sub-tidal *Halophila* species preferred by dugong and turtles as a food resource. Losses of seagrass abundance have also occurred in the southern Broadwater, Peel Island and areas around Coochiemudlo Island. The impacts of this habitat loss on local populations of dugong and turtle species and on broader fishery productivity are poorly understood. However, it would be reasonable to suggest that the loss has put additional pressure on other suitable dugong and turtle feeding areas within the Bay and could have lead to changes in fish and prawn recruitment success and possibly productivity. Further investigations are required to determine whether this could be considered to represent a change to ecological character.

**Lyngbya**

As outlined in the 2007 Healthy Waterways Action Plan for Algal Blooms, the toxic marine cyanobacterium *Lyngbya majuscula* has formed large (10 $km^2$ in Deception Bay), persistent and annually recurring blooms in Moreton Bay since around 1998. While historical research suggests blooms have occurred in the region for at least the last 100 years, there has been an increase in intensity and frequency of lyngbya blooms since the mid 1990's, with blooms occurring each summer across several locations within Moreton Bay, including Deception Bay in the Western Bay and on the Eastern Banks.

Results from the SEQ Healthy Waterway Partnership's Lyngbya Research and Management Program 2005-2007 identify that the key environmental factors for lyngbya growth in Deception Bay are a combination of increases in bioavailable nutrients (including iron, phosphorus, nitrogen and dissolved organics) and suitable light, salinity and temperature regimes. Specifically, the research has found that the disturbance and subsequent oxidation of Acid Sulfate Soils is of concern, as it leads to the release of nutrients such as iron. The cause of lyngbya blooms in the Eastern Banks region is less understood although the natural infiltration of nutrient-rich groundwater from the islands into surface waters are postulated as a likely trigger during favourable climatic conditions.

Lyngbya can impact on Ramsar values through the smothering of seagrass beds by dense blooms which has been found to lower the density and extent of seagrass in the affected areas. Likewise, high density blooms of lyngbya covering mangrove mudflats have been linked to malformation and mortality of mangrove seedlings. Harmful algal blooms of cyanobacteria species (including lyngbya) may also release toxins that cause illness or even mortality of marine fauna. Lyngbya can have an equally significant economic impact on wetland tourism and recreational activities in the Bay during summer bloom periods making coastal waters unfit for primary contact and beaches unuseable.

**Water quality in the Western Bay**

As mentioned in Section 3, the rates of organic loading of benthic zones (due to a combination of point and diffuse carbon sources) in the Western Bay are at greatest threat from continued poor water quality with the process of denitrification in the sediments 'poised' to turn off. If this were to occur, there would be potentially very serious consequences, as water column nutrient levels would increase. This would in turn encourage greater water column primary productivity, which would further affect subtidal vegetation in the Ramsar wetlands, and a potentially continual cycle of ecosystem decay could be initiated. It should be noted that recent and ongoing efforts to reduce sewage carbon and nutrient loads to the region may assist in reducing the potential for this scenario to develop.

**Water quality in the Southern Bay**

In terms of long term trends in water quality, the Healthy Waterways Strategy indicates that the area within the Bay of most concern is the steadily decreasing grade of the Southern Bay area; in 2002 it rated as "good", however by 2006 it had declined to "poor". This decline is linked with the increasingly poor water quality in the Logan and Albert River estuaries. While the most recent Report Card has seen an improvement in grade back to a B-, this is reported as being due, in part, to the application of less stringent water quality guidelines to the area. Future urban expansion adjacent to the Southern Bay is indicative that much greater pressure on the water quality (and associated wetland values such as seagrass) in this region is likely in coming years.

### 5.1.2 Management Responses Since Listing

It is important in the context of Moreton Bay to highlight that the impacts discussed in the previous section (and those that pre-date Ramsar listing) signalled a significant public appreciation of environmental threats to the Bay. This fuelled the impetus for significant Government investment in planning, management and monitoring of the Bay over the past two decades.

The early 1990's saw the genesis of a number of major planning and management regimes relevant to the Bay and its resources. Some of the key responses during this early period included:

- Declaration of the Bay as a marine park under the Queensland *Marine Parks Act 1982* and promulgation of the Moreton Bay Strategic Plan 1993 by the then Department of Environment and Heritage (note that the marine park would be zoned several years later in 1997);
- Alignment of the Moreton Bay Water Quality Study and Brisbane River Management Group activities toward the formation of the Healthy Waterways Partnership and significant investment and improvement in wastewater discharges by local authorities;
- The prohibition and removal of commercial fishing activities from Pumicestone Passage by the then Queensland Department of Primary Industries/Queensland Fisheries Management Authority; and
- Increased emphasis and funding to improve rural land management through integrated catchment management by the then Department of Natural Resources and Department of Primary Industries.

By the 2000's, the management response to the conservation and sustainable management of the Bay saw further progress. Significant investments were made in water quality monitoring (EHMP), urban wastewater treatment and stormwater management, improved rural land management and preparation of numerous statutory land use plans and strategies recognising the Bay's environmental values by State Government, local governments and the regional NRM bodies (many of which still apply and are outlined in this report). This was underpinned by significant investment in projects by the community through funding programs like Coastcare and Coast and Clean Seas as well as investment by the private sector to both monitor and improve environmental practices.

Discussions with Committee members also highlighted some perceived positive effects on ecological character as a result of mitigation schemes and works. Particular examples include creation of shorebird habitat at Boondall through placement of dredge spoil, rehabilitation of mangroves at the Kerkins Levee site in Pimpama, and saltmarsh restoration at both Hays Inlet and Bulimba Creek (J Beumer, pers. comm. 2008).

Despite the significant investment to date and demonstrable improvement in ecosystem health in some localised areas, there is recognition by stakeholders that more broad scale improvement of highly modified aquatic ecosystems will be a long term process in the Bay and its waterways. Further, the maintenance of current values (by stopping the further decline of these systems) will continue to be challenging given the economic and infrastructure growth the region is experiencing.

## 5.2 Overview of Threats

A range of threats have been identified in the summary tables for the critical services/benefits contained in Section 7 of this report. In analysing this list, a number of common threats to ecological character can be derived.

In general, threats can be categorised between threats occurring *within* the boundaries of Ramsar site and those that are occurring *outside* the site boundaries that because of their scale or intensity can have an adverse impact on ecological character.

This categorisation is important given the nature of the boundaries of the site which are essentially a series of discontinuous polygons that are limited to nearshore estuarine areas and extend selectively over State controlled lands or similar above the high water mark. In addition, the site excludes major rivers such as the Brisbane and the Logan and in most cases does not extend up the smaller adjoining estuaries and creeks to their full tidal extent.

It is also important to recognise that many important wetland species identified in the critical services/benefits (birds, some fish, turtles, and dugong) are highly mobile both within the site and across much larger habitat ranges. As such there is an inherent difficulty in using a management regime like the Ramsar Convention to effectively manage threats and impacts to such fauna.

For this reason, most management regimes (including the EPBC Act) tend to focus on regulating activities that will or may have an impact on the values of the site without necessarily occurring within the boundaries of the site or involving direct disturbance.

Through the expert panel process undertaken with the Scientific Expert Panel (refer Appendix A), threats and stressors at a habitat-scale and species-scale within the estuarine and marine areas of Moreton Bay were developed. Table 5-1 provides a summary of the outputs of these discussions focussing on those habitats and species relevant to the Ramsar site.

**Table 5-1 Threats and Stressors on Key Habitats and Species**

| Habitat Type | Stressors/Threats *(note that the items are not listed in any order of priority)* |
|---|---|
| Seagrass meadows | Anchoring/propeller damage; Fishing (bait collection); Algal Growth (*caulerpa* and *lyngbya*); Dredging; Fishing (trawling); Water pollution (run-off); Climate change |
| Mangroves and Saltmarsh | Direct clearing or filling; Water pollution (nutrients and hydrocarbons); Adjacent works (eg. urban development); Off road vehicle driving (tyre tracks); Climate change; Algal growth/weed infestation |
| Tidal flats | Fishing (netting); Fishing (bait collection); Direct clearing or filling; Adjacent works (ie. dredging, urban development); Climate change; Water pollution (nutrients) |
| Rocky shores | Fishing (bait collection); Recreational use and collection (trampling); Climate change; Water pollution (run-off and sedimentation) |
| Ocean beaches and foredunes | Fishing (line and netting); Fishing (bait collection); Works (extraction, structures, nourishment projects); Human use (off road vehicle driving); Introduced predators; Climate change; Water pollution (nutrients) |
| Inshore coral communities | Fishing (line and netting); Anchoring; Aquarium fish collection; Human use (recreational and tourism diving); Dredging and placement of spoil; Water pollution (land based runoff); Climate change; Water pollution (vessel based); Algal growth |
| Inshore mud (sub-tidal areas with predominantly muddy substrate) | Dredging and placement of spoil; Fishing (trawling); Water pollution (plumes and runoff; Changes to fluvial flow regime |
| Inshore sand (sub-tidal channels, banks and bars with predominantly sandy substrate) | Works (sand extraction; dredging; training river mouths); Fishing (netting, line, trawling and crabbing) |
| Wallum freshwater habitats (including peat swamps) | Urban development; Fire regimes; Introduced species and weeds; Groundwater extraction; Climate Change; Water pollution (run-off). |
| **Species Type** | **Stressors/Threats (not listed in any order of priority)** |
| Dugong | Harassment; Fishing (traditional hunting); Boat strike; By-catch and entanglement; Water pollution; Climate change; |
| Marine turtles | Rubbish and plastic ingestion; Fishing (traditional hunting); By-catch and entanglement; Boat strike; Introduced predators (particularly for nesting); Water pollution; Climate Change; Off road vehicle driving; Algal blooms (*lyngbya*) |

| | |
|---|---|
| Shorebirds | Human disturbance (visual and noise and habitat modification); Introduced and native predators; Climate change |
| Little tern | Human disturbance (visual and noise, habitat modification and direct mortality from beach driving); Introduced and native predators; Climate change; Line fishing (impact on food source) |
| Water mouse | Human disturbance (habitat modification); Introduced and native predators |
| Illidge's ant blue butterfly | Human disturbance (habitat modification in mangrove areas) |
| Acid frogs | Habitat loss and fragmentation; Altered hydrological regimes (water diversion); Water pollution; Weed and mosquito control; Introduced predators (Eastern Gambusia); Fire regimes; Climate Change |
| Painted snipe and Australasian bittern | Habitat modification (drainage of wetlands); Altered hydrological regimes (water diversion); clearance of wetland vegetation (particularly dense sedge) and overgrazing |
| Oxleyan pygmy perch and honey blue-eye | Human disturbance (habitat modification); Water pollution; Groundwater extraction; Introduced predators (Eastern Gambusia); Algal blooms |

Given the diverse range and varying magnitude of threats and stressors at a habitat or species scale, further analysis was needed in order to identify the most prominent threats to the Ramsar site, particularly at the whole of site scale.

Accordingly, the study team sought to identify and group threats into categories considering the following criteria:

- The degree of salience or relevance to the nominated critical services, components and processes in the ECD;
- The propensity of the threat to affect a broad area;
- The propensity of the threat to impact the site cumulatively over time.

In this context, threats were considered both in terms of stressors or threats occurring within the boundaries of the site and those that were external to the site boundaries.

The key threats derived from this analysis are set out in section 5.2.1 – 5.2.8 and are summarised into the following categories:

- Harmful interaction with wetland species;
- Sustainability of fishing and harvesting;
- Sediment and nutrient input into the Bay from point and non-point sources;
- Groundwater extraction;

- Urban encroachment into the Ramsar boundary and adjacent wetland areas;
- Significant changes to wetland ecosystem processes from major infrastructure/development projects;
- Oil spills or other large scale marine pollution incident;
- Altered fire regimes; and
- Impact on coastal wetlands from climate-change induced sea level rise and related threats.

In characterising the nine (9) key threats identified above, a qualitative risk assessment matrix has been used to assist in assignment and prioritisation of risk. This involves assessing the likelihood and severity of potential impacts based on a range of threat categories. Description and assignment of risk levels using this framework is summarised in Tables 5-2 to 5-6 below.

As part of this risk assessment it is also important in a highly managed environment like Moreton Bay to consider the effectiveness of National, State and local laws and policies to regulate and reduce risks to wetland values from threatening processes. Thus, the final residual risk for each threat has been presented with this regulatory/management adjustment.

**Table 5-2 Spatial Application of Impact Categories**

| **Spatial Application of Impact** |
|---|
| Broad Scale - Impacts will occur at a Whole-of-Ramsar -site scale, with marked impacts to populations/sub-populations of key flora and fauna listed in the critical services |
| Regional Scale – Impacts will occur beyond the local scale (eg. potentially across several habitat types) with some impacts to populations/sub-populations of key flora and fauna listed in the critical services |
| Local Scale – Impacts will be at an individual habitat or community scale (eg. within a habitat type) but will not have any measurable effect on population or subpopulations of key flora and fauna listed in the critical services |
| Individual Scale – Impacts will be at an individual species level and will not affect population or subpopulations of key flora and fauna listed in the critical services |

**Table 5-3 Duration of Impact Categories**

| **Duration/Irreversibility of Impact** |
|---|
| Permanent or otherwise Long Term and Irreversible |
| Medium Term Impact |
| Short Term Impact |

*Notes:*
- ***Permanent/Long Term** = Recovery of habitat or population measured in decades or irreversible*
- ***Medium Term** = Recovery of habitat or population measured in years*
- ***Short Term =** Recovery of habitat or population measured in days to months*

**Table 5-4 Impact Risk Category Table**

| Impact Risk Category | |
|---|---|
| High | Irreversible Impacts at the Broad Scale or Regional Scale<br>Medium Term Impact at the Broad Scale |
| Medium | Irreversible Impact at a Local Scale<br>Medium Term Impacts at the Regional Scale<br>Short Term impact at a Broad Scale |
| Low | Irreversible Impact at the Individual Scale<br>Medium Term Impact at a Local scale<br>Short Term impact at a Regional Scale |
| Very Low | Medium Term Impact at the Individual Scale<br>Short Term Impact at a Local Scale |

**Table 5-5 Likelihood that the Impact could lead to a significant/marked change to Ecological Character**

| Likelihood that impact to ecological character will occur from the threat | High Impact Level | Medium Impact Level | Low Impact Level | Very Low Impact Level |
|---|---|---|---|---|
| Likely or Certain | 4 – High Risk | 4 – High Risk | 3 – Medium Risk | 2 – Low Risk |
| Possible | 4 – High Risk | 3 – Medium Risk | 2 – Low Risk | 1 – Very Low Risk |
| Not Likely | 3 – Medium Risk | 2 – Low Risk | 1 – Very Low Risk | 1 – Very Low Risk |

*Notes:*

- ***Likely/Certain*** *indicates that a significant or marked change to ecological character (eg. one or more limits of acceptable change have been compromised) is likely or certain to occur from a particularly threatening process*
- ***Possible*** *indicates that while change could occur to a Ramsar value or Service, this change may not necessarily be one that represents a significant or marked change to ecological character (eg. limits of acceptable change have not been compromised)*
- ***Not Likely*** *indicates that a change could occur but this change is not seen as having any material impact on ecological character (eg. change does not compromise limits of acceptable change)*

**Table 5-6 Management Regime Adjustment to Residual Risk**

| Perceived Effectiveness of Management Regime (eg. application of EPBC, State laws, Local laws) to reduce risk of threat having significant/marked change to ecological character | |
|---|---|
| Highly Effective | Reduce Risk Rating by One – Two Rankings |
| Effective | Reduce Risk Rating by One Ranking |
| Somewhat Effective | Unmitigated Risk becomes residual risk |

*Notes:*

- ***Highly Effective*** *is indicative that there is an existing regulatory or management regime in place for the threat and implementation is comprehensive and effective.*
- ***Effective*** *is indicative that there is an existing regulatory or management regime in place for the threat and implementation is considered to be effective but is likely limited by extent, jurisdiction, resources or a similar issue.*
- ***Somewhat Effective*** *is indicative that there may not be a regulatory or management regime in place for the threat or otherwise that the existing regime is considered to be somewhat ineffective.*

### 5.2.1 Harmful Interactions with Wetland Species

Growing population in the region has led to increased usage and access within, across and through the various wetland habitats of the Ramsar site for a range of commercial and non-commercial activities.

These activities present a further threat to critical wetland services/benefits and ecological character. Human presence and use of wetland habitats can have indirect impacts on the quality of the habitat for important wetland species, particularly where such disturbance is occurring at a critical or sensitive life stage (eg. nesting). While isolated incidents are unlikely to result in marked or observable changes to ecological character in the short term, the cumulative impacts of these activities on particular habitats or on the populations of important species are perhaps of greater concern.

Specific threats within this category include:

- Beach driving and other human usage resulting in on-going disturbance to shorebird nesting, roosting and feeding areas;
- Disturbance to shorebirds (roosting and breeding) that can occur as a direct result of human recreational activities including: 4WD vehicles on beaches (Moreton and North/South Stradbroke Islands); boating/kite surfing/jet skin around feeding and roost sites (e.g. Days gutter, Amity banks, Jumpinpin, Caloundra sand banks), pedestrian activity (with or without companion animals) through or in close proximity to shorebird roost sites;
- Localised wetland habitat degradation through trampling of reed beds in areas with high levels of human visitation (e.g. Blue Lake – North Stradbroke Island; Blue Lagoon - Moreton Island), which has the potential to impact seriously on local acid frog populations;
- Interaction between important marine fauna and commercial and recreational fishing activities including provision of food resources from by-catch; and
- Increase potential for boat strike/disturbance of dugongs and turtles through increased commercial shipping, major dredging activities and recreational boating activities (including jet-skis).

Management of these threats in a manner consistent with the objectives of the Ramsar Convention (eg. so as to maintain ecological character) is reliant on the application of legislative powers and management measures by the various State Government agencies and Local Governments as well as those industries directly involved. Funding and resources to undertake planning, day to day management and enforcement functions are key management challenges in the context of these activities.

| Threat: Harmful Interactions with Wetland Species | Risk Level |
|---|---|
| Threats under this category include beach driving, by-catch, boat strike and similar and their likelihood to cause a significant/marked change to ecological character | Beach Driving – Low and Possible– 3 |
| | By-Catch – Low and Possible – 2 |
| | Boat Strike – Low and Possible - 2 |
| | Others – Low and Possible - 2 |
| Critical Services of the ECD relevant to this threat | S2a and 2f, S3, S4, S6, S7 |
| Overall Unmitigated risk | Risk Level 2 – Low Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | A range of regulatory regimes apply. However, these threats generally relate to day to day management activities and are difficult to enforce. Education programs and similar have been implemented with some success. |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.2 Sustainability of Fishing and Harvesting

The Queensland Department of Primary Industries and Fisheries (DPI&F) manages the state's fisheries resources. DPI&F, through the *Fisheries Act 1994*, has implemented a range of programs and strategies that aim to manage fisheries in a sustainable manner. This includes gear/vessel restrictions, fish size limits, area and seasonal closures, and bag limits for recreational fish species. For most species, there are no overall total quotas (total allowable catch). Note that revised limits are to come into force in 2008/2009.

There are several key fisheries of relevance to the Moreton Bay Ramsar site (Table 5-7). The key fisheries of relevance to the site are the East Coast Otter Trawl, Inshore Finfish, Rocky Reef, Mud Crab, Blue Swimmer Crab, Spanner Crab and Beche-de-mer fisheries. Most of these fisheries are accredited under the EPBC Act, in line with the *Guidelines for the Ecologically Sustainable Management of Fisheries* (Department of the Environment and Water Resources 2007).

In addition to the above strategies, there are a range of monitoring programs in place to assess potential impacts of the fishery and the effectiveness of fisheries management arrangements. Monitoring activities include reviews of commercial logbook data, recreational fishery diaries, boat ramp surveys, and a range of fisheries dependent and independent sampling programs. Stock assessments for Queensland fisheries resources are also undertaken on a 3 yearly basis (e.g. Tanimoto *et al.* 2006; O'Neil and Leigh 2006; Allen *et al.* 2006). It should be noted however that in general terms, it is difficult to quantify trends in the abundance of most fisheries species based on available information, and impacts of fisheries activities, at local spatial scales.

Annual status reports are prepared by DPI&F for each major fishery, which considers fisheries management arrangements, trends in long-term catch and effort data, and an assessment of the sustainability of the fishery based on catch-effort data (see Table 5-7). The status of the fishery is examined on a state-wide and regional basis, and in most cases, does not consider finer spatial scale trends (i.e. site specific data for Moreton Bay). The broad spatial scale of monitoring (and associated reporting) is appropriate in the context of fisheries management, as few fish stocks are likely to be restricted to local geographic area (such as Moreton Bay, or sites with the Bay). However, this approach does prevent an understanding of trends in the relative abundance of key fisheries in time at spatial scales relevant to the ECD.

**Table 5-7 Status of key fisheries operating within Moreton Bay**

| Fishery | Status | Source |
|---|---|---|
| Inshore finfish | Potential issues regarding sustainability of fishery for some shark species. No other issues raised, although data are of insufficient resolution to determine any issues at a regional scale. | DPI&F (2007b) |
| East coast trawl fishery | Major changes in catch, effort and overall harvest over time, reflecting changes in fisheries management arrangements. Insufficient data at this stage to assess status of key resources. | DPI&F (2007g) |
| Rocky reef fishery | The Rocky Reef Fin Fish Fishery is under review following concerns from the commercial, recreational and charter fishing sectors about the sustainability of rocky reef fish stocks. | DPI&F (2007f) |
| Mud crab | Relatively stable Catch Per Unit Effort (CPUE) at both the State and East Coast Regional scales (2001-2006). No fisheries independent data from the Long Term Monitoring Program (LTMP) presented in this report to validate these trends.<br>LTMP data, which provides fishery-independent relative abundance (CPUE) data (DPI&F 2006), shows that the Moreton Bay region had highly variable mud crab abundance over time (2000-2005), unlike the other areas in the State. The reasons for this are unclear. | DPI&F (2007d, 2006) |
| Blue swimmer crab | Commercial CPUE within Moreton Bay has remained relatively stable from 1999 onwards, excluding a peak in 2001. The lowest reported catch occurred in 2005 & 2006, and was thought to be linked to a decline in the number of days fished, together with a possible reduction crab numbers due to drought conditions. RFISH surveys conducted in 2002 & 2005 indicate that the recreational harvest has remained fairly stable over this period. | DPI&F (2007e) |
| Spanner crab | Trend of increasing CPUE in the south coast (Managed Area A) region between 1990 and 1997. Independent estimates from DPI&F's Long Term Monitoring Program (LTMP) from 2000-2003 also support the suggestion of an increase in spanner crab abundance. | DPI&F (2007a) |
| Beche-de-mer | Static CPUE in 2003-2005, decline in distribution and abundance in 2006. Given that a small proportion of population is harvested, DPI&F argues that reduction is unlikely a fishery effect. | DPI&F (2007c) |

This mix of zoning and fishery management tools (administered through the Fisheries Act) aim to ensure fisheries are managed in an ecologically sustainable manner. The Moreton Bay Zoning Plan prepared under the Queensland *Marine Parks Act 2004* also regulates fishing activities in the Bay by restricting the type of fishing that can be undertaken in different zonal areas. Based on the draft zoning map released in 2008 by the Queensland Government, increased regulation of commercial and recreational fishing is also likely to occur through proposed amendments to the zoning plan.

| Threat: **Sustainability of fishing and harvesting** | **Risk Level** |
|---|---|
| Threats from fishing activities and their likelihood to cause a significant/marked change to ecological character | Medium and Possible |
| Critical Services of the ECD relevant to this threat | S7 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective (and improving) – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.3 Water Quality Inputs

Considerable investment has been made over the past 15 years to improve point source discharges from regional sewage treatment plants, noting that the improvement and upgrade of existing facilities remains a priority as populations grow. However, it is diffuse sources of pollution that constitute the largest threat to long term ecosystem health in the Bay.

As part of the SEQ Healthy Waterways Strategy 2007-2012, the SEQ Healthy Waterways Partnership has identified the need to set sustainable load targets to assess whether or not waterways of the Bay will meet water quality objectives and protect environmental values. Scenario modelling has been undertaken as part of the development of the Strategy to predict the impact of population growth and subsequent land use change on annual pollutant loads. With a ‘business as usual’ approach, the Strategy predicts that by 2026, there will be a 14% increase in Nitrogen, 21% increase in Phosphorous and 17% increase in Total Suspended Solids loads to Moreton Bay. This increase is broken down between increases from point sources, diffuse urban, diffuse rural and diffuse natural sources of these nutrients and sediments of which land based sources of pollution represent the greatest threat to long term ecosystem health. As mentioned in the impacts section previously, two areas of the Ramsar site of particular concern in terms of future water quality include Bramble Bay in the Western Bay region and the Southern Bay area. Lyngbya blooms remain an important indicator of the water quality of run off in the Western Bay area.

The investigation and implementation of new water infrastructure in the region in the form of reverse osmosis wastewater recycling and desalination plants present a new point source threat, generally involving the discharge of concentrated pollutants (generally high salinity and high nutrients) associated with the purification process. However, all new wastewater recycling and desalination projects are likely to trigger State and possible Commonwealth assessment under relevant environmental impact legislation, further reducing their potential to cause unacceptable impacts to Ramsar values. Where reverse osmosis technology is being used to treat existing STP discharges such as is proposed at Luggage Point, there may be a net improvement in water quality from the current discharge accepting that a range of positive and negative impacts would need to be assessed (eg. loss of flows into the system, different concentration/proportions of nutrients, increased salinity, etc.).

| Threat: Diffuse-sources of water pollution | Risk Level |
|---|---|
| Threats from diffuse sources of pollution | High and Possible |
| Critical Services of the ECD relevant to this threat | All, possibly excluding S4, S5, S7 and S9 |
| Overall Unmitigated risk | Risk Level 4 – High Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective (and improving) – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 3 – Medium Risk |

| Threat: Point-source of water pollution | Risk Level |
|---|---|
| Threats from point sources of pollution | Medium and Possible |
| Critical Services of the ECD relevant to this threat | All, possibly excluding S4, S5 and S9 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective (and improving) – Reduce Risk Level by Two |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.4 Groundwater Extraction

Groundwater extraction in the Moreton Bay region principally occurs on North Stradbroke Island with several bores located in and around the three major townships and extraction from Herring Lagoon near 18 Mile Swamp. These bores are operated by Redlands Shire Council to service both on- and off- island potable water supply. Other bores on the island provide water for industrial use by Consolidated Rutile Limited in its sand mining operations, though almost all of this water is recycled back to the aquifer through the mining processes.

More significant groundwater extraction from the Bay Islands has recently been investigated by the Queensland Government and local governments as part of the SEQ Regional Water Supply Strategy on North Stradbroke Island and Bribie Island.

The Eastern Pipeline Inter-Connector project investigated the feasibility of extracting groundwater from North Stradbroke Island and water from Leslie Harrison Dam, for the purpose of supplying water to Logan City Council. Extensive hydrological models of groundwater on the island were developed and continue to be refined and analysed by local and State Government in the context of the potential impacts of the project on Blue Lake and other wetlands on the island. However, the Queensland Premier, the Hon. Anna Bligh MP stated in October 2007 that,

> *'the Environmental Impact Study on the Eastern Pipeline Inter-connector Project {will} not proceed until alternatives are explored. I am determined to ensure that every piece of infrastructure we build is not only built on time and on budget, but is environmentally sustainable.'* (from www.qwc.qld.gov.au)

Investigations to extract up to 10 ML/day from the groundwater resources of Bribie Island continue with that project (as of March 2008) moving to construction of test and monitoring bores, construction of associated pipeline infrastructure and water treatment facilities (Moreton Bay Regional Council 2008 Progress Report from www.qwc.qld.gov.au).

As has been the case with the major proposals to date, new water extraction proposals will likely be subject to environmental impact assessment processes at the State and Commonwealth level.

Redland Shire Council's mainland water supply is supplemented by water extracted from an unconfined aquifer on North Stradbroke Island in the vicinity of 18 Mile Swamp (Herring Lagoon). The extent to which this water extraction has affected the peatlands of the Swamp has not been extensively studied or quantified although it is noted that the extraction is regulated, has been previously assessed and is operating under lawful permit. The greatest potential impact identified as part of the literature search and as part of discussions with Knowledge Committee Members relates to the effect the reduction in the groundwater table has on the wetness of upper layers of the peatland, and the increased susceptibility of the wetland to irreversible impacts from fire.

| Threat: Groundwater Extraction | Risk Level |
|---|---|
| Threats from groundwater extraction | Medium and Possible |
| Critical Services of the ECD relevant to this threat | S1, S2e, S3, S4, S5 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.5 Habitat Loss Due to Urban Encroachment

The development of urban areas, often with minimal buffer areas to coastal wetlands, can result in disturbance to shorebird feeding and roosting habitat and degradation of aquatic habitat through uncontrolled recreational access, contaminated stormwater and litter.

Given that the Ramsar site is generally over state land and waters, the risks from urban expansion causing direct habitat loss within the boundaries is unlikely. However, removal or degradation of coastal wetlands situated outside the Ramsar site can result in indirect, cumulative loss of overall fish habitat values that can affect fisheries values (refer Service 7) and other important wetland fauna and populations that rely on overall ecosystem health.

The effect of urban encroachment is particularly noteworthy for transitionary wetland habitats such as *Melaleuca* and *Casuarina* swamps and supratidal saltmarsh areas that provide fish habitat as well as other wetland services (eg. habitat for water mouse and other species listed in Service 4). These habitats are afforded less protection than intertidal marine plants under Queensland legislation and often are not of sufficient size to be mapped as remnant under the Vegetation Management Act (thus avoiding protection under that Act). Saltmarsh habitats are particularly at risk given the additional impact of climate change which will make these habitats more susceptible to mangrove intrusion as sea levels rise. In many areas, the natural succession of saltmarsh areas landward in response to rising sea levels will be blocked or otherwise inhibited by existing coastal development.

The placement of human populations close to wetlands also places pressure on wetland resources through day to day management issues. Managing the introduction of increased domestic pets and feral animals into wetland ecosystems including within the foreshores of the Ramsar site is a particular issue in the Western and Southern Bay areas where a large proportion of the population accesses the foreshore.

Likewise, the encroachment of urban areas in close proximity to wetlands increases the risk of fire and the need for implementation of fire management strategies (such as controlled burns, etc.) that while reducing risks to human populations, can have acute temporary and potentially long term impacts on wetland flora and fauna.

| Threat: Urban Encroachment | Risk Level |
|---|---|
| Threats from urban encroachment | Low and Likely |
| Critical Services of the ECD relevant to this threat | S1, S4, S6, S7, S8, S10 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.6 Major Infrastructure Projects

Large-scale projects can affect the hydrologic, hydrodynamic or water quality conditions of the Bay and associated Ramsar site at broader spatial scales. Examples of major projects that have previously been undertaken or proposed in the context of Moreton Bay include:

- reclamation or capital dredging of tidal areas;
- large-scale placement of contaminated dredge material;
- construction and operation of major water desalination facilities;
- construction and operation of major dams on rivers and streams that input into Moreton Bay; and
- sea cage or other intensive aquaculture facilities.

While potentially causing more significant impacts, the likelihood that these projects will affect the ecological character of the Ramsar site is reduced by the regulatory processes and environmental impact assessment processes that would be needed prior to approval and operation. In this regard, any project that could cause impacts to the Ramsar site (and ecological character) would generally need to be considered to be in the National or State interest.

| Threat: Major Infrastructure | Risk Level |
|---|---|
| Threats from major infrastructure | High and Possible |
| Critical Services of the ECD relevant to this threat | All |
| Overall Unmitigated risk | Risk Level 4 – High Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 3 – Medium Risk |

### 5.2.7 Oil Spills and Other Incidents

The Port of Brisbane and associated heavy industrial uses of the Australia Trade Coast lie at the doorstep of the Ramsar site. Oil spills are a potential risk to the marine environment associated with the shipping industry and on-shore petrochemical industries, with national and local plans formulated to respond rapidly to clean up spills and minimise impacts.

In March 2003, almost 2000 tonnes of light crude oil seeped from a ruptured pipeline at Lytton near the mouth of the River. This spill was controlled through a multi-agency effort such that impacts on the Ramsar site and Bay environment were largely avoided except at highly localised scales.

Introduction of exotic organisms through ballast water or on the hulls of foreign ships are a further potential threat to the Ramsar site, acknowledging that the Port of Brisbane and related agencies (AQIS, etc) implement strict controls to manage the translocation of potentially harmful organisms.

| Threat: Oil Spill or other incident | Risk Level |
|---|---|
| Threats from oil spill or other incident | Medium and Possible |
| Critical Services of the ECD relevant to this threat | All, possibly excluding S4, S5 and S9 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Effective – Reduce Risk Level by One |
| Residual Risk Rating | Risk Level 2 – Low Risk |

### 5.2.8 Altered Fire Regimes

Changes in land-use over time have led to modified natural fire regimes, and continue to alter fire regimes. Furthermore, predicted changes in climate are also likely to result in changes to fire regimes. Altered fire regimes threaten vegetation communities as regeneration processes are directly impacted, and often controlled, by fire. Consequently, fires experienced at inappropriate (too high or too low) frequencies, intensities or seasonality may lead to substantial changes in community composition and/or structure. Alterations to fire regimes threaten terrestrial vegetation communities within the site, with wallum freshwater habitats including peat swamps notably susceptible. In turn, threats may be exerted on fauna species that are dependent on these habitats, with the acid frogs of particular importance.

While management activities of protected vegetation communities may incorporate controlled burning, the possibility to reduce risks associated with altered fire regimes is limited by the lack of knowledge regarding specific fire requirements of vegetation communities and species.

| Threat: Fire Regimes | Risk Level |
|---|---|
| Threats from climate change | Medium and Possible |
| Critical Services of the ECD relevant to this threat | S1, S2e, S4 and S5 |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Somewhat Effective |
| Residual Risk Rating | Risk Level 3 – Medium Risk |

### 5.2.9 Climate Change

The potential impacts of climate change on the natural values of the Moreton Bay Ramsar site and the natural capacity of the system to cope with the change will vary depending on the nature of the impact as well as the location and type of wetland habitat.

In the context of current trends, recent projections of sea level rise have been made by the National Tidal Centre (as reported in the 2007 Queensland State of the Environment Report) as 1.2mm/yr.

Potential impacts of climate change on coastal ecosystems are summarised in Voice *et al.* (2006). The most salient potential threats to the Moreton Bay Ramsar site include:

- Sea level rise and shoreline erosion (noting that the response to this may be the proliferation of works to armour the foreshore and further impact on natural values);
- Changes in wind and wave climate causing changes in local erosion rates;
- Increased coastal flooding and saltwater intrusion by higher mean sea levels;
- Changes to freshwater flows regimes caused by changes in rainfall and runoff rates that can affect the condition of wetland environments such as mangroves and saltmarsh;
- Progressive inland migration of coastal ecosystems likely leading to increased pressure on saltmarsh communities from mangrove colonisation (noting in many areas there are physical barriers to such migration as a result of the presence of coastal development);
- The possibility of coral reef bleaching from increased sea temperature and coral degradation through water acidification; and
- Increased frequency/intensity of coastal storms and increased damage to coastal property.

Estuaries like Moreton Bay are considered as being particularly susceptible to climate change given their propensity to multiple stressors of which climate change becomes an additional or exacerbating factor.

Climate change impacts on the cultural values of the Ramsar site are also noteworthy. Many of the natural assets of the site important for tourism and recreation such as coral reefs, sandy beaches, fisheries and flora and fauna in protected areas will also be adversely affected by climate change leading to more direct and measurable economic flow-on effects should they be perceived as being altered or degraded.

Currently, there is significant investment and adaptation to climate change being implemented across a broad spectrum of planning and management activities by resource managers. As such, the assessment of the local risks of climate change within the region and the management response to climate change is expected to improve over time.

| **Threat: Climate Change** | **Risk Level** |
| --- | --- |
| Threats from climate change | Medium and Possible |
| Critical Services of the ECD relevant to this threat | All |
| Overall Unmitigated risk | Risk Level 3 – Medium Risk |
| Effectiveness of Regulatory/Management Regime to reduce Risk | Somewhat Effective (improving) – No change at present |
| Residual Risk Rating | Risk Level 3 – Medium Risk |

# 6 INFORMATION GAPS, MONITORING AND EDUCATION

## 6.1 Information Gaps

The ECD preparation process promotes the identification of information gaps about the Ramsar site that are principally derived through interrogation of the nominated ecosystem services, components and processes and associated understanding of natural variability and limits of acceptable change.

This section summarises the key information gaps identified from the detailed description of ecological character provided in Section 7 for each critical service/benefit and reflects the discussions and outcomes of the SEP expert panel process in relation to key habitats and species within Moreton Bay (refer Appendix A).

### 6.1.1 Summary of Information Gaps

In general, data and information gaps have been identified in this ECD in two ways:

1) In relation to the natural variability and limits of acceptable change for critical wetland habitats and species (as outlined in the summary tables in Section 4) particularly for those attributes/controls where no data (*nd*) is stipulated; and

2) In the context of the discussion of each of the ten (10) critical services/benefits (refer Section 7).

<u>Service 1: Diversity of Habitats</u>

- The lack of a definitive baseline for assessment of changes in spatial extent of habitats over time is a significant information gap in the context of setting limits of acceptable change and assessing ecological character changes over time.
- In this context, there needs to be further alignment between the Ramsar Wetland Classification System and EPA's wetland mapping methodology such that more exact spatial data can be obtained or developed about the extent of relevant wetland types. Steps include -
    - Greater identification, description and mapping of the Ramsar wetland types at a local spatial scale;
    - Identification of how the Ramsar typology can be nested within the EPA's standard mapping methodology either as particular REs (for wetland types with vegetation) or as sub-categories within the broader classification set (eg. palustrine, lacustrine, riverine, estuarine and marine).

<u>Service 2: Representative Habitats</u>

- Noting the above inconsistencies in mapping techniques prevent direct comparisons between existing data-sets over time, for each of the representative habitats more systematic information is required on background variability in wetland habitat extent, condition and linkages to controlling or impacting processes.

- As outlined in section 4.3.1, there is a broad information gap around the issue of pontenial changes to ecological character as a result of changes to habitat extent or species populations. While response curves to particular stressors in particular habitats may be able to be developed, broader limits of change (such as acceptable habitat loss as a percentage of the total habitat area present in the Bay) are difficult to apply holistically at a habitat or species population scale.

- Key areas for further assessment for each of the representative habitats include:

  - For Eastern Banks and other seagrass habitats – extent of habitat (both in terms of areal extent and depth limits for key species); gross productivity (in terms of biomass and density); and community composition and structure (in terms of presence/abundance of dugong and turtle as well as commercially and recreationally important fisheries)

  - For Pumicestone Passage and other tidal flats habitats – extent of habitat (areal); habitat condition measured through Total Organic Carbon in the sediments; and community composition and structure using indicators such as polychaete density, abundance of benthic microalgae, and crab burrow density

  - For the Southern Bay and other mangrove and saltmarsh habitats– extent of habitat (areal); extent or trends in dieback; community composition and structure in terms of ratio of mangroves to saltmarsh over time; presence/abundance of commercially and recreationally important fish species.

  - For Coral Communities – Habitat condition (in terms of the recruitment and fecundity of coral species); extent of bleaching or other mortality; and community composition/structure (such as the relative abundance of coral versus macroalgae, the ratio of massive to branching corals and individual coral populations over time).

  - For Bay Island Wallum habitats, as outlined in Marshall *et al.* 2006 -

    i. Further development of groundwater modelling techniques to take into account ecological assets and impacts from potential changes to groundwater levels

    ii. Implementation of real time aquifer, surface water and ecological monitoring to confirm the thresholds critical to ecological assets are not exceeded

    iii. Targeted research on the nature of groundwater dependency of wetland ecosystems, species and communities

  - For Ocean Beach and Foredune Habitats - More systematic survey of key species (birds and turtle) populations over time including usage and quality of nesting sites; further research of the impact of ORV usage on sandy beach invertebrate communities; long term changes to beach morphology.

<u>Service 3: Aquatic/marine fauna</u>

*Marine Species*

- Present-day and historical marine vegetation mapping done at relevant spatial scale (minimum 1:25,000) and temporal (at least every 5 years, preferably with analysis of seasonal changes).

- Information on factors controlling temporal changes in seagrass.

- Natural variability in dugongs and green and loggerhead turtles and factors controlling these changes.
- Sustainability of dugongs, green turtles and loggerhead turtles given existing pressures and management arrangements.
- Health/condition status of turtles, and identification of factors causing disease.

*Freshwater Species*

- Environmental flow requirements of wallum fish species.
- Impacts of introduced species on wallum fish species.
- Up-to-date assessment of the distribution, population status and site-specific threats to wallum-habitat fish species, including an assessment of any changes of population status.

Service 4: Wetland-dependant terrestrial fauna

- Natural population variability for all species and factors controlling these changes.
- Sustainability of beach stone-curlew pairs (and breeding success) (particularly related to impacts of recreational activities) and water mouse populations (in relation to development or degradation of habitat adjoining the site).
- Extent of populations of acid frogs and water mouse outside/adjoining study area boundaries.
- Systematic information to assess background variability in wetland community structure and linkages to controlling processes; environmental flow requirements of acid frogs; impacts of introduced species (on acid frogs, beach stone-curlew, and little tern) and congeneric competitors (to acid frogs).
- Locations and sustainability of little tern nesting sites (primarily in southern parts of site). Longer-term variability in patterns of usage of little tern roost sites.
- The need for monitoring and survey data collected for shorebirds is collated in a consistent manner, with data held in relevant databases that can be accessed to inform decision-making.

Service 5: Wetland-dependant terrestrial flora and communities

- Systematic surveys of flora and mapping of significant species is lacking.
- Research to understand groundwater dependencies for communities and species is very limited.
- Research to identify species tolerance to salinity and desiccation is lacking.

Service 6: Shorebird Populations

- Indices/trends for shorebird abundance and diversity over time, patterns of roost and feeding habitat usage, particularly in terms of the proportion of shorebird aggregate feeding outside the Ramsar site boundaries.

- Natural population variability for all species and factors controlling these changes.
- Information on factors controlling temporal changes in seagrass, mangrove and saltmarsh.
- Information on natural population variability of invertebrate prey and factors controlling temporal changes.
- Current distribution and categorisation of roost habitats (e.g. size, level of disturbance, position in relation to HAT and feeding grounds) within and adjacent to study area boundaries.

Service 7: Fisheries

- Present-day and historical marine vegetation mapping done at relevant spatial scale (minimum 1:25,000) and temporal (at least every 5 years, preferably with analysis of seasonal changes).
- Information on factors controlling temporal changes in seagrass, mangrove and saltmarsh.
- Natural variability in fish and shellfish stocks, and factors controlling these changes.
- Specific environmental flow requirements of estuarine vegetation and fisheries species.
- Sustainability of current recreational and commercial fisheries management practices.
- Values and functions of proposed no-take 'green zones' in the future Marine Park Zoning Plan.
- Estimates of the abundance of key fisheries species over time at a local (Moreton Bay) spatial scale.
- Impacts of fisheries activities on abundances in Moreton Bay.
- Assessment of impacts of climate change on commercially and recreationally important fish stocks such as changes to migration patterns and initiation of critical life stage processes.

Service 8: Indigenous

- While some values and resources have been identified, further articulation of the values and cultural significance of the site are seen as only able to be set and measured through consultation with Traditional Owners.

Service 9: Research and Education

- A range of science priorities for Moreton Bay have been identified as part of the 2007-2012 Healthy Waterways Strategy (Moreton Bay Action Plan component). In addition to these priorities, the information gaps and monitoring recommendations of this ECD are seen as essential for monitoring the ecological character of the Ramsar site.

Service 10: Tourism and Recreational Uses

- Reliable visitor statistics, including tourist expenditure and other economic contributions.
- Carrying capacity of the Ramsar site for activities and locations.

- The importance placed on the Ramsar site and values by visitors when undertaking tourism and recreational activities and experiences.

### 6.1.2 Priority Information and Data Gaps

In analysing this expansive list, the following thematic information gaps are identified as priority areas:

- Additional research and monitoring expenditure to establish an ecological character baseline for the near-natural representative habitats, particularly those more localised habitats within the Ramsar site such as the freshwater wallum habitats of the Bay islands, the Eastern Bay coral reefs and peatlands such as Eighteen Mile Swamp;

- The need for better information and data sets about the presence and natural history of critical wetland species and their habitat including for example, surveys of vulnerable and endangered plant species on the Bay islands, aquatic species such as Oxleyan pygmy perch and more systematic surveys of important avifauna species and populations;

- Better information and understanding about the natural variability of critical wetland fauna populations and key attributes and controls on those populations (including whether or not any non-avian fauna species meet the 1% population requirement in Ramsar Nomination Criterion 9);

- The ecological character thresholds of particular habitats and communities to changes in key attributes/controls such as water quality and hydrology need additional investigation. Noting that any interim limits of acceptable change stated in the ECD should be revised as improved information becomes available;

- Resilience of habitats, community structure and key species to acute or prolonged impacts from water quality degradation such as nutrient enrichment, increased levels of salinity and sedimentation/turbidity (eg. similar to the approach in ANZECC for toxicants); and

- Consultation and involvement of traditional owners of the Moreton Bay Ramsar site if a greater understanding of historic and contemporary wetland values of the site to indigenous people is to be obtained and appreciated.

## 6.2 Monitoring Needs

### 6.2.1 Summary of Monitoring Needs

A broad range of monitoring recommendations are provided in this ECD based on the information gaps and monitoring recommendations provided under each critical service and critical process summary table.

Similar to the above section on data and information gaps, monitoring needs can be derived from the ECD in two primary areas:

1. In relation to the natural variability and limits of acceptable change as they relate to the Ramsar Nomination Criteria and underlying critical wetland habitats and species of the site

particularly for those attributes/controls where no data (*nd*) is stipulated and an interim limit of acceptable change is presented; and

2. In the context of the detailed discussion of each of the ten (10) critical services/benefits (refer Section 7 of the report).

**Limits of Acceptable Change**

Some level of monitoring will be needed to assess the suitability of interim limits of acceptable change (versus natural variability) and to assess if unacceptable changes as outlined in the summary table for LAC (refer Table 4-3) are being approached or are occurring. Principally, this monitoring will need to relate to:

- Broad-scale observation/monitoring to ensure each wetland type outlined in the ECD continues to be represented across the site;
- Wetland habitat extent monitoring (noting that a precursor to being able to do this will be to establish a better correlation between EPA wetland mapping and the Ramsar Classification System);
- Habitat condition monitoring (principally in the form of monitoring underlying wetland ecosystem processes such as water quality and hydrological process or surrogate biological indicators such as crab burrow density);
- More targeted surveys of the threatened flora and fauna species (perhaps on a five year or ten year basis) to assess presence/absence or population changes of noteworthy species or communities; and
- More regular counts of roosting and feeding shorebirds with a particular emphasis on those species that meet the 1% population criteria.

In the context of assessing whether or not ecological character is being maintained, the following monitoring objectives and measures are recommended in Table 6-1.

**Table 6-1 Monitoring Changes to Ecological Character**

| Basis of Monitoring | Objectives of Monitoring | Indicator/Measure | Frequency | Priority |
|---|---|---|---|---|
| Nomination Criterion 1 | Ensure current diversity of wetland types are maintained | Establish reference sites for each Ramsar wetland type and record observations about extent and condition | Annually | High |
| | Monitor extent of Ramsar wetland types (all) | Correlate and map Ramsar wetland types within broader EPA mapping product<br><br>Establish baseline extent for each habitat type based on the revised mapping<br><br>Re-map at regular intervals and assess extent and determine if changes are part of natural variability or represent anthropogenic change | Undertake as part of planned updates of EPA wetland mapping | Medium |
| | Monitor extent and condition of key habitats including reference habitats | Establish reference sites for each key habitat type (eg. seagrass, tidal flats, etc) and monitor extent and condition – refer Table of LACs for key habitat attributes (refer Table 4-4)<br><br>Continue and augment EHMP monitoring for water quality and seagrass habitat extent with consideration of additional sampling locations and indicators based on this ECD | Monthly - Annually<br><br>Monthly | Medium - High<br><br>High |
| Nomination Criterion 2 | Determine presence/absence of threatened wetland species | Undertake more detailed surveys of species and communities within the Ramsar site<br><br>Assess presence/absence with consideration of relevant LAC | Species specific – generally studies will need be undertaken every 5 – 10 years and may need to be undertaken over | High |

| Basis of Monitoring | Objectives of Monitoring | Indicator/Measure | Frequency | Priority |
|---|---|---|---|---|
| | | | several seasons | |
| | Assess condition/change to populations | Undertake more detailed surveys of species populations and communities within the Ramsar site<br>Assess any changes to population (eg. breeding success, mortality rates, health etc.) and any applicable underlying wetland processes (eg. water quality of key habitats – refer relevant species-based LACs in Table 4-5) | See above | Medium |
| Nomination Criterion 3 | Loss of biodiversity | Utilise indicator/measures from Criteria1 and 2 | See above | Medium |
| Nomination Criterion 4 | Use of the site as refugia habitat | Survey and monitor the following key refugia functions:<br>1) Feeding habitat for green and loggerhead turtles<br>2) Feeding and breeding habitat for dugong<br>3) Refuge habitat for freshwater fish of conservation significance<br>4) Roosting habitat for migratory shorebirds<br>5) Critical overwintering habitat and flyway staging area (both northern and southern migration routes) for migratory shorebirds | Specific monitoring programs for each refugia function to be developed – monitoring to occur during key usage periods | High |
| Nomination Criterion 5 | Use of the site by at least 20 000 waterbirds | Ensure regular surveys of waterbird usage of the site during key visitation periods<br>Use of surrogate species (bar-tailed godwit, Eastern curlew and Pacific golden plover) for overall abundance | Undertake annual counts of waterbird usage of the site | High |
| Nomination | The site supports | Undertake more detailed surveys of | Specific | High |

| Basis of Monitoring | Objectives of Monitoring | Indicator/Measure | Frequency | Priority |
|---|---|---|---|---|
| Criterion 6 | the 1% of individuals of populations for the key avifauna species in the ECD | 1% candidate species of avifauna listed in the ECD | monitoring programs for each species to be developed | |
| Nomination Criterion 7 | Long term impacts on the sustainability of populations of important commercial and recreational fishery species that occur within the site | Continue to fund and implement monitoring of fisheries by the Department of Primary Industries and Fisheries (eg. CFISH [Commercial Fisheries Information System] and RFISH [Recreational Fishing Information System]. | As per current programs | Medium |
| Nomination Criterion 8 | Assess reduction in the extent or condition of wetlands or other areas and a corresponding measurable impact on important spawning, nursery or migration pathways for fisheries | Identify reference sites for key spawning, nursery and migration pathways within the Ramsar site<br><br>In assessing the interim LAC, attention should be given to assessing changes in the extent of mangroves, saltmarsh, seagrass and tidal flat environments, which represent key nursery habitats to many commercially important species within the site | Medium to long term (>5 years) | Medium |

**Critical Services/Benefits**

In addition to undertaking monitoring to assess potential changes to ecological character as discussed above, a summary of more specific monitoring needs identified under each critical service (as summarised in Section 7) is contained below. In most cases, these recommendations provide additional detail and context to the information already presented above in Table 6-1.

Service 1: Diversity of Habitats

While preliminary work has been done in this ECD, assignment of more detailed definitions and provision of spatial data for each of the wetland types in the Ramsar site (using the Ramsar Classification System) is needed such that a baseline for each wetland type represented in the site can be monitored over time. This needs to be closely aligned to the Queensland Wetlands Mapping Project.

Service 2: Representative Habitats

2a (Eastern Banks) Examination of long-term changes in seagrass based on aerial photograph interpretation and review of existing information.

2a (Eastern Banks) Additional EHMP/Seagrass Watch monitoring sites in representative areas subject to different wind/wave regimes.

2b (Pumicestone Passage) Examination of long-term changes in extent of tidal flats based on aerial photograph interpretation and review of existing information.

2c (Southern Bay) Examination of long-term changes in mangroves and saltmarsh based on aerial photograph interpretation and review of existing information.

2d (Coral Reefs) Additional EHMP monitoring sites in representative areas subject to different wind/waves regimes.

2d (Coral Reefs) Monitoring of coral growth (individual colonies) over time.

2e (Freshwater wetlands on Bay Islands) Additional EHMP monitoring sites in representative sites within North Stradbroke Island and Moreton Island.

2e (Freshwater wetlands on Bay Islands) Development of locally specific ecosystem condition objectives. Additional measures recommended by Marshall *et al.* (2006) related to assessing changes to ecological assets as a result of future water extraction include -

- Further development of groundwater modelling
- Implementation of real time aquifer, surface water and ecological monitoring to confirm the thresholds critical to ecological assets are not exceeded
- Targeted research on the nature of groundwater dependency.

2f (Moreton Island Ocean Beach) Examination of long-term changes in habitat extent using aerial photograph interpretation and review of existing information.

2f (Moreton Island Ocean Beach) Schlacher *et al.* (2008) also recommends research into the implications of habitat loss and fragmentation as well as weakened linkages across critical ecotones and habitats for the conservation of sandy beach biodiversity and the effects of cumulative impacts from multiple stressors and disturbances on the structure, function, and recovery dynamics of sandy beach ecosystems.

Service 3: Aquatic/marine fauna

Fauna population monitoring at appropriate spatial and temporal scales.

Marine vegetation monitoring.

Continuation and expansion of EHMP to monitor key species identified in the ECD.

Service 4: Wetland-dependant terrestrial fauna

Acid frogs - Identify key populations and for those populations, monitor presence/absence, breeding evidence (tadpoles and metamorphs), and maintenance of parapatry (speciation) between acid frog congener species during optimum breeding conditions until markers/trends of population variability are evident. Quarterly monitor water quality for key population sites (salinity, pH range 3-5, dissolved oxygen, nitrate levels (maintain <0.7 mg/L) and other toxicants (e.g. monomeric Aluminium and surfactants)). Assess impacts of fire on habitat of key frog populations from fires.

Beach stone-curlew – Monitor habitat usage and breeding success at key habitat sites (bi-annual).

Little tern – Identify locations and sustainability of Little Tern nesting sites (primarily in southern parts of site) (yearly). Monitor abundance and pattern of usage at key roosts within northern Pumicestone Passage and northern sector of South Stradbroke Island (annual).

Water mouse – Identify full extent of water mouse habitat within and outside the site and monitor nest activity and diversity of nest types as surrogate for species distribution and abundance (annual and during breeding period).

Continuation and expansion of EHMP to monitor key species identified in the ECD

<u>Service 5: Wetland flora and communities</u>

Systematic flora surveys would quantify the representation of wetland communities and species of conservation significance within the Ramsar site. This would assist in prioritising targeted areas for conservation and management actions, and in specifying limits of acceptable change more accurately (i.e. in terms of percentage area for RE's or population numbers for species).

<u>Service 6: Shorebird populations</u>

Early and late summer monitoring events at key roost sites and feeding grounds (to be conducted annually) to target bar-tailed godwit, Eastern curlew and Pacific golden plover (species which currently exceed the 1% threshold and which may provide useful surrogate for numbers of other shorebirds using the site and of habitat usage).

Annual audit of roost sites (condition and use).

Monitor habitat usage and breeding success (bi-annual) of pied oystercatcher (key resident species) on outer bay islands.

<u>Service 7: Fisheries</u>

Fish stock monitoring based on DPI&F state-wide LTMP, CFISH (Commercial Fisheries Information System) and RFISH (Recreational Fishing Information System) programmes.

Marine vegetation monitoring.

Continuation and expansion of EHMP to monitor key commercial and recreational species identified in the ECD.

Service 8: Indigenous

No specific monitoring needs for this Service were recorded.

Service 9: Research and Education

No specific monitoring needs for this Service were recorded.

Service 10: Tourism and Recreational Uses

Reliable visitor statistics, including tourist expenditure and other economic contributions.

Number of visitors participating in each activity/location and the resultant environmental impacts and potential indicators for monitoring.

Importance/awareness of Ramsar site and values for visitors.

### 6.2.2 Monitoring Alignment

In making recommendations for future monitoring of the Ramsar site, the information gaps and monitoring needs identified in the ECD were also considered in the broader context of the Southeast Queensland Healthy Waterways Partnership's Ecosystem Health Monitoring Program (EHMP) and the monitoring program being implemented to assess the effect of proposed re-zoning of the Moreton Bay Marine Park by the Queensland EPA.

To ensure close alignment between these initiatives, a special sub-group of the Southeast Queensland Healthy Waterways Partnership Scientific Expert Panel (SEP) met several times with the consultant study team and the Knowledge Management Committee to workshop and discuss synergies and commonality between the existing and proposed monitoring programmes (refer Appendix A). A separate report outlining the outcomes of these discussions has been produced by BMT WBM (2008b) as part of the ECD project and is summarised here.

To facilitate the determination of monitoring priorities and identify possible efficiencies, there were two key hypothesis questions posed to the workshop project group for discussion:

1. What species/habitats/processes are salient to all three programs (eg. Ramsar, Marine Park and EHMP) and should be monitored in order to most cost effectively assess if health/character is being maintained (or improved by management interventions)?

2. What is the most effective and efficient sampling design in the context of overall information needs for management?

Key indicators seen by the group as relevant to the Moreton Bay Ramsar site (as well as the other two programs) are outlined below:

In relation to **habitats**, the following indicators were identified as high priorities:

- Areal extent of seagrass meadows (though use of the light penetration and depth surrogate is seen as most appropriate);

- Gross production of seagrass meadows;
- Presence abundance of key species in seagrass meadows (particularly dugong and green turtles);
- Areal extent of mangroves and saltmarsh;
- Ratio of mangroves to saltmarsh;
- Abundance and diversity of key species within mangrove and saltmarsh habitats;
- Areal extent of dieback of mangroves and saltmarsh and changes over time;
- Areal extent of tidal flats;
- A range of indicators presented relevant to inshore coral communities;
- Bird nesting/feeding usage (including birds of prey) in ocean beaches and foredunes; and
- Abundance/diversity of benthic invertebrates across several habitat types (ocean beaches and foredunes, tidal flats and inshore mud and sand habitats).

In relation to **species**, the following indicators were identified as high priorities:

- Monitoring indicators related to dugong;
- Monitoring indicators related to marine turtles (green and loggerhead);
- Monitoring indicators related to migratory and resident shorebird species including little tern; and
- Monitoring indicators related to water mouse.

Key **ecosystem processes** identified as critical across a range of wetland habitat types included:

- Hydrodynamic controls including sedimentation and inundation patterns;
- Water quality; and
- Biogeochemical processes.

Key **stressors and threats** identified to habitats and species in Moreton Bay were:

- For habitats - Dredging/placement of dredge spoil and related marine works, various forms of fishing, water pollution and climate change were the most common stressor/threats listed.
- For species – Climate change, habitat modification, and by-catch/entanglement were the most common stressor/threats listed.

While specific priorities and methodologies for monitoring were not sought to be developed through the workshop process, the information presented in the analyses above provides a basis for the next phase of monitoring and sampling design under EHMP and other monitoring regimes that is cognisant of the important/significant habitats and species, key attributes and associated stressors and threats affecting the Moreton Bay Ramsar site.

## 6.3 Communication, Education and Awareness Messages

### 6.3.1 Existing CEA Messages

This section reviews the key communication, education and awareness messages (CEA) related to the Moreton Bay Ramsar site and identifies perceived gaps.

The role of the Healthy Waterways Partnership over the past decade in raising public awareness about the environmental values of the Bay has been significant. These communication and education messages include many of the values and services identified by the ECD as being critical such as:

- The ecosystem values of wetland to important fauna such as birds, turtles and dugong;
- The impacts of human uses and activities on Bay water quality and amenity; and
- The use of best practice measures and water quality technology to manage runoff.

The Annual Ecosystem Health Monitoring Programme Report Card produced by the Healthy Waterways Partnership remains a powerful tool to convey the current condition of waterways to the public and to elected officials that is now being pursued in a number of other areas and jurisdictions such as the Port Curtis area in Central Queensland and as part of the Great Barrier Reef Water Quality Protection Plan.

The Report Card provides a snapshot of both current information as well as trend information over time across a broad area of the Bay. Of note in the context of the current study is the predominant emphasis on physico-chemical parameters in the estuarine and marine Report Card. The inclusion of more biotic indicators in the form of key habitats and key fauna would better align the Estuarine and Marine Components with similar indicators used in the Freshwater Components of Western Catchments as well as recognise key fauna and habitat values important to the Bay's Ramsar designation.

Community education and monitoring programs also remains a key facet of NRM investment programmes in the region such as the long running 'Seagrass Watch' and emerging complementary programmes for mangrove and saltmarsh.

Educational facilities such as the Boondall Wetland Centre and Nudgee Beach Environmental Education Centre located in the Western Bay utilise the resources, values and threats to the Bay as key components of their curriculum and activities.

### 6.3.2 Gaps

As identified in Section 3 of the report, the Moreton Bay Ramsar site is recognised in a wide array of plans and strategies for the Bay and region. As site manager, the EPA has a number of brochures and information sheets about the site that are available to the public.

A general observation about CEA messages for Moreton Bay is the sense of overlap regarding planning instruments and which Government authorities are involved in management. As such, alignment under a common banner (such as the Healthy Waterways Partnership) and the promotion of consistent messages about conservation and management of the Bay are a continuing priority for resource managers, recognising that there will always be a wide range of plans and legislation that apply and these instrument need to be implemented in a coherent and integrated way.

To this end, in parallel with the ECD project, a Conceptual Framework for the ecological health and character of Moreton Bay has been developed as an outcome of the SEP workshop process that seeks to align the management and monitoring goals of this ECD, the Healthy Waterways Strategy and the Moreton Bay Marine Park Zoning Plan. The Framework (documented in BMT WBM 2008b) is a useful first step in trying to look at the Bay's habitats and species more holistically and to recognise where and how the various planning and regulatory instruments under the three conservation/management initiatives can be better aligned.

More specific areas or issues where the critical elements of the Ramsar site nominated in this ECD are perhaps not being fully articulated in the context of current CEA messages include:

- The importance of freshwater wallum and peatland wetland habitats on the Bay islands and adjacent to Pumicestone Passage and the unique aquatic fauna that exists in these areas such the Oxleyan pygmy perch, water mouse and acid frogs. This also includes the associated critical wetland flora and communities identified in this report (noting that significant work is needed by to better identify and survey the extent and values of these endangered and vulnerable communities and species);

- In keeping with the wise use paradigm of the Ramsar Convention, promotion of the diversity of sustainable wetland-based tourism and recreational values of the Ramsar site;

- The current state of fisheries resources and the need for continued conservation of fish habitat;

- The use and significance of the site to Indigenous people; and

- The importance of Moreton Bay for migratory shorebirds.

Each of these items is discussed below:

<u>Freshwater wetlands and associated systems</u>

The relative isolation and near-naturalness of the freshwater wetland habitats found on the Bay islands remain, at least anecdotally, a scarce-known resource outside of SEQ, although recent investigations as part of the Queensland Water Commission groundwater resource development on North Stradbroke Island has raised the profile of the values and threats to a greater audience. It is likely that the public is aware many of the larger more prominent water bodies such as Blue Lake are within protected areas but less knowledge that a diversity of freshwater wetland environments made up of dune lakes, palustrine depressions, and creeks and streams are within the boundaries of the Ramsar site.

Peatlands such as Eighteen Mile Swamp are also of growing importance at a global scale with Ramsar Contracting Parties calling for further cooperation on their conservation through a global action plan to conserve their unique biodiversity, paleo-geologic significance and their role as a major storehouse for carbon.

Sustainable Tourism

If Moreton Bay is to be differentiated as a sustainable tourism destination, Whitmore and De Lacy (2005) as part of their report on Sustainable Tourism in Moreton Bay identify the need for and recommend the establishment of a 'destination management committee of stakeholders' to develop Moreton Bay as a sustainable, 'Platinum Plus' Destination. This is underpinned by a range of recommendations to conduct tourism future modelling and visioning for the Bay, ensuring environmental sustainability through industry compliance and certification programmes and investigating a 'Tourism in Protected Areas" initiative between Tourism Queensland and Queensland Parks and Wildlife. Acknowledging the impacts that increased tourism and recreational use of the Bay can bring, sustainable tourism and recreational use of the Bay remains a critical part of its cultural services and promotion of this industry is seen as an important driving economic force in the future for continued conservation efforts within and external to the Ramsar site. In this context, nomination of the site as a Ramsar wetland should be heavily embraced as part of any future promotional push.

Fisheries and Fish Habitat

As discussed in the critical services section, there is a strong social (eg. cultural) as well as economic value associated with the fisheries of the Bay which is shared by commercial fishers, recreational fishers and indigenous fishers. It is likely that all of these groups embrace the notion that fisheries and fishing effort should be ecologically sustainable such that there are sufficient fish resources to support commercial, recreational and indigenous fishing activity now and in the future with some degree of intergenerational equity (eg. the fisheries of commercial, recreational or indigenous significance are maintained over time for the use and enjoyment of future generations).

In this context there have been improvements in the management of fisheries by the industry (such as the Moreton Bay Seafood Industry Association Environmnetal Management System (EMS) initiative and promotion of sustainable practices such as biodegradable bait bags by the recreational fishing industry as well as through the involvement and recognition of fisheries management practices by indigenous people in traditional fishing activities and Government regulatory and management responses to conserve fish habitat and fish populations.

Maintaining this critical service over time will depend on building upon the positive initiatives of these various groups with a vested interest in maintaining the health of the Bay and its fisheries over time.

Indigenous Values and Significance

As outlined in the Cultural Heritage Report by Converge Heritage and Community prepared as part of the ECD contained in Appendix C, the Ramsar site is likely to hold significant cultural values to the relevant Traditional Owner group/s that use the site. These values may include physical and non-physical cultural heritage areas and objects, oral knowledge, such as stories, animals and plants, and the natural environment itself;

Traditional Owners are already taking an active role in managing Ramsar areas as part of their management of the wider Moreton Bay area, and they would likely wish to increase this role if offered the opportunity. The Traditional Owners have already formed an encompassing organization (SEQTOLSMA) which may prove to be a vehicle through which consultation and planning for the future could be organized. However, only through consultation with the individual Traditional Owner groups could this be ascertained.

Migratory Shorebirds

As demonstrated throughout this ECD, the assemblage of diverse habitats of the Bay makes it one of Eastern Australia's most significant coastal ecosystems. This diversity of habitat types present in the Bay and within the boundaries of the Ramsar site (sheltered estuary versus active systems such as beaches and sandy channels) in close proximity are especially important for migratory species that use the Bay such as birds and turtles that will utilise different habitats within the Bay for feeding versus roosting/breeding/nesting.

Despite its proximity to one of Australia's fastest growing regions, Moreton Bay continues to be one of Australia's top 12 shorebird habitats and is in the top three in Queensland (EPA 2005b). Likewise, the site is a critically important stop along the East Asian-Australasian Flyway and many species that utilise Moreton Bay are recognised in the bilateral agreements for shorebird conservation between Australia and Japan, China and the Republic of Korea.

These values and obligations justify continued promotion and investment in effective education and communication activities with respect to shorebirds and shorebird habitats. To this end, a range of community education actions are already outlined in the EPA Shorebird Management Strategy and should continue to be implemented.

# 7 DETAILED ECOLOGICAL CHARACTER DESCRIPTION

Sections 4 – 6 of this report summarises the ten (10) nominated critical services/benefits of the Moreton Bay Ramsar site and provides information about the underpinning ecosystem components and processes, natural variability and limits of acceptable change, threats, information gaps and monitoring needs and recommendations associated with the ecological character of the site.

The broader, more detailed assessment of the critical elements of the Ramsar site on which the summary sections were based is presented in this section. The information is presented through a combination of text and tabular information using a standard template prepared for each nominated service/benefit. The standard reporting template is shown in Table 7-1.

**Table 7-1 Reporting Template for Critical Services**

| Summary Table | Critical Service # and Name |
|---|---|
| Reason for inclusion | Relates back to the Ramsar Nomination Criteria or similar justification for selection as a critical service |
| Type of Service | From the National Framework document, list if the service relates to a supporting, cultural, regulatory, provisioning service or combination thereof |
| Description of Service | Quantified description of the service (using literature sources or similar) |
| Spatial application (if relevant) | Whether or not the element applies to a specific component of the site (such as a wetland type) a locality (such as one of the bay islands) or to the site as a whole |
| Critical component habitat types underpinning the service (if applicable) | If applicable, lists the key or noteworthy wetland types underpinning the wetland service/benefit |
| Critical component species that underpin the service (if applicable) | If applicable, lists the noteworthy or indicator species (such as species of conservation significance) underpinning the wetland service/benefit |
| Critical wetland processes underpinning the service | Lists the key wetland ecosystem processes underpinning the wetland service/benefit |
| Natural variability (if relevant) | Describes the natural variability of the relevant service and its underlying components/processes if known |
| Principal threats | Lists the key threats to the service or its underlying components or processes |
| Data quality underpinning this critical service | List the level of confidence in the data or information used in defining the limit (see below) |
| Information gaps | Cognisant of the information provided in the rows above, this section lists out the information gaps for the critical service and any underlying components and processes |
| Recommended monitoring | Based on the information gaps, this section sets out proposed monitoring to be carried out in relation to the critical elements |

As outlined in the methodology in Section 4, following the assignment of the critical processes, components and services of the wetland, information and data gaps related to these critical elements were analysed. As part of this task, an assessment of the quality/value of the main information and data sources was undertaken using the definitions described in Table 7-2. These definitions are used in the ECD, particularly with respect to describing natural variability and the limits of acceptable change, to identify the basis on which the suggested measures have been developed and to provide a qualitative degree of confidence about the accuracy of the proposed measure.

**Table 7-2 Data Quality/Quantity Review Definitions**

| Level Code | Description |
|---|---|
| 1 | Data are current, have been collected using a robust sampling design (adequate replication in time and space) and are likely to be accurate. |
| 2 | Data have been collected with respect to the research issue but there are one or more of the following limitations in the data:<br>➢ Limited sampling effort in time (e.g. does not consider inter-annual or seasonal variations);<br>➢ Limited sampling effort in space (e.g. inadequate replication at different spatial scales, or mismatch in spatial scale with issue under investigation);<br>➢ Potential/likely inaccuracies in collected data (e.g. due to methods of data collection, reporting etc.);<br>➢ Data are not current (e.g. significant changes in environmental conditions since survey undertaken). |
| 3 | Semi-quantitative assessment based on general scientific principles and limited data |
| 4 | Best scientific judgement or wholly qualitative assessment |

Using the approach set out above, sections 7.1 to 7.10 outline the detailed description of the ten (10) critical services/benefits identified.

## 7.1 Service 1 ~ Diversity, Representativeness and Connectivity

Photos showing various wetland habitats in Moreton Bay (Source: EPA photo library)

The wetland types of the Moreton Bay Ramsar site are extremely diverse, ranging from perched freshwater lakes and sedge swamps, to intertidal mudflats and mangroves and sub-tidal seagrasses, to oceanic, high-energy beaches. An overview of the twenty-two (22) Ramsar wetland types present in the boundaries of the site and some examples of these wetlands are cited in Section 3 of this report.

As outlined previously, the study team sought to divide the Ramsar site into four geographic areas that shared common components and processes. As identified previously, the key areas used for reporting were: a) Bribie Island and Pumicestone Passage; b) Western Bay; c) Moreton Island and Eastern Banks; and d) Stradbroke Islands and the Southern Bay.

As part of this sub-regional analysis, the Ramsar wetland types were identified and listed for each of these areas in order to identify any trends in terms of the abundance and representativeness of different habitat types across the broader area. From this analysis, the following characterisation of the site in terms of the diversity of wetland habitat types can be made:

- A number of wetland habitats types are **common** across the breadth of the site (all four areas) and therefore best represented. These include: Type B (marine sub-tidal aquatic beds), Type D (rocky marine shores),Type E (sand, shingle or pebble bars; sandbars and dunes), Type F (estuarine waters), Type G (intertidal mud, sand or salt flats), Type H (intertidal marshes including saltmarsh), Type I (intertidal forested wetlands including mangroves), Type M (permanent rivers, creeks and streams), Type N (seasonal/intermittent rivers, creeks and streams) Type Tp (permanent freshwater marshes), Type Ts (seasonal/intermittent freshwater marshes) and Type Xf (freshwater, tree-dominated wetlands and swamps).

- Wetland habitats that are **well represented** in 3 of the 4 areas include: Type A (permanent shallow marine waters), Type J (coastal brackish/saline lagoons), and Type K (coastal freshwater lagoons) all of which are absent in the Western Bay.

- Wetland habitat that are **localised** (occurring in 2 or less of the areas) include: Type C (coral reefs) which are present in the Southern and Eastern Bay only; Type O (permanent freshwater lakes) which are present on the offshore sand islands, Type W (shrub dominated wetlands) characteristic of RE 12.2.12 which have been mapped by the Queensland Herbarium in the Bribie/Pumicestone and Southern Bay areas, and Type Y (freshwater springs) which generally are associated with freshwater habitats on the outer sand islands.

- Wetland habitat that are **highly localised** (occurring in 1 area only) include Type U (non-forested peatlands) of which 18 Mile Swamp on North Stradbroke Island is the site's most notable example.

In general there is a much greater diversity of wetland types present on the Bay islands than elsewhere within the boundaries of the site, in part due to the complexity of dune, freshwater wallum and peatland, and transitional terrestrial habitats present in those locations as well as the array of traditional estuarine wetland communities such as mangroves, saltmarsh and sand and mud flats in intertidal areas

In a number of areas within the Ramsar site, there is also a high degree of connectivity between the terrestrial, intertidal and subtidal habitat types. For example, the southern part of Pumicestone Passage contains a complex mosaic of mangroves, seagrass, unvegetated shoals and deeper waters in close proximity to each other. This combination and diversity of habitat types may represent potentially important nursery habitat for many fish (Laegdsgaard and Johnson 1995; Tibbetts and Connolly 1998) and prawn (Young 1978) species of commercial significance. Similar comments have been made with regard to the relationship between saltmarsh, mangrove and seagrass in the Southern Bay.

In this context, there is an emerging view that fish and nektobenthic crustacean community structure in mangroves and unvegetated habitats is influenced by their proximity to seagrass beds (e.g. Jelbart 2004, Olds 2002). Some documented examples of the beneficial interaction between wetland habitats illustrating this connectively include:

Despite being devoid of seagrass, Melville and Connolly (2003) demonstrated that organic matter, particularly from seagrasses, was important as the base of food webs for fish species of commercial significance on adjacent unvegetated mudflats in Moreton Bay.

Studies by Olds (2002) in Moreton Bay and Jelbart (2004) in central NSW both found that seagrass beds (particularly dense beds – Olds 2002) in close proximity to mangroves tend to contain more abundant nekton assemblages than seagrass remote from mangroves. Both studies also found that the suite of species inhabiting seagrass varied with distance from mangroves.

Given the size and complexity of habitats present in the Ramsar site, while there is a range of local scale relevant processes, it is the broad scale processes that are seen as important to maintaining the overall diversity of habitat types. These include:

- Physical Coastal Processes. Natural (equilibrium) hydrodynamic controls on habitats through tides, currents, erosion and accretion;

- Hydrology. Natural patterns of tidal inundation and freshwater flows to wetland systems;

- Groundwater. For those wetlands influenced by groundwater interaction, the groundwater table;

- Energy and Nutrient Dynamics. Primary productivity and the proper functioning of carbon and nutrient cycling processes;
- Water Quality. Water quality that provides aquatic ecosystem values within wetland habitats;
- Climate. Patterns of temperature, rainfall and evaporation; and
- Geomorphology. Key geomorphologic/topographic features of the site

**Table 7-3 Critical Service 1**

| **Summary Table** | **Critical Service (S1)** |
|---|---|
| Reason for Inclusion | The diversity of habitats as a critical service is underpinned by Ramsar Nomination Criterion 1. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Using the Ramsar wetland type classification system, the Moreton Bay Ramsar site contains 22 different types of wetlands in the coastal/marine, inland wetland and man-made categories. The different types represented and examples of each are listed in Section 3 of the report. |
| Spatial Application (if relevant) | Section 3 lists the wetland types present in the site. |
| Critical habitat components underpinning this service | All habitat types, noting that based on a broad qualitative assessment of wetland types across the site, wetlands of the following types are less widespread/common than other wetland types represented on the site:<br>• Type C (coral reefs);<br>• Type O (permanent freshwater lakes);<br>• Type W (shrub dominated wetlands);<br>• Type U (non forested peatlands);<br>• Type Y (freshwater springs). |
| Critical species underpinning this service | Not applicable; this service relates primarily to habitat. Other services address particular species and populations. |
| Critical processes underpinning this service | Broad-scale wetland processes as listed above; noting that individual wetland habitats will be influenced by a range of local/site specific processes. |
| Natural Variability (if relevant) | The geomorphology and biotic components of the wetland habitats of the Bay have formed over thousands of years, in a sedimentary environment that is characterised by major fluctuations in sea level.<br>Near natural and representative environments that remain in the Bay (refer Service 2 below) are indicative that there is natural stability in the system that will retain these habitats in the long term in the absence of anthropogenic influences.<br>Notwithstanding, wetland environments can show significant seasonal/local variation depending on key drivers such as rainfall, hydrological inputs, nutrients, and sedimentation.<br>Particular habitats will be more susceptible to temporary disturbance (be it natural or of anthropogenic origin) than others. For example, seagrass, coral reefs, dune lakes and similar environments are highly dependant on stable water quality conditions whereas mangroves and saltmarsh communities can be highly resilient to water quality impacts but are more susceptible to changes to hydrology and inundation patterns. |
| Principal threats | Key threats to the overall diversity of habitats present in the site include:<br>• Major changes to the Bay hydrodynamics in terms of coastal processes and other |

| Summary Table | Critical Service (S1) |
|---|---|
| | hydrodynamic controls on habitat<br>• Major changes to the Bay hydrology in terms of freshwater flows and inputs from rivers and streams<br>• Long term and significant changes to water quality – particularly the assimilative capacity of the western and southern bay to carry out essential nutrient cycling processes and the broadening of catchment-based water quality impacts into the central and eastern bay<br>• Localised die-back and other impacts particularly if the wetland type is one of the less widespread types in the Ramsar site (refer list above)<br>• Inadequate buffers between human settlement and wetland areas and associated edge effects<br>• Changes to the groundwater table and groundwater interaction with surface water in freshwater lakes and creeks on the sand islands including increased susceptibility to fire (particular impact for peatlands)<br>• Climate change and exacerbation of current mangrove intrusion into traditional saltmarsh habitats as a result of sea level rise |
| Data quality underpinning this critical service | Level 3 – The wetland habitat types identified and analysed as part of this Service rely on the interpretation of a number of sources of information including the EPA wetland mapping data layer (which is itself based on a combination of RE and waterbody data). |
| Information gaps | There needs to be further guidance about the identification of the Ramsar wetland types such that more exact spatial data can be obtained or developed. This should be compatible where possible with State mapping methodologies such as that employed by the EPA. In the meantime, the EPA dataset (using RE types as surrogates for vegetated Ramsar wetland types) provides a baseline for measuring the extent of various wetland types across the site. |
| Recommended monitoring | Assignment of more detailed definitions and provision of spatial data for each of the wetland types in the Ramsar site such that a baseline extent for each wetland type represented in the site can be monitored over time (and natural variation analysed). |

## 7.2 Service 2 ~ Near-Natural Wetland Habitat Reference Sites

As discussed in Service 1, the Moreton Bay Ramsar site contains a range of marine, estuarine, palustrine, lacustrine and terrestrial biotopes.

Among the 22 wetland types listed as being represented, several key wetland habitat types are seen as most critical to the ecological character of the site based on the range of wetland services/benefits supported. These include for example, core habitat for threatened flora and fauna species (refer Services 3, 4 and 5), supporting important populations of shorebirds (Service 6), and supporting cultural values such as fisheries habitat and productivity, indigenous significance, education and research values and tourism and recreation values (refer Services 7-10).

The six key habitats identified and are as follows:

a. Seagrass and sandy shoals

b. Unvegetated intertidal flats (and associated adjacent estuarine assemblages)

c. Mangrove and saltmarsh communities

d. Coral communities

e. Freshwater wetlands (including both wallum and peatlands)

f. Ocean beaches and foredunes

Several of these wetland habitats are considered, either individually or collectively, to represent particularly outstanding examples of near-natural 'reference' areas within the biogeographic region. It is acknowledged that there are numerous examples of such habitat areas within the site, however for reporting purposes six key reference sites have been identified as follows:

- Seagrass and shoals - Eastern Banks area
- Intertidal flats and estuarine assemblages - Pumicestone Passage
- Mangrove and saltmarsh communities - Southern Bay
- Coral communities - Eastern Bay
- Freshwater wetlands (including wallum and peatlands) - Moreton and North Stradbroke Islands
- Ocean beaches and foredunes - Moreton Island

These representative areas were selected on the basis that they:

- are in natural or near-natural condition based on existing ecosystem health and other monitoring data;
- contain representative examples of key habitats within the site;

- contain excellent representative examples of various wetland habitat types within the IMCRA and IBRA biogeographic regions; and
- contain wetland habitats of recognised high conservation significance, as prescribed under legislation (protect areas) and State management plans (i.e. State Coastal Plan).

Table 7-4 provides summary information on these points underpinning the six reference sites.

A more detailed description of each of the six habitat types and the selected reference site are contained in the sections below.

**Table 7-4 Ramsar wetland types, ecosystem condition ratings and statutory conservation values in each representative wetland area**

| Attribute | (A) Eastern Banks seagrass & shoals | (B) Pumicestone Passage intertidal flats | (C) Southern Bay mangroves and saltmarsh | (D) Eastern Bay coral communities | (E) Moreton & North Stradbroke Is. freshwater wetlands | (F) Moreton Island ocean beaches and foredunes |
|---|---|---|---|---|---|---|
| **Ramsar wetland types** | B, E, F, G, H, I | B, D, E, F, G, H, I | B, D, E, F, G, H, I | B, C, F | M, N, O, Tp, Ts, W, Xf, Xp, U, Y | A, D , E |
| **Ecosystem Condition**[5] | • 'A to A-' (Excellent)<br>• Excellent water quality<br>• Intact natural habitats present; deep & stable seagrass & healthy and diverse coral in some parts<br>• *Lyngbya* present | • 'B to C+' (Good)<br>• Fair water quality, with generally poorer water quality in the northern reaches<br>• Intact & stable natural habitats with extensive mangrove forests & stable seagrass meadows<br>• *Lyngbya* present | • 'B- to D' (Good)<br>• Fair to poor water quality, strongly influenced by floods<br>• Shallow & unstable seagrass meadows in main channel closest to the coast but expansive meadows in Canaipa Passage<br>• *Lyngbya* present | • Note – Following is for Eastern Bay, which includes reef areas.<br>• ' A to A-' (Excellent)<br>• Excellent water quality<br>• Intact natural habitats remain; deep & stable seagrass and healthy & diverse coral in some parts<br>• *Lyngbya* present | • No EHMP monitoring data | • No EHMP data. Based on adjacent habitats, excellent water quality expected throughout.<br>• Intact natural habitats present including presence & usage by endangered & vulnerable shorebirds<br>• Principle impact from Off Road Vehicle Usage |
| **Statutory Conservation Zones** | | | | | | |
| High Ecological Value area[6] | E1B | PLE1, PLE1, PME1 | Part – S1, B1 | C1 (also incl. Waterloo Bay) | M1 (All Moreton Island)<br><br>ST1A, ST1B (Part of North Stradbroke Is.) | E1C (coastal waters along northern Moreton Island & northern coastline of North Stradbroke Island) |
| Marine National Park (Draft) | Part – MNP14; MNP20 | MNP02; MNP01 | Part – MNP27; MNP26; MNP28; MNP29; MNP30 | Part – MNP22 | N/A | MNP05-07; MNP 16 |
| National Park | N/A | N/A (adjacent to Bribie Island NP) | Southern Moreton Bay Islands NP | N/A (adjacent to Teerk Roo Ra (Peel Island) National Park) | Moreton Is. NP<br><br>Blue Lake NP | Moreton Island National Park |
| Fish Habitat Area (FHA)[7] | Moreton Banks FHA; Amity-Myora Banks FHA | Pumicestone Channel FHA | Pimpama FHA; Coomera FHA; Jumpinpin-Broadwater FHA | Peel Island FHA; Amity-Myora Banks FHA | N/A | N/A |
| State Coastal Plan | State Significance (natural resources) – Significant Coastal Wetlands; Coastal Biodiversity | State Significance (natural resources) – Significant Coastal Wetlands; Significant Coastal Dunes; Coastal Biodiversity | State Significance (natural resources) – Significant Coastal Wetlands; Coastal Biodiversity | State Significance (natural resources) – Significant Coastal Wetlands; Coastal Biodiversity | State Significance (natural resources) – Significant Coastal Wetlands; Significant Coastal Dunes; Protected Areas etc.; Coastal Biodiversity | State Significance (natural resources) – Significant coastal dunes, wetlands; and coastal biodiversity |

[5] Based on EHMP reporting – EHMP (2007) Report Card.
[6] Sub-zones outlined in plans within Schedule 1 of EPP Water - Moreton Bay, North Stradbroke, South Stradbroke, Moreton and Moreton Bay Islands Environmental Values and Water Quality Objectives published by the department in March 2007; Pumicestone Passage Environmental Values and Water Quality Objectives published by the department in March 2007
[7] See discussion in Beumer *et al.*. (1997). Declared Fish Habitat Areas in Queensland. Brisbane, DPI Fisheries.

**A. Eastern Banks Seagrass and Shoals**

Photo of *H. Ovalis* (Source: EPA photo library)

This area is located on the tidal delta west of South Passage, which extends from Moreton Island and North Stradbroke Island west and south west almost to Peel Island. The Eastern Banks area encompasses Coonungai, Boolong, Pelican, Chain, Maroom, Warragamba Banks; South Passage; Rous and Rainbow Channels; and the various gutters and passages within the shoal complex. Maxwell (1970) describes this area as *"…a large, complex system of banks and ridges separated by channels and re-entrants of 2-3 fathoms (~ 3.6 to 5.5 m) depth. It is flanked on the east and west by deeper water."*

These banks provide large areas of potential and actual seagrass habitat. Seagrass mapping undertaken by EHMP in 2004 indicates that the seagrass meaadows within this area represented the largest contiguous/semi-contiguous seagrass meadow in Moreton Bay. Most of the seagrass is comprised mainly of *Zostera muelleri, Halophila ovalis* and *H. spinulosa*. This seagrass provides an important food resource for green turtles and dugongs (Poiner *et al.* 1989; Marsh 1990; Abal *et al.* 1998; Dennison 2001).

Carruthers *et al.* (2002) proposed a number of generalised models of key seagrass processes and controls that vary across various biotopes, namely estuary, coastal, deepwater or reef. The wider eastern and northern Moreton Bay area supports potential coastal and deepwater seagrass habitat. In general terms, coastal habitats can be both intertidal and subtidal (depth <15m) and are primarily controlled by physical disturbance by waves and currents, while light availability is typically the dominant control on deepwater seagrass habitat (depth >15m) (Carruthers *et al.* 2002).

Seagrass distribution and extent is generally thought to be controlled by the following key processes (Edgar 2001; Carruthers *et al.* 2002):

- Physical Coastal Processes (waves and currents). Turbulent wave action and currents can result in physical disturbance of seagrass. Shallow, exposed banks tend to be exposed to greater wave turbulence (particularly during storms) than deeper, sheltered waters, and seagrass beds in shallow waters can be more patchy and comprised of species such as *Halophila ovalis*, which is capable of rapid re-colonisation (Rasheed 2004). The maintenance of suitable substrates for seagrass is also dependent on the maintenance of existing hydraulic and wave processes, and associated sediment transport regimes.

- Water Quality. Water quality conditions, particularly water clarity and concentrations of nutrients, also regulate seagrass distribution and extent (Young and Kirkman 1975; Dennison *et al.* 1993; Abal and Dennison 1996; Udy and Dennison 1998). Some species of *Halophila* are able to survive in areas with 5% surface light (Udy and Levy 2005). The Eastern Bay has low ambient turbidity and nutrient concentrations, reflecting the high degree of tidal flushing and limited influence of riverine discharges (EHMP 2006). This high water clarity allows seagrass to occur in deeper waters than in the more turbid southern and western Moreton Bay, with *Zostera* extending to 3 m (Seagrass Watch unpublished data) and *Halophila spinulosa* and *H. ovalis* occurring at water depths of 12 m (Dr James Udy unpublished data). In a recent survey (BMT WBM unpublished data) in northern Moreton Bay *H. ovalis* was found at depths of approximately 14m and 20m.

- Energy and Nutrient Dynamics. This section of the study area has characteristically low rates of phytoplankton productivity, reflecting the low nutrient status of waters. Seagrass represents a key primary producer in this area.

- Grazing. Grazing by dugongs and green turtles also has a major influence on seagrass communities, by altering species composition, distribution and sediment nutrient cycling processes (Perry 1997; Aragones and Marsh 2000). Grazing of benthic invertebrates by loggerhead turtles (Preen 1996) and fish (including rays) also results in the disturbance of bed sediments, altering sediment-nutrient patterns and processes. Grazing results in increased sediment aeration, burial of detritus, and increased sulfate reduction and nitrogen fixation (Perry 1997). Areas grazed by dugongs typically can also have lower shoot biomass but higher productivity than ungrazed areas (Perry 1997). Given the high densities of dugong and turtles within the Amity/Eastern Banks area (Lanyon 1997), grazing is likely to be a significant control on ecosystem functioning in this area.

- Other Biological Processes. A wide range of biological processes are important to the maintenance of ecosystem functions and values, including growth and reproduction, use of the site as a nursery habitat, recruitment, feeding and predation. No studies to date have assessed the relative importance of these processes in regulating marine flora and fauna communities within this section of the site (see Section 3 of the report for a general discussion).

Together with limited ongoing anthropogenic disturbances, these and other patterns and processes together maintain extensive, 'healthy' seagrass meadows within the Eastern Banks area. Table 7-5 summarises the key attributes of this critical service.

The primary value of this feature for shorebirds is linked to the intertidal exposure of sandbanks which roost opportunities in close proximity to large areas of feeding intertidal habitat on the south-western side of Moreton Island and those along the north-western side of North Stradbroke Island. The relatively large feeding grounds, which include exposed seagrass, may be particularly important for species such as Eastern Curlew, Bar-tailed Godwit and Grey-tailed Tattler.

A conceptual model of this key reference habitat is shown in Figure 7-1.

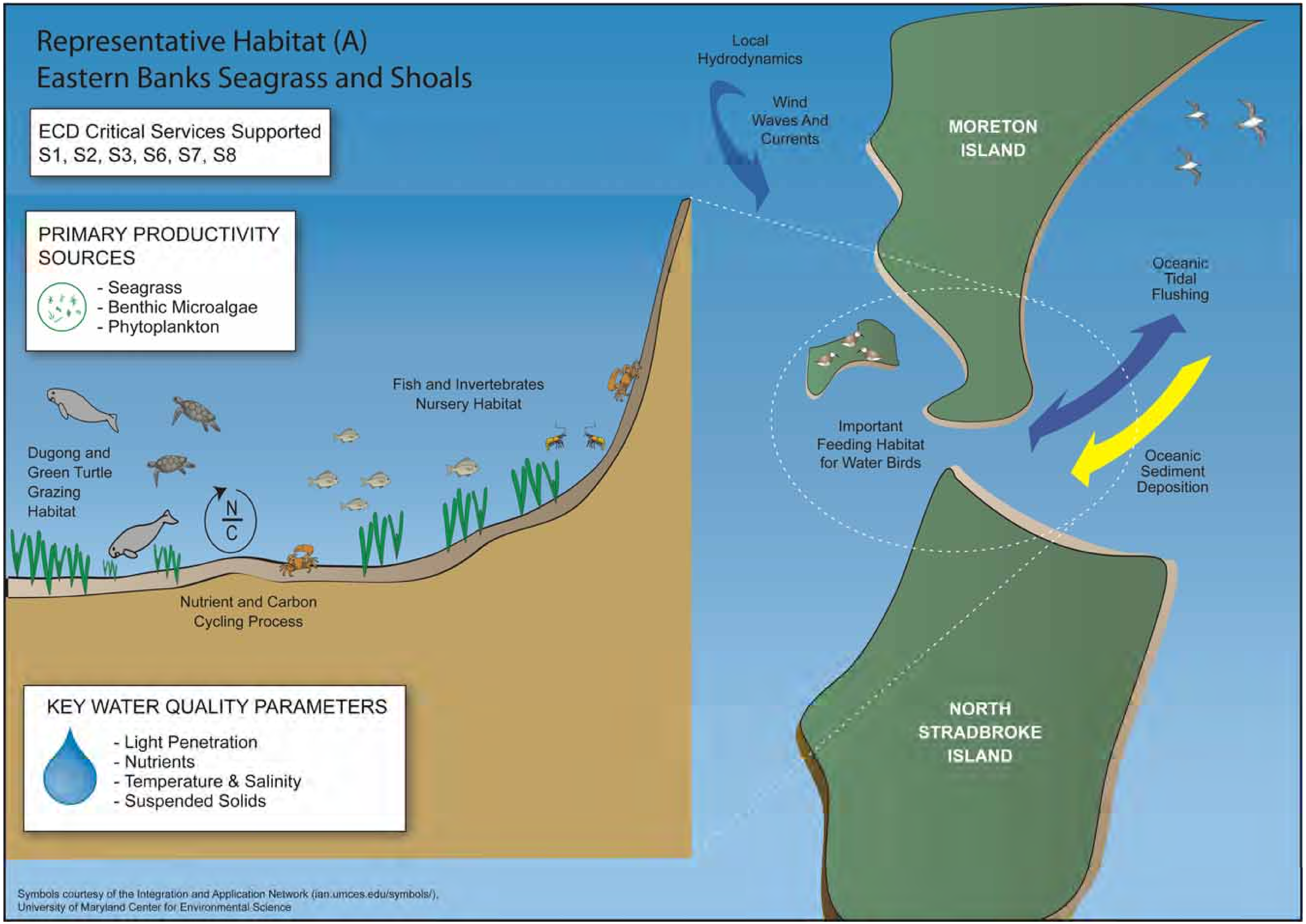


**Figure 7-1 Conceptual Model of Eastern Banks**

**Table 7-5 Critical Service 2A - Eastern Banks Seagrass & Shoals**

| **Summary Table** | **Critical Service (S2A)** |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for shoals and coastal/deepwater seagrass. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application (if relevant) | Eastern Banks area in eastern Moreton Bay |
| Critical habitat components underpinning this service | Seagrass; shoals |
| Critical species underpinning this service | See S3 (dugongs, turtles) |
| Critical processes underpinning this service | • Currents and waves<br>• Turbidity and water quality<br>• Nutrient cycling<br>• Grazing<br>• Other biological processes (growth, reproduction, nursery habitat, predation, feeding, recruitment) |
| Natural Variability (if relevant) | Seagrass – No major changes in distribution, extent and structure are known to have occurred in the last 5 years. Long-term changes unknown. Possible cyclic, seasonal changes in distribution and extent due to seasonal changes in wind patterns. Episodic catastrophic storms may also lead to short-term reductions in seagrass cover. |
| Principal threats | Activities that alter water quality, particularly nutrients, algal biomass and turbidity. |
| Data quality underpinning this critical service | Level 1-2 - based on Seagrass Watch cover data, seagrass mapping data (EHMP 2004; (Hyland *et al.* 1989); SDR data (EHMP monitoring) |
| Information gaps | More systematic information is required on background variability in wetland habitat extent and linkages to controlling processes. Note inconsistencies in mapping techniques prevent direct comparisons between existing data-sets, and therefore long-term changes in seagrass. |
| Recommended monitoring | Examination of long-term changes in seagrass based on aerial photograph interpretation and review of existing information<br><br>Additional EHMP/Seagrass Watch monitoring sites in representative areas subject to different wind/waves regimes. |

### B. Pumicestone Passage Tidal Flats and associated Estuarine Wetland Assemblages

Photo of intertidal flats in the vicinity of Pumicestone Passage (Source: BMT WBM photo library)

Pumicestone Passage is a narrow passage-type estuary that separates the mainland and Bribie Island and contains a wide diversity of estuarine wetland habitat types that are generally considered to be in 'good' condition. Pumicestone Passage is a relatively shallow waterbody (<2 m deep at Mean Sea Level for >80% of its area, QDEH 1993), which supports shallow sub-tidal sandy channels, intertidal flats (both with and without seagrass), and fringing mangrove, saltmarsh and freshwater/brackish wetland communities. It is one of four major passage-type estuaries in Queensland (Queensland Department of Environment and Heritage 1993).

The distribution, extent and configuration of structural habitats present in the Passage are ultimately controlled by geomorphologic processes operating over a range of time scales. Contemporary hydraulic (i.e. tidal forces, groundwater and pulsed stream flow events) and sedimentary processes also interact to regulate local conditions, for example:

- sedimentary processes that configure creek and channel mouth deltas. There is a tendency for sediment deposition at the mouth of tributary creeks during the dry season and scouring during flood events. Sand bar formation processes and patterns at the entrances of the Passage are a function of entrance morphology, tidal and freshwater discharge velocities and oceanic swell patterns near the mouths (Queensland Department of Environment and Heritage 1993). An extensive sand bar occurs at the northern entrance (near Caloundra) due to low tidal discharge, exposure to oceanic swell and shallow depths. The southern entrance does not contain an extensive bar system due to stronger tidal currents, its greater width and depth, and protection from swells;

- sedimentary processes that configure the extent and distribution of shoals and channels, and sediment characteristics. Sediment loading on the Passage is a function of oceanic process (tidal inflows and waves), which dominate at the entrances of the Passage, and tributary discharges. The entrances are comprised predominantly of fine to coarse sands, which are predominantly of marine origin, whereas finer silts and clays derived from fluvial sources dominate further up the estuary (Queensland DEH 1993);

- the frequency and extent of tidal inundation, which together with the competing influence of freshwater inflows, controls the extent and distribution of littoral wetland components (i.e. mangroves, saltmarsh, freshwater wetlands, seagrass, benthic algae etc.);

- tidal flushing and associated water quality characteristics of estuarine waters. The average nett tidal flow in the passage is in a northerly direction, although currents also run in a southerly direction, discharging into Deception Bay (WBM 2005). Residence/flushing (E-folding) times within the passage are estimated to be in the order of days at the south end, and up to 4 to 6 weeks through the middle sections of the Passage (WBM 2005). Tidal exchange at the northern entrance is curtailed by the oceanic sand bar at the mouth of the Passage (Queensland Department of Environment and Heritage 1993); and

- biogeochemical cycles within sediments and overlying waters.

The physico-chemical characteristics of waters (water quality), which are in part controlled by hydraulic processes, is a key control on wetland ecology. EHMP (2007) noted that water quality within the Passage was degraded in places, with generally poorer quality water (higher nutrients and turbidity) in the northern and central reaches compared with the southern reaches. Several small creeks discharge into the Passage, which are known to contain high levels of nitrogen, sediments and tannins, and are considered to be of 'fair' quality (EHMP 2007).

Turbidity is a particularly important control, particularly in terms of regulating the depth distribution and extent of seagrass, macroalgae and micro-phytobenthos. Less well known are the direct physiological and behavioural effects of turbidity on aquatic fauna (e.g. fish larvae behaviour to turbid waters, reduced predation success, interference of feeding efficiencies of filter feeders etc.). Turbidity within western Moreton Bay, and most likely Pumicestone Passage, is controlled by re-suspension of sediments by waves and currents, pulses of turbid freshwater inflows, and to a lesser extent, phytoplankton biomass.

Nutrients also represent a stressor, with slightly elevated TN, TP and chlorophyll *a* concentrations recorded within the Passage. Nutrient loading regimes are linked to transportation, deposition and resuspension of particulate material. Nutrient sources include Deception Bay, which is the receiving waters for the Caboolture River and other sources, stormwater runoff from the adjacent catchment, oceanic inputs, groundwater inflows, sediment fluxes and a range of point sources including wastewater treatment plants, gravel washing plants etc.

Important biogenic habitat components include littoral freshwater wetlands, saltmarsh, mangroves, seagrass and microalgae. The 2007 EHMP report card (EHMP 2007) describes Pumicestone Passage as containing *'intact and stable natural habitats throughout with extensive mangrove forests and stable seagrass meadows'.* The degree of 'stability' in seagrass and mangroves over longer timescales (timescales measured in 10's of years) than assessed by EHMP has not been quantified and requires further investigation.

In terms of spatial distribution of seagrass, the most recent broad scale data comes from EHMP 2004, which was derived from a survey conducted in Autumn 2002 *Zostera muelleri (=capricorni)* was the most abundant and widespread species, followed by *Halophila ovalis.* In the southern region of the Passage *Halophila spinulosa* was recorded, together with a small meadow of *Cymodocea serrulata*. The total area of seagrass within the Passage was ~1200ha, with the most extensive meadows located at Tripcony Bight and the south-western intertidal areas of the Passage. Seagrass cover was low (sparse cover of *H. ovalis*) in the area north of Tripcony Bight, possibly reflecting poorer water clarity. The average maximum seagrass depth was approximately 1m. To the south of Pumicestone Passage in Deception Bay there has been an almost complete loss of seagrass in the last decade (Abal *et al.* 1998), as a result of high turbidity and *Lyngbya* blooms (EHMP 2007).

As discussed in Critical Service 3 (see next section), the deeper water in southern Pumicestone Passage is thought to be an important year-round dugong habitat (Lanyon 1997; Lanyon *et al.* 2005). Grazing by dugongs is likely to influence seagrass communities, in much the same way as discussed above for the Eastern Banks. In terms of maintenance of reference habitat values, the other most notable biological processes are likely to be growth and reproduction of littoral vegetation (mangroves, saltmarsh, freshwater wetlands), seagrasses, phytoplankton and benthic microalgae.

The extensive tidal flats in the Pumicestone area also represent important estuarine wetland habitats for waterbirds and other important wetland fauna as described in Critical Services 4 and 6.

A conceptual model for this critical habitat is shown in Figure 7-2. Table 7-6 summarises the key attributes of this critical service.

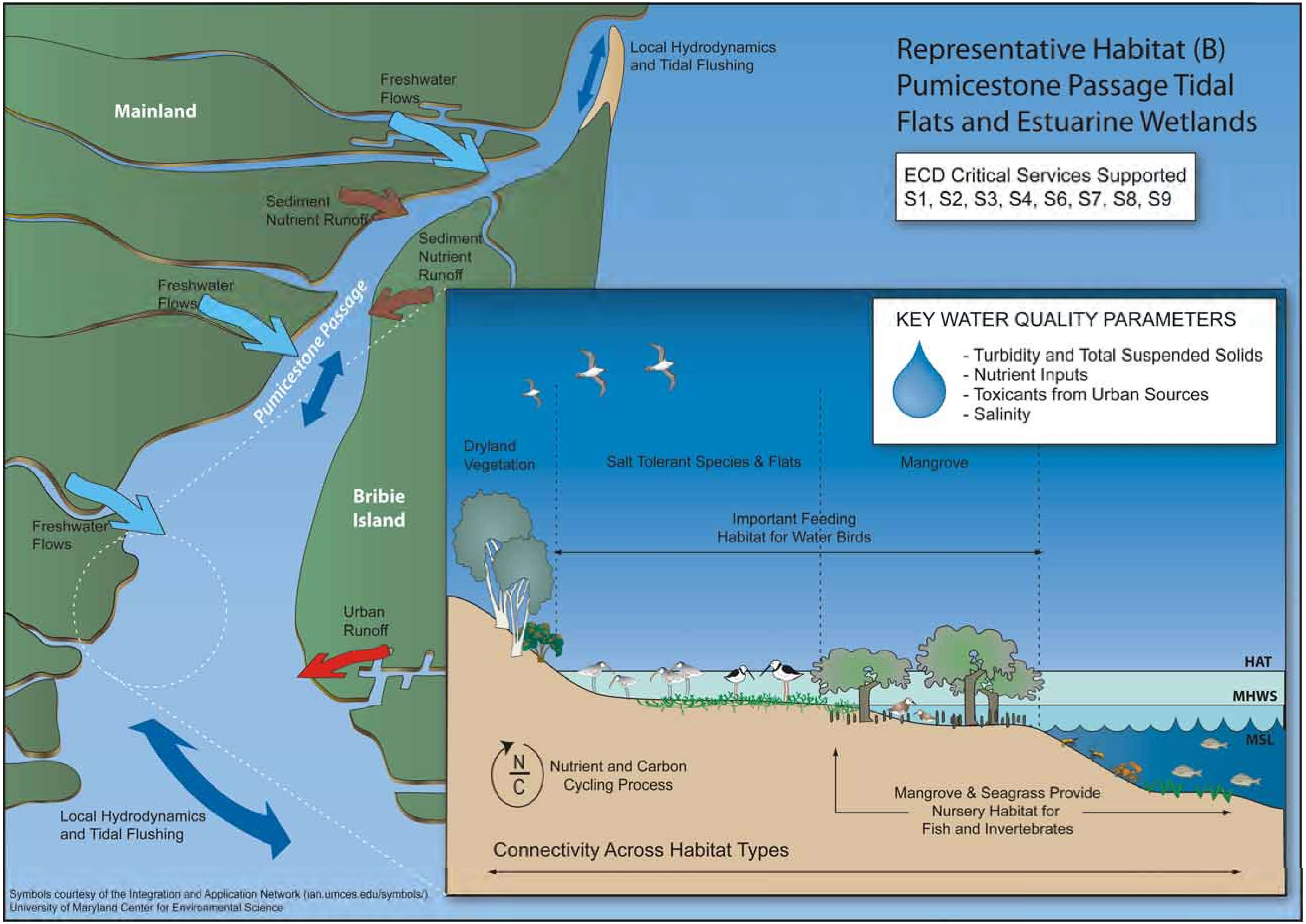


**Figure 7-2 Conceptual Model of Pumicestone Passage Flats and Estuarine Wetland Assemblages**

**Table 7-6 Critical Service 2B - Pumicestone Passage Tidal Flats and Estuarine Wetland Assemblages**

| Summary Table | Critical Service (S2B) |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for nearshore tidal flats and adjacent vegetated habitats such as seagrass. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application (if relevant) | Pumicestone Passage is located in north-western Moreton Bay |
| Critical habitat components underpinning this service | Intertidal flats and shoals; seagrass |
| Critical species underpinning this service | See S3 (dugongs, turtles), S4 (wetland dependant terrestrial fauna) and S6 (shorebirds) |
| Critical processes underpinning this service | Currents and natural coastal processes<br>Hydrology/freshwater flows<br>Water and sediment quality (turbidity and nutrient cycling)<br>Other biological processes (growth and reproduction of marginal freshwater assemblages, mangroves, saltmarsh, seagrasses and algae) |
| Natural Variability (if relevant) | Flats and Shoals – No data available to assess changes in distribution and extent<br>Seagrass – Based on EHMP data, no major changes in distribution, extent and structure of seagrass communities are known to have occurred in the last 5-10 years. Long-term changes unknown. Possible cyclic, seasonal changes in distribution and extent due to seasonal changes in wind patterns and freshwater flows. Episodic catastrophic storms may also lead to short-term reductions in seagrass cover. |
| Principal threats | Land use activities that alter water quality, particularly nutrients, algal biomass and turbidity. |
| Data quality underpinning this critical service | Level 1-2 - semi-quantitative based on Seagrass Watch data, seagrass mapping data (EHMP 2004; (Hyland *et al.* 1989). |
| Information gaps | More systematic information is required on background variability in seagrass habitat extent and linkages to controlling processes. See notes for Eastern Banks (Table 7-5) |
| Recommended monitoring | Examination of long-term changes in seagrass based on aerial photograph interpretation and review of existing information<br>Examination of long-term changes in tidal flat extent (particularly in terms of impacts from sea level rise) |

**C. Southern Bay Mangroves and Saltmarsh**

Photos of grey mangrove/saltmarsh environments in the Moreton Bay region (Source: BMT WBM photo library)

Southern Moreton Bay is bounded in the east by the dune-island barriers of North and South Stradbroke Islands, and low-lying fluvial dominated coastal plain and mangrove islands to the west. The central and eastern sections of southern Moreton Bay contain a complex network of mangroves and saltmarsh on low-lying silt and sand islands interspersed by tidal channels. These features represent important estuarine wetland habitats for wader birds and species of direct fisheries significance.

The geomorphologic processes that maintain mangrove-colonised islands in the Southern Bay vary spatially, and over a range of time scales (geological to years) (Lockhart *et al.* 1998). Fluvial deposits from the Logan River, together with some inputs of marine sands, have formed a bayhead delta with a series of associated islands. These islands have been colonised by mangroves, which have increased in extent in recent decades (Lockhart *et al.* 1998). The relict Jumpinpin flood-tide delta to the south also contains a series of mangrove-colonised mud and sand islands. The relict delta has a marine origin, whereas fluvial deposits in this area are predominantly restricted to the mouths of the Logan, Coomera and Pimpama Rivers (Lockhart *et al.* 1998). These fluvial-dominated river mouth environments also contain large areas of mangroves.

Hydraulic processes (tides, waves and freshwater flows) control, and are controlled by, geomorphologic processes and patterns. These patterns are described in Section 3. The distribution of mangroves and saltmarshes is ultimately determined by patterns of tidal inundation. Since the opening of the Jumpinpin Bar in 1898, tidal levels within the Southern Bay are relatively similar to those experienced in the ocean. An increase in sea levels would be expected to result in a retreat in the seaward extent of mangroves, and possible loss of mangroves on low-lying islands if sedimentation rates are lower than the rate of rise.

Mapping of mangroves based on aerial photography from 1944, 1987 and 1997 indicated that the mangrove areas associated with the Coomera and Pimpama Rivers have been markedly influenced by agricultural practices and changes to hydraulic regimes (WBM 2001). Approximately 1043 hectares of mangroves were mapped in the Coomera/Pimpama Rivers region in 1944, compared to 1241 hectares in 1997. Increases in mangrove area have occurred mostly on Coomera and Woogoompah Islands, with a general movement of mangroves landward. The trend of mangroves becoming established in more landward regions is probably related to alterations in the tidal regime of the region associated with the opening of the Jumpinpin Bar. Davie (pers. comm. in WBM 2001) notes that mangroves have been, and are presently, replacing saltmarsh and paperbark communities and that an equilibrium has apparently not occurred.

Mangrove losses in the area since 1944 totalled 60 hectares, and were all recorded between 1987 and 1997. All losses were associated with clearing, with the largest loss recorded in the upper Pimpama River (49 hectares). No data are available to assess changes in saltmarsh extent in this area.

In Moreton Bay in general, there has been a loss of saltmarsh vegetation of ~3051 ha between 1974 and 2002, most of which has been due to filling and reclamation works (Centre for Marine Studies 2006).

Mangroves and saltmarshes are not particularly sensitive to water quality modifications, although changes in the supply of suspended sediments can affect depositional patterns and habitat availability for mangroves.

The freshwater flow requirements of mangroves are not well understood. Freshwater pulses are thought to represent a source of sediment (and nutrients) required to maintain mangrove and saltmarsh habitat. In response to physiological tolerances and species interactions, freshwater inputs can also influence vertical 'zonation' patterns of saltmarsh species and may also control horizontal zonation patterns of mangroves (ie. replacement of *Avicennia* by *Aegiceras* in upstream areas).

A reduction in freshwater flows can also lead to higher ambient salinities in rivers, possibly leading to the upstream expansion of mangroves in rivers that do not have a tidal barrage, and possible loss of saltmarsh.

Figure 7-3 shows a conceptual model of this critical reference habitat. Table 7-7 summarises the key attributes of this critical service.

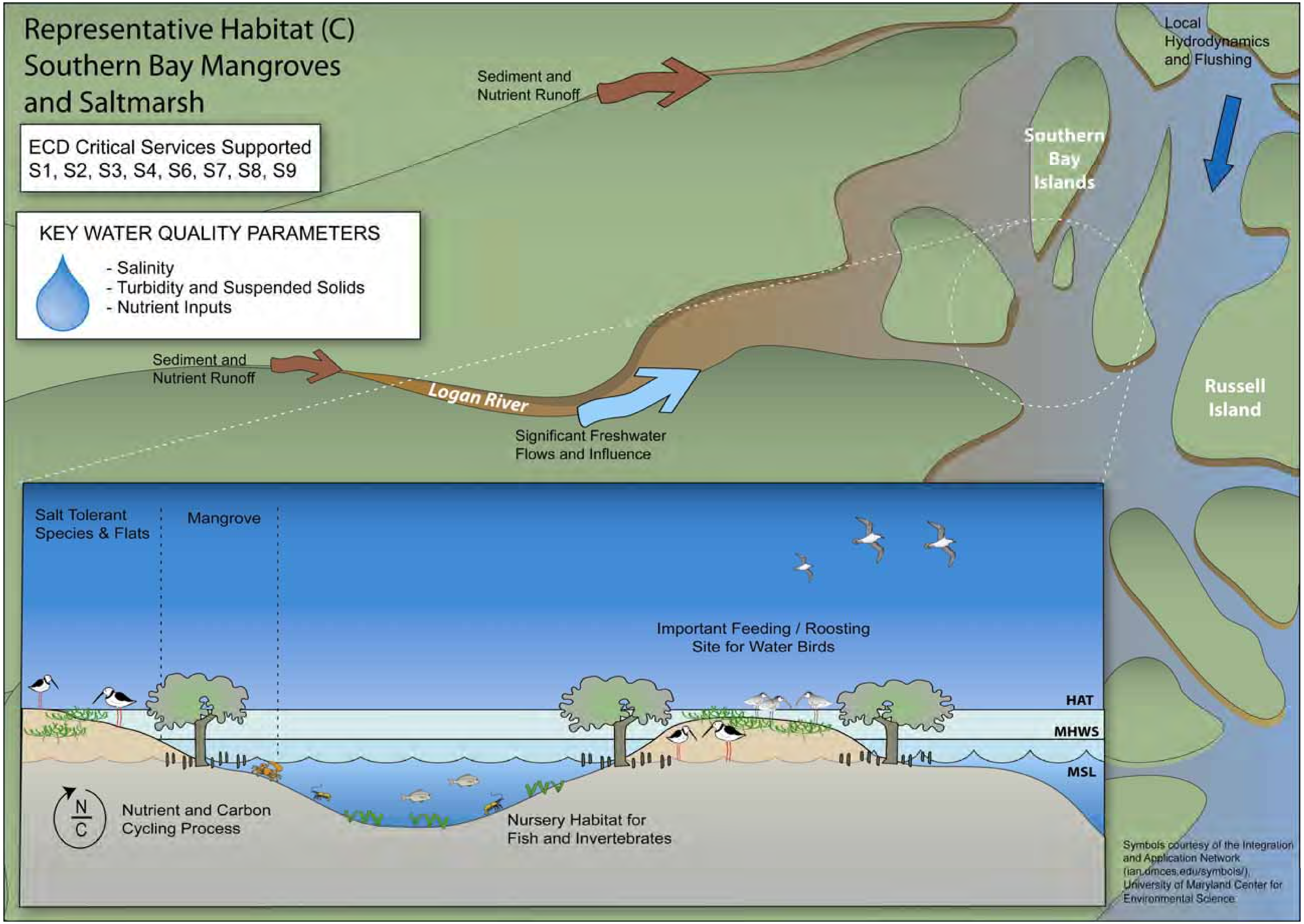


**Figure 7-3 Conceptual Model of Southern Bay Mangroves and Saltmarsh**

**Table 7-7 Critical Service 2C - Southern Bay Mangroves and Saltmarsh**

| Summary Table | Critical Service (S2C) |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for mangroves and saltmarsh communities. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application (if relevant) | Southern Moreton Bay |
| Critical habitat components underpinning this service | Mainland littoral habitats, mangrove-colonised islands |
| Critical species underpinning this service | Mangrove and saltmarsh species |
| Critical processes underpinning this service | Tidal hydraulics – currents, waves and sea level rise<br>Freshwater flows – Source and delivery of sediment<br>Physical (geomorphologic) coastal processes that maintain mangrove islands<br>Energy and nutrient dynamics<br>Other biological processes (growth, reproduction, recruitment, and possibly competition?) |
| Natural Variability (if relevant) | Mangrove losses reported following storms<br><br>No studies have examined broad-scale changes in mangrove extent across the Southern Moreton Bay area. Large increases in mangrove extent were recorded in the Pimpama and Coomera catchments associated with changed agricultural practices and tidal inundation patterns over the last 60 years (WBM 2001). Landward increases in mangrove extent have resulted in the loss of saltmarsh in many areas within the Pimpama and Coomera catchments.<br><br>Overall, there has been a large reduction in saltmarsh over the last 50 years as outlined in the text above in the Southern Moreton Bay area from a range of natural and anthropogenic factors. |
| Principal threats | Mangroves/saltmarsh - Clearing; reclamation and filling; and sea-level rise; Competition between species types.<br>The combination of sea level rise with limited coastal land area for saltmarsh migration places these habitats at particular risk. |
| Data quality underpinning this critical service | Level 1-3 (Dowling 1986; Hyland and Butler 1989; WBM 2001; EPA 2005a) |
| Information gaps | More systematic information is required on background variability in mangrove and saltmarsh habitat extent and linkages to controlling processes. |
| Recommended monitoring | Examination of long-term changes in mangroves and saltmarsh based on aerial photograph interpretation and review of existing information |

**D. Eastern Bay Coral Reef Communities**

Photo of typical coral reef flat in Central Moreton Bay (Source: BMT WBM photo library)

Coral communities occur on relict carbonate (coral) reefs throughout the Moreton Bay. The coral communities of Eastern Moreton Bay, namely northwest Peel Island, Goat Island, Bird Island, Myora Reef and Lazaret Gutter, are considered to be in near natural condition.

Living corals form a thin veneer over predominantly unconsolidated Holocene carbonate deposits that are interspersed patches of soft sediment and seagrass. The seaward edge of hard corals is delineated by the edge of hard substrate (Harrison *et al.* 1991), which typically occurs in water depths <3 m (Lovell 1975). The upper limit of corals typically occurs in the upper subtidal zone, but may occasionally extend into the lower intertidal zone (Johnson and Neil 1998b).

Tidal exchange through South Passage, and then Rainbow and Rous channels, dominates flow movement around the Peel Island reefs. Tidal flows maintain relatively clear, nutrient poor waters at these reefs (EHMP 2007), which is essential to the maintenance of corals and many other reef species. Oceanic exchange through South Passage is also thought to be important in the dispersal of larvae among reefs (Harrison *et al.* 1998), but is not thought to have a major influence of sea surface temperatures in the Bay (Johnson and Neil 1998a,b). The wide variability in sea surface temperatures within the Bay (compared to oceanic waters) is thought to prevent the colonisation of many coral species found in the wider region (Johnson and Neil 1998a,b).

Peel Island receives limited fluvial sediment inputs and has lower proportion of fine sediment material compared to Western Bay reefs (Johnson and Neil 1998a,b). However, re-suspension of fine sediments by wind, particularly during the summer months, can increase turbidity and sedimentation rates at these reef sites (Johnson and Neil 1998a,b). Major flood events, which result in reduced salinity and high turbidity, can also result in coral mortality on these reefs. However, floods are not thought to be a major determinant of spatial patterns in coral community structure within the Bay (Johnson and Neil 1998a,b).

Reef communities in this section of the Bay are numerically dominated by bare substrate, hard coral. Macroalgae cover is relatively low, in contrast to reef communities in the Western Bay (Harrison *et al.*

1991; Harrison *et al.* 1995; EHMP 2006). The actual controls on reef community structure have not been examined to date. However, grazing (e.g. by sea urchins), inter-species competition and possibly nutrient availability, could have a strong influence on these spatial patterns of macroalgae and other reef components. In order to develop LAC, further work is required to assess the proximal controls of reef communities, and the spatial and temporal scales at which that these controls operate.

Figure 7-4 shows a conceptual model of this critical reference habitat. Table 7-8 summarises the key attributes of this critical service.

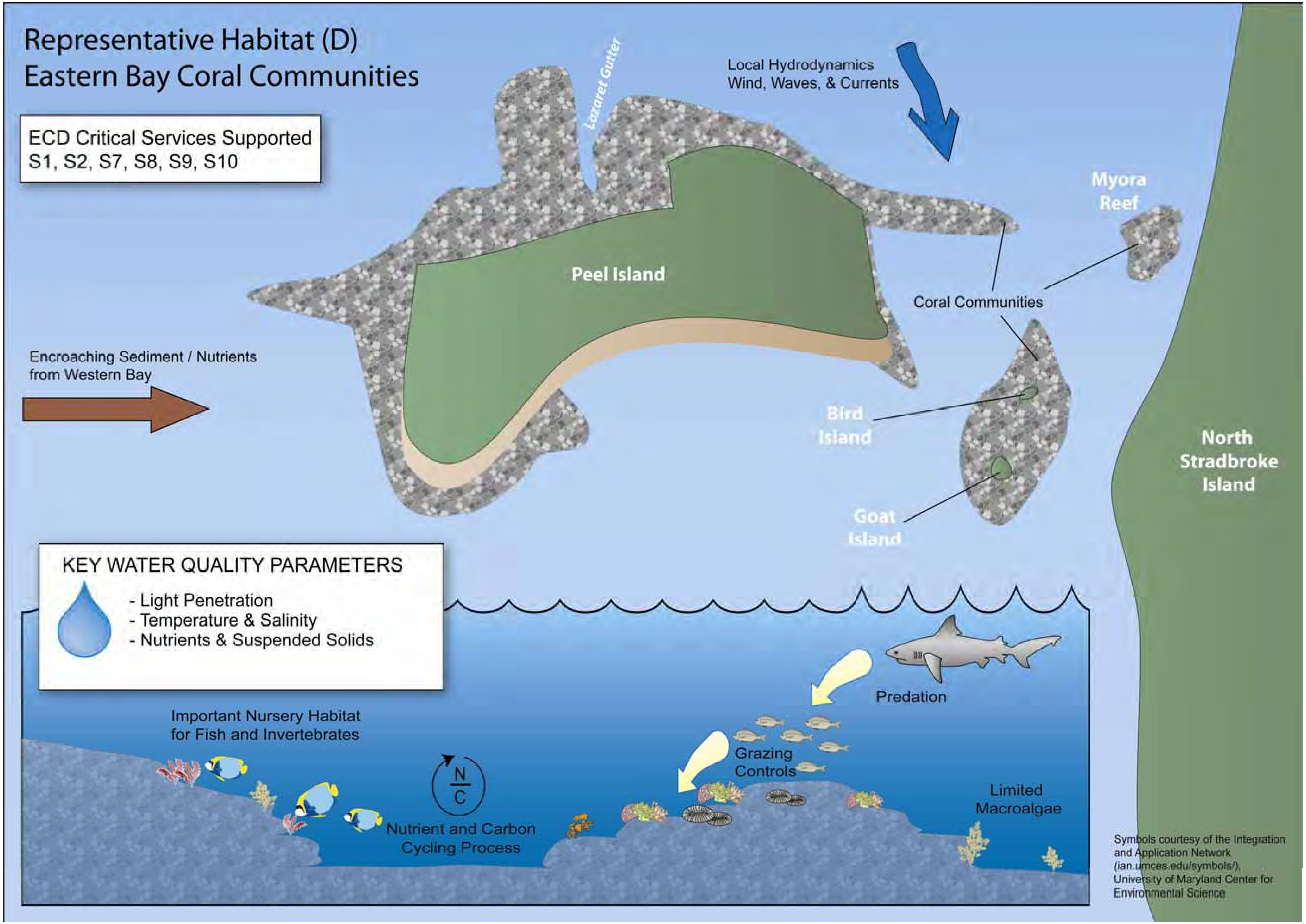


**Figure 7-4 Conceptual Model of Coral Reef Communities**

**Table 7-8 Critical Service 2D - Eastern Bay Coral Reef Communities**

| **Summary Table** | **Critical Service (S2D)** |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for coral reef communities. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application<br>(if relevant) | Eastern Moreton Bay, including northwest Peel Island, Goat Island, Bird Island, Myora Reef and Lazaret Gutter |
| Critical habitat components underpinning this service | Coral reef |
| Critical species underpinning this service | Coral reef associated flora and fauna |
| Critical processes underpinning this service | Physical Coastal Processes (Currents and waves)<br>Water quality (particularly turbidity and nutrients, but also toxicants, salinity and nutrient cycling processes)<br>Grazing<br>Other biological processes |
| Natural Variability (if relevant) | No major changes in distribution, extent and structure are known to have occurred in the last 5-10 years. Long-term changes unknown. Possible cyclic, seasonal changes in distribution and extent due to seasonal changes in wind patterns. Episodic catastrophic storms may also lead to short-term reductions in some reef flora and fauna. |
| Principal threats | Activities that alter water quality, particularly nutrients, algal biomass and turbidity. |
| Data quality underpinning this critical element | Level 1-2 - based on EHMP monitoring data and previous reef surveys (Harrison *et al*. 1991; Harrison *et al*. 1995) |
| Information gaps | More systematic information is required to assess background variability in coral reef community structure and linkages to controlling processes. |
| Recommended monitoring | Additional EHMP monitoring sites in representative areas subject to different wind/waves regimes.<br>Monitoring of coral growth (individual colonies) over time. |

**E. Freshwater Wetlands of North Stradbroke and Moreton Islands**

Photo of Blue Lake overflow creek on North Stradbroke Island (Source: BMT WBM photo library)

The Moreton Bay Ramsar site includes several near natural freshwater wetlands on Moreton and North Stradbroke Islands. A list of wetland types and key representative examples of each type are provided in Table 7-9. Several wetland habitat types are represented, as described below. Table 7-10 summarises the key attributes of this critical service.

*Lacustrine wetlands (lakes)*

These include both perched lakes and water table window lakes.

Perched lakes are fed by seepage from a perched aquifer system that has formed above relatively shallow sand layers, has a low permeability and which lie above the regional water-table. These waterbodies typically have distinctive water quality characteristics including (Kalf 1998):

- brown coloured water and associated with this, a shallow euphotic zone;
- low dissolved oxygen levels near the lake bed;
- low pH resulting from accumulation of humic material in the water;
- low to moderate concentrations of bio-available nutrients (dystrophic conditions); and
- variable water levels depending on the amount of rainfall, evaporation and seepage through the perching layer.

Perched lakes are the most common lake type on both islands.

Water-table window lakes form between dunes in depressions that extend at or below the upper surface of the regional water-table. Water quality and hydraulic characteristics typical of water-table window lakes include (Kalf 1998):

- high water clarity;
- low electrical conductivity, dominated by sodium and chloride ions;
- high transparency;
- slightly acidic pH;
- low nutrient concentration and productivity (oligotrophic conditions), with low levels of organic matter; and
- relatively constant water levels.

Blue Lake on North Stradbroke Island and Blue Lagoon on Moreton Island are examples of water table window lakes. Note that recent hydraulic and environmental investigations by DNRW suggest that Blue Lake is not entirely fed by regional water table, but instead is partially perched above the regional aquifer.

*Palustrine (marshes and freshwater peat swamps)*

Palustrine wetlands are natural low-lying areas from which groundwater emerges above the ground surface level. Hydrology, morphology and water quality processes may vary greatly among wetlands. Some palustrine wetlands, such as Eighteen Mile Swamp and most wetlands on the northern and western sides of North Stradbroke Island, are predominantly fed by the regional groundwater table, and therefore have water quality and hydrological characteristics that are similar to water table window lakes. Palustrine wetlands that are contiguous with nearby perched lakes are often fed by the local groundwater table of the perched lake. From a hydrological perspective, these wetlands are analogous to perched lakes, but are typically shallower and have a higher vegetation cover than lakes (e.g. sections of Ibis Lagoon, Mugaree and Jaragill Lagoons on North Stradbroke Island).

*Freshwater Creeks*

There are three basic types of creeks and drainages on Moreton and North Stradbroke Island:

- Coastal drainages, which are drainages with a defined channel that discharge directly into the sea. The largest of these watercourses on North Stradbroke Island is Freshwater Creek, which discharges through Eighteen Mile Swamp and ultimately to Swan Lagoon at the southern end of the island. On the western side of North Stradbroke Island, Laycock (1975) noted that stream flows occur to the north of Dunwich in Aranarawai Creek, Cooroon Cooroonpah Creek, Campebah Creek, Myora Springs, Yerrol Creek, and One Mile Creek. Similarly to the south of Dunwich stream flows occur to Canalpin Creek, Little Canalpin Creek and several other smaller, unnamed creeks.
- Coastal seeps are groundwater expressions that do not have a defined channel which discharge directly into the sea. Several seeps occur on the west coast of North Stradbroke Island, such as those associated with the Canalpin Swamp system.

- Internal drainages. These are creeks and drainages that flow into and out of wetlands and lakes. The most notable example on North Stradbroke Island is the Blue Lake Overflow. Several other internal drainages are also associated with perched lakes and palustrine wetlands.

*Important Wetland Controls*

Geomorphologic processes (and associated aeolian and to a lesser extent hydraulic processes), mostly operating over geological timescales, control such factors as landform and waterbody configuration, elevation and drainage patterns (Benussi 1975; Heidecker 1984). This in turn controls patterns in connectivity and among waterbodies, and associated with this patterns in the genetic exchange, generic diversity, species composition, and species richness of waterbodies (Page *et al*. 2006). For example, the presence of a high sand ridge separating the eastern and western sides of North Stradbroke Island, together with a higher degree of interconnectivity between waterbodies on the east side of the island (i.e. Eighteen Mile Swamp complex), are thought to explain differences in fish populations and communities between these areas.

- Climate, rainfall and groundwater hydrology. These wetlands are groundwater dependent ecosystems. The key processes and patterns that control wetland hydrological characteristics are rainfall (and hence regional climate), evaporation, infiltration, groundwater flows, and in some creeks (e.g. Blue Lake Overflow, Little Canalpin Creek, Spitfire Creek), surface expression of groundwater. All freshwater waterbodies are fed by groundwater exfiltration, with the degree of influence of the regional versus the local groundwater table dependent on whether the waterbody is 'perched' above the regional groundwater table (Laycock 1975; Lee-Manwar *et al.* 1980; James 1984). Eighteen Mile Swamp on North Stradbroke Island and Blue Lagoon on Moreton Island represent surface water expressions of the regional groundwater table, although local perched waterbodies may also exist. Blue Lake is also fed by the regional watertable, but in contrast to previous views (Lee-Manwar *et al.* 1980), also has its own perched layer, and is therefore considered a semi-perched lake (DNRW unpublished data).

- Water chemistry. The physico-chemical properties of waters are controlled mainly by soil properties, rainfall, groundwater processes and surface-groundwater interactions. *In-situ* cycling of nutrients is also important in perched lakes with a bed comprised of humic material, whereas interactions between tidal processes and freshwater flows influence the water quality characteristics of many coastal seeps, creeks and palustrine wetlands. These properties exert a strong influence on resident aquatic fauna and flora communities and key ecosystem patterns and processes. In particular:

- Clear, dystrophic[8] waters that characterise water-table window lakes and palustrine wetlands have flora and fauna communities that are distinctly different from those found in tannin-stained, humic perched lake systems (Bayly 1964; Bensink and Burton 1975; Arthington 1984);

- Water chemistry, particularly low pH, humic waters, provide habitats for several species that are uniquely adapted to such conditions e.g. Oxleyan pygmy perch (Arthington 1996), the zooplankter *Calamoecia tasmanica* (Timms 1982), several dragonfly (Arthington and Watson 1982) and caddisfly species (Neboiss 1978), and 'acid' frogs (Ingram and Corben 1975).

[8] tannin stained, humic

- Rainfall patterns and groundwater flows have a profound influence on dissolved oxygen concentrations of certain creeks (e.g. Little Canalpin Creek) and wetlands. Rainfall and groundwater processes also control concentrations of dissolved and particulate iron, which can influence habitat structure in some areas due to the creation of a layer of iron 'flocs' on the lake bed.

- Fire regimes. Fire regimes play an important role in the life cycle of many plant species, and consequently exert a strong influence on wetland vegetation (e.g. Gill 1981). Reproductive mechanisms of vegetation that are dependent on fire include promotion of germination, triggering of seed release and stimulation of flowering, as well as promotion of vegetative sprouting; while key processes include the influence of fire over nutrient availability and opening up of the canopy. Changes to fire regimes over time, primarily post European-settlement, may result in changes in vegetation community structure (see Fensham 1997; Watson 2001), although the extent to which modified fire regimes have altered the community structure of Bay island wetlands has not been comprehensively addressed. Fire is a particularly acute threat to peatland wetlands as these systems either cannot or are extremely slow to regenerate following a fire event. The risk of fire is exacerbated during periods of lowered groundwater levels.

- Soil types, including the age of underlying sand deposits, also directly control wetland vegetation communities. Smaller scale heterogeneities arise from variations in topography and elevation, the layering of new soil horizons and the mosaic of past and contemporary fire regimes (Westman 1975). Many of these controlling elements are interrelated. For example, soils in gullies are often deeper and richer in nutrients when compared to soils along slopes.

Wetland habitats of both islands are largely undisturbed. Past sand mining activities have resulted in localised, but long-term modifications to the landscape (and waterbodies) of several wetlands. This includes the creation of a Lacustrine system (i.e. Keyholes and Yarraman Lakes) within the Eighteen Mile Swamp complex, which are located outside the boundaries of the Ramsar site. Water extraction also occurs from the Eighteen Mile Swamp system to supplement the Redland Shire water supply, as well as to supply water for sand mining operations on the island.

Figure 7-5 shows a conceptual model of these freshwater wetland reference habitats. Table 7-10 contains a summary of the critical service attributes.

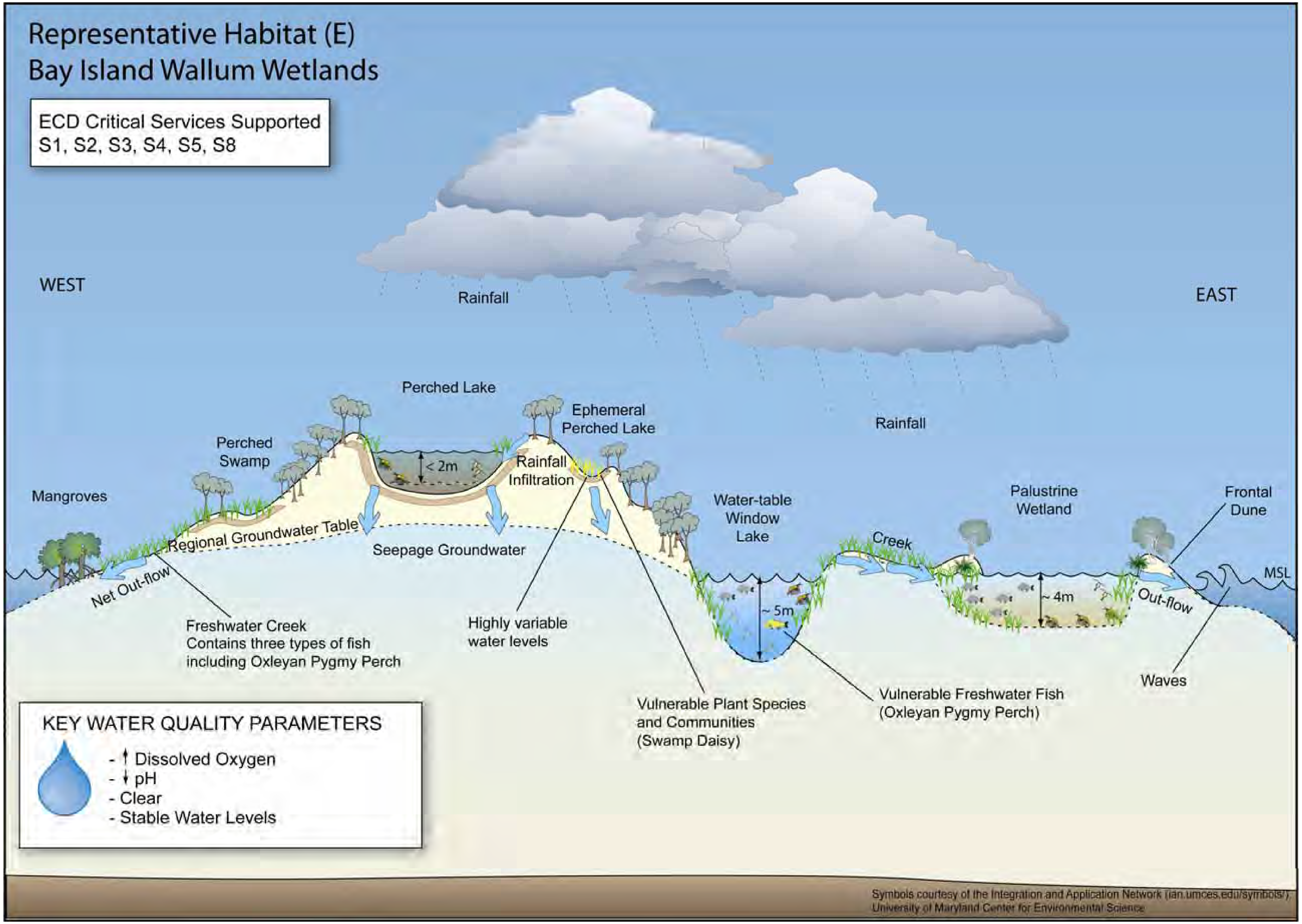


**Figure 7-5 Conceptual Model of Bay Island Wallum**

**Table 7-9 Key examples of freshwater wetland types**

| Major wetland type (EPA) | Wetland sub-type | Ramsar types | Notable examples: | |
|---|---|---|---|---|
| | | | **Moreton Is.** | **N. Stradbroke Is.** |
| Lacustrine | Perched lakes | K – Coastal freshwater lagoon<br>O – Permanent f/w lakes (>8ha)<br>P – Seasonal f/w lakes (>8 ha)<br>Also found in association with:<br>M – Permanent creeks<br>N – Intermittent creeks<br>Tp – Permanent f/w marshes/ pools on inorganic soils<br>Ts – Intermittent marshes/ pools on inorganic soils<br>U – Non-forested peatlands<br>W – Shrub-dominated wetlands<br>Xf – F/w, tree-dominated wetlands<br>Xp – Forested peatlands<br>Y – Freshwater springs | Jabiru Lake; Mirapool Lagoon; Honeyeater Lake | Welsby; Tortoise; Blaksley; Shag; Black Snake; Ibis; Tea Tree; Native Companion; Duck; and South Lagoons |
| | Water table window lakes | O and K, also associated with M, N, Tp, Ts, U, Xf, Xp, Y | Blue Lagoon | Blue Lake |
| Freshwater Creeks | Coastal drainages | M, N. Also see types cross-referenced above | Eagers, Craven's & Spitfire, Ben-Ewa Creeks; Drainages associated with Jabiru Swamp | Freshwater Creek (Eighteen Mile Swamp);<br>North-western drainages: Aranarawai, Cooroon Cooroonpah, Campebah Creek, Yerrol, One Mile Creeks; Myora Springs.<br>South-western drainages: Little Canalpin & Canalpin Creek, Creeks; numerous small, unnamed creeks. |

| Major wetland type (EPA) | Wetland sub-type | Ramsar types | Notable examples: | |
|---|---|---|---|---|
| | | | Moreton Is. | N. Stradbroke Is. |
| | Coastal seeps | Y. Also see types cross-referenced above | Unnamed seeps associated with major swamp systems | |
| | Internal drainages | M, N. Also see types cross-referenced above | Cowan; Shrapnel; Monash Gullys | Blue Lake Overflow and unnamed inflow drainages;<br>Unnamed drainages at Brown Lake. |
| Palustrine | Peat marshes, fed by either perched lakes, regional watertable or freshwater creeks | M, N, Tp, Ts, U, W, Xf, Xp, Y | Bulwer (Comboyuro to Cowan Cowan); Eagers and Jabiru Swamps | Eighteen Mile; Flinders Beach; Amity; Kounpee; Canalpin; Little Canalpin; Horseshoe Swamps |
| | Groundwater dependent woodlands, forests & shrublands. Includes Casuarina woodland; Woodland/open forest of Casuarina equisetifolia; Livistona/Melaleuca forest; Open-forest/ woodland of Melaleuca quinquenervia; Notophyll vine forest | W, Xf, Xp. Also see types cross-referenced above | Associated with major waterbodies listed above. | |

**Table 7-10 Critical Service 2E – Freshwater Wetlands of Moreton and North Stradbroke Islands**

| Summary Table | Critical Service (S2E) |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for freshwater wetlands. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application (if relevant) | Moreton Island and North Stradbroke Island |
| Critical habitat components underpinning this service | Peat swamp, window water-table lakes, perched lakes, freshwater creeks |
| Critical species underpinning this service | Wetland vegetation associated flora and fauna. Vulnerable species including Oxleyan Pygmy Perch (refer Service 3) and Swamp Orchid (refer Service 5). |
| Critical processes underpinning this service | Geomorphic processes (predominantly aeolian and marine)<br>Groundwater hydrology<br>Water quality<br>Fire regimes<br>Energy and nutrient dynamics (including soil and sediment nutrient processes) |
| Natural Variability (if relevant) | Vegetation communities show a high degree of variability over multiple spatial and temporal scales<br>Water levels usually stable in Blue Lake, but show marked variability in many other wetlands (WBM 2002a;b) |
| Principal threats | Extraction of groundwater, water quality modifications, fire |
| Data quality underpinning this critical service | Level 2 – North Stradbroke Island<br>EHMP monitoring data with limited spatial and temporal context<br>Quantitative baseline flora and fauna survey results are available for parts of North Stradbroke Island, most of which is not current (Arthington 1984; Arthington 1996; WBM 2002a;b; WBM 2003)<br>Level 3-4 – Moreton Island<br>Very few baseline data describing aquatic flora, fauna and their habitats at Moreton Island |
| Information gaps | More systematic information is required to assess background variability in wetland community structure and linkages to controlling processes. |
| Recommended monitoring | Additional EHMP monitoring sites in representative sites within North Stradbroke Island and Moreton Island<br>Development of locally specific ecosystem condition objectives. |

**F. Ocean Beaches and Foredunes of Moreton Island**

Photo of Moreton Island beach coastline (Source: EPA photo library)

Ocean beaches within the Moreton Bay Ramsar site occur along the eastern coastlines of Bribie Island, Moreton Island, North Stradbroke and South Stradbroke Islands. These beaches can generally be characterized as dissipative in nature, with high waves >2 m, fine sand and the presence of offshore bars.

In looking at the Ramsar site as a whole, the ocean beaches of the planning area are quite distinct from the estuarine habitat assemblages of the Bay both in terms of geomorphologic form and function. In particular, the composition, diversity, and abundance of fauna communities on beaches are likely to be more strongly controlled by physical factors (e.g. wave climates, sediment properties) than by the biological interactions.

The intertidal zone of ocean beaches is dominated by wave action causing the sand to be in a constant state of disturbance. The coastal processes cause organic nutrients to continually re-suspend, meaning there is limited food available, particularly compared to more sheltered estuarine areas. While the environment limits the presence of larger invertebrates, beach ecosystems can contain significant species diversity when smaller invertebrate forms (i.e. the interstitial micro- and meiofauna) are included in surveys. Beaches also provide unique ecological services, such as filtration of large volumes of seawater, not covered by any other ecosystem (Schlacher *et al.* 2008).

Above the active surf zone, macrobenthic organisms are a key structural and functional component of sandy beach ecosystems, with benthic invertebrates playing roles in both the cycling of nutrients and as serving as prey species for larger crustaceans, fish and birds. Foredunes situated landward of the active surf zone provide important habitat for range of fauna species including nesting by shorebirds and marine turtles and roosting by coastal birds of prey.

Of the beach environments of the Ramsar site, the ocean beach environments of Moreton Island are seen as the most representative and near natural of the site which is supported by a long term conservation management regime over the site as a national park. The ocean beach of the island provides critical habitats (nesting, roosting and foraging sites) for migratory and resident birds of

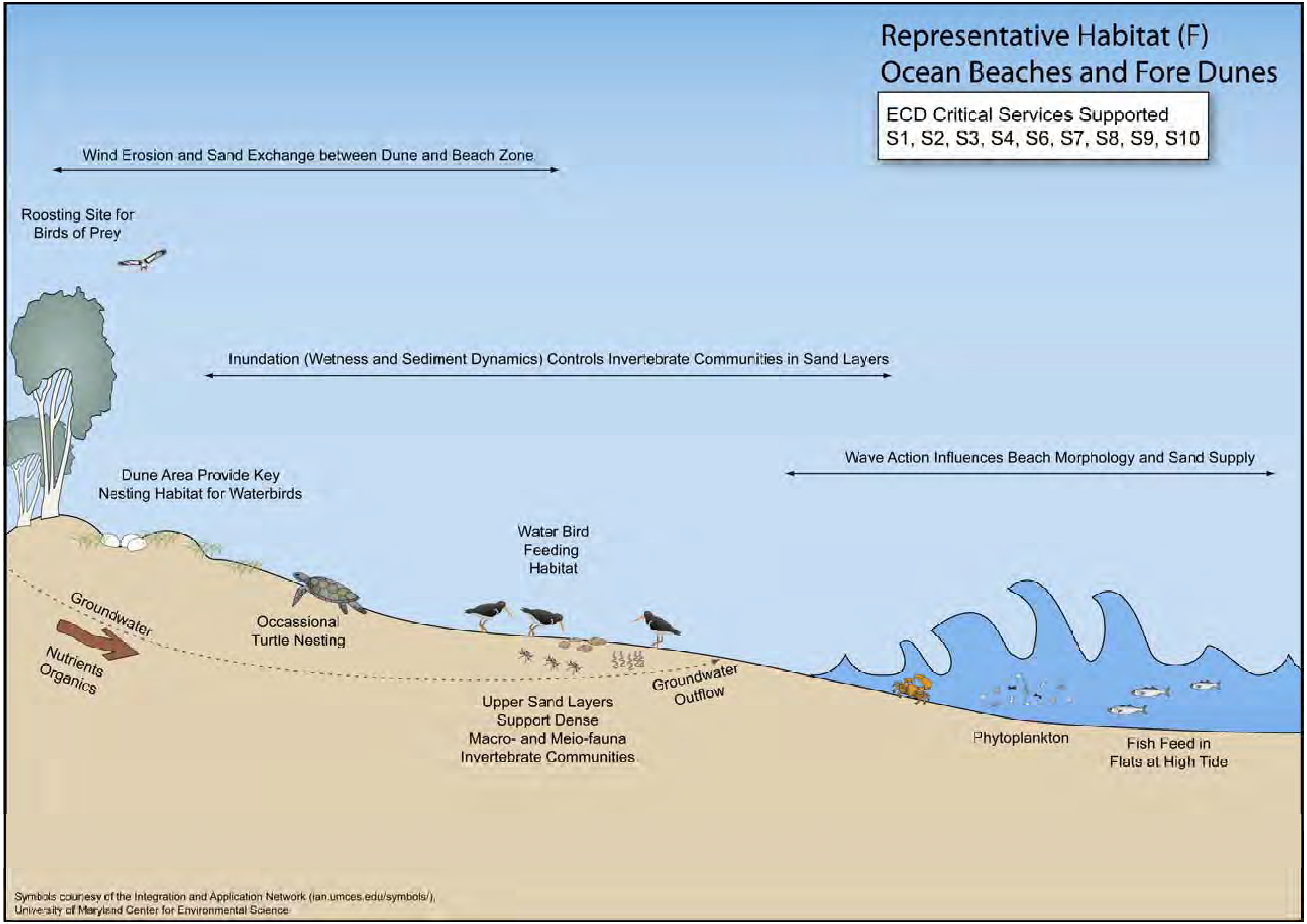


**Figure 7-6 Conceptual Model of Moreton Island Ocean Beaches and Foredunes**

**Table 7-11 Critical Service 2F – Ocean Beaches and Foredunes of Moreton Island**

| Summary Table | Critical Service (S2F) |
|---|---|
| Reason for Inclusion | While there a number of ocean beaches represented in the site, the ocean beaches of Moreton Island have been selected as a representative near-natural reference site, underpinned by Ramsar Criteria 1. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application<br><br>(if relevant) | Moreton Island ocean beaches and foredunes |
| Critical habitat components underpinning this service | Sandy Beach, Dune systems, Marine Waters |
| Critical species underpinning this service | See S3 (turtles), S4 (principally little tern and other avifauna), S7 (shorebirds) |
| Critical processes underpinning this service | Waves and current and their effect on sediment deposition and shoreline morphology including erosion and accretion<br><br>Changes to tidal regimes/tidal drainage patterns<br><br>Sediment stability, compactness and structure (eg. most animals surviving within upper sand layers)<br><br>Wind erosion (stabilisation) |
| Natural Variability (if relevant) | Seasonal changes in distribution and extent of the habitat due to coastal processes.<br><br>Episodic catastrophic storms may also lead to short-term reductions in available habitat. |
| Principal threats | Activities that disturb or otherwise reduce the quality of habitat for important fauna (nesting and feeding birds and turtles)<br><br>Crushing of invertebrate species and communities from sediment disruption (principally by Off Road Vehicles)<br><br>Removal and damage to dune vegetation (reducing habitat quality and increasing susceptibility to wind erosion) |
| Data quality underpinning this critical service | Level 3-4: There is emerging research into the impact of ORV on sandy beach ecosystems that demonstrates the diversity and abundance of species within beach ecosystems are adversely affected by ORV use compared to control sites. |
| Information gaps | • More systematic survey of key species (birds and turtle) populations over time including usage and quality of nesting sites<br><br>• Further research of the impact of ORV usage on sandy beach invertebrate communities. |
| Recommended monitoring | • Examination of long-term changes in habitat extent using aerial photograph interpretation and review of existing information<br><br>• Schalcher *et al.* (2007) also recommends research into the implications of habitat loss and fragmentation as well as weakened linkages across critical ecotones and habitats for the conservation of sandy beach biodiversity. Effects of cumulative impacts from multiple stressors and disturbances on the structure, function, and recovery dynamics of sandy beach ecosystems are also recommended. |

conservation significance and to a lesser extent turtles (noting the ocean beaches of South Stradbroke Island are recognised as being more significant for turtle nesting). The prominent bird species include the pied oystercatcher (*Haematopus longirostis*), the little tern (*Sterna albifrons*) and the beach stone-curlew (*Esacus neglectus*) with the beach and adjoining dune areas important breeding and chick rearing areas with close access to marine feeding zones. Mirapool Lagoon in the southeastern corner of Moreton Island and Heath Island area on the Island's northern coast are recognised vital feeding and roosting site for waders in both the National Park and Marine Park Zoning Plans (EPA 2007b).

The principal impacts to wetland values that occur in ocean beach environments are from off-road vehicle usage. Research on the impacts on wetland fauna from beach driving have traditionally focused on disturbance to rare and vulnerable species such as birds and turtles, particularly in the context of disturbance to breeding activities and nests. However, recent research on the impacts of off road vehicles (ORV) on beach ecosystems by Schlacher *et al.* (2008) demonstrated that macrobenthic assemblages on heavy traffic ORV beaches contained significantly fewer species at much reduced abundances than beaches without vehicles present. This was particularly marked in the upper and middle part of the beach where vehicle usage is highest. As identified above, these species provide an important prey source for a range of higher order vertebrates (such as shorebirds and birds of prey) that are of direct relevance to the Ramsar site.

Figure 7-6 shows a conceptual model of this critical reference habitat. Table 7-11 summarises the key attributes of this critical service.

## 7.3 Service 3 ~ Marine / Aquatic Fauna

Photos of marine turtle, dugong and Oxleyan pygmy perch (Source: BMT WBM photo library)

For the purposes of this assessment, species of conservation significance are considered to be those that are listed as endangered or vulnerable under National (EPBC Act 1999) or state (Nature Conservation (Wildlife) Regulation 2006) legislation.  The definition has also been extended to include marine mammal and reptile species that are protected under the EPBC Act 1999.

**Dugongs**

Dugongs have a global IUCN listing of "vulnerable to extinction" (IUCN 1996) and the Queensland dugong population is considered as "vulnerable" under the Queensland *Nature Conservation (Wildlife) Regulation 2006*.

Moreton Bay represents the southern limit of the dugong's Australian distribution (Lanyon and Morrice 1997) and currently contains one of the largest populations of dugongs on the east coast of Australia (Marsh *et al.* 1996).  A study estimated the Moreton Bay dugong population to be comprised of approximately 500 individuals (Great Barrier Reef Marine Park Authority (GBRMPA) 2003) compared with an estimated population of 503 ± 63 (S.E) (July) to 1019 ± 166 (S.E) (December) individuals in 1995 (Lanyon 2003).  However as noted by GBRMPA (2003), there were differences in sampling techniques, which preclude direct comparisons between the two studies.  Recent population modelling estimates that the Moreton Bay dugong 'population' is ~970 ±75 animals (Dr Janet Lanyon, pers. comm. 2008).  It should be noted, however that this figure should be considered as indicative only, subject to further investigations.  A range of studies are either underway or are planned to gain a more detailed appreciation of dugong movement patterns (within and external to the site), population dynamics, genetics and ecology within the site (Dr Janet Lanyon, pers. comm. 2008).

Dugongs are believed to move in and out of Moreton Bay in ranging movement patterns, but principally through the South Passage and not the northern delta region (Lanyon and Morrice, 1997). There is uncertainty regarding the movement patterns of dugongs within and external to the site (Dr Janet Lanyon, pers. comm. 2008).  Dugong densities appear to be concentrated around the extensive seagrass beds associated with the Moreton Banks area (located 10-12 km to the south) in the Eastern Bay (Lanyon and Morrice, 1997), with relatively few individuals sighted in other portions of Moreton Bay.  However, areas containing dugong foraging habitat (i.e. seagrass areas) have been recognised as far north as Tangalooma Point on the west coast of Moreton Island. The importance of the Moreton/Eastern Banks area to this species has been recognised by the Environmental Protection Agency in the *Marine Parks (Moreton Bay) Zoning Plan 1997*, with the area designated as a Conservation Zone and the implementation of "go slow zones" in areas such as Moreton Banks.

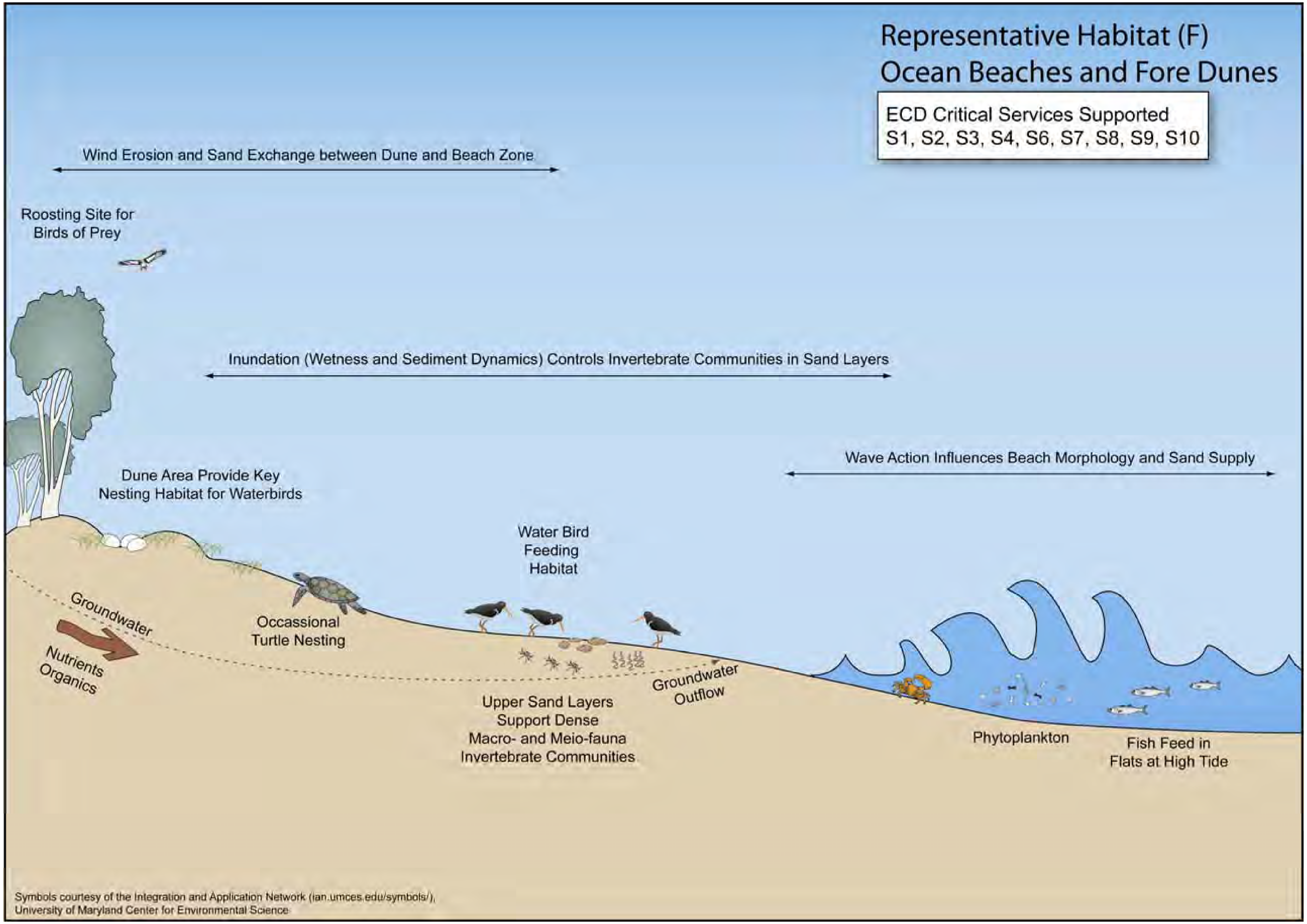


**Figure 7-6 Conceptual Model of Moreton Island Ocean Beaches and Foredunes**

### Table 7-11 Critical Service 2F – Ocean Beaches and Foredunes of Moreton Island

| Summary Table | Critical Service (S2F) |
|---|---|
| Reason for Inclusion | While there a number of ocean beaches represented in the site, the ocean beaches of Moreton Island have been selected as a representative near-natural reference site, underpinned by Ramsar Criteria 1. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application<br><br>(if relevant) | Moreton Island ocean beaches and foredunes |
| Critical habitat components underpinning this service | Sandy Beach, Dune systems, Marine Waters |
| Critical species underpinning this service | See S3 (turtles), S4 (principally little tern and other avifauna), S7 (shorebirds) |
| Critical processes underpinning this service | Waves and current and their effect on sediment deposition and shoreline morphology including erosion and accretion<br><br>Changes to tidal regimes/tidal drainage patterns<br><br>Sediment stability, compactness and structure (eg. most animals surviving within upper sand layers)<br><br>Wind erosion (stabilisation) |
| Natural Variability (if relevant) | Seasonal changes in distribution and extent of the habitat due to coastal processes.<br><br>Episodic catastrophic storms may also lead to short-term reductions in available habitat. |
| Principal threats | Activities that disturb or otherwise reduce the quality of habitat for important fauna (nesting and feeding birds and turtles)<br><br>Crushing of invertebrate species and communities from sediment disruption (principally by Off Road Vehicles)<br><br>Removal and damage to dune vegetation (reducing habitat quality and increasing susceptibility to wind erosion) |
| Data quality underpinning this critical service | Level 3-4: There is emerging research into the impact of ORV on sandy beach ecosystems that demonstrates the diversity and abundance of species within beach ecosystems are adversely affected by ORV use compared to control sites. |
| Information gaps | • More systematic survey of key species (birds and turtle) populations over time including usage and quality of nesting sites<br><br>• Further research of the impact of ORV usage on sandy beach invertebrate communities. |
| Recommended monitoring | • Examination of long-term changes in habitat extent using aerial photograph interpretation and review of existing information<br><br>• Schalcher *et al.* (2007) also recommends research into the implications of habitat loss and fragmentation as well as weakened linkages across critical ecotones and habitats for the conservation of sandy beach biodiversity. Effects of cumulative impacts from multiple stressors and disturbances on the structure, function, and recovery dynamics of sandy beach ecosystems are also recommended. |

Dugongs are principally herbivores and have been shown to be highly selective feeders, preferring certain species of seagrass to others. Preen (1995b) reported dugongs showing a preference for grazing on seagrass from the genus *Halophila*, three species of which (*H. ovalis, H. spinulosa* and *H. decipiens*) are found in Moreton Bay. This is despite the dominance in biomass of another species of seagrass (*Zostera*) in the region. Dugongs in Moreton Bay are also reported to feed deliberately on invertebrates such as ascidians. This omnivory is thought to be a response to nutritional stress caused by seasonality in abundance of seagrasses in Moreton Bay (Preen 1995a).

**Marine Turtles**

Six species of marine turtle are known to use Moreton Bay as a feeding area. Two of these species – the green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles, have relatively high abundances within the site, while the hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*) and flatback (*Natator depressus*) turtles are seasonal visitors to the region, or do not have high abundances within site (Limpus *et al.* 2006). For this reason, emphasis in this critical service (and the ECD as a whole) is on the two most common species.

Moreton Bay is not an important turtle breeding area, with most turtles in the Bay believed to have originated from rookeries on the central and north Queensland coast and Islands. Loggerhead turtles nest at low densities on the local sand islands of Bribie, Moreton, and North and South Stradbroke.

The distribution and abundance patterns of turtles within Moreton Bay are thought to be greatly influenced by the availability of suitable food resources. Green turtles in Moreton Bay feed directly on seagrasses and algae (Brand-Gardner *et al.* 1999) with most concentrated numbers of these fauna (c.f. dugongs) also centred on the important foraging areas at Moreton/Eastern Banks. By comparison, loggerhead turtles are carnivorous, and feed on jellyfish, crustaceans, echinoderms, and bivalve molluscs from seagrasses and reef areas (Limpus *et al.* 1994).

'Population' estimates of turtles in Moreton Bay in 1995 range from 800 and 900 individuals (Lanyon 1997). However, the authors acknowledge that this is likely to be an underestimate due to bias inherent in the survey methodology. It should also be noted that the term 'local population' is a misnomer, given the large home range of these species. The number of green turtles is consistently higher in the Eastern and Southern Bay than elsewhere due to the presence of extensive (seagrass) foraging areas (Limpus *et al.* 2006). With the exception of green turtles, there is a paucity in data to describe key or preferred foraging habitats for the remaining marine turtles in Moreton Bay, possibly due to the lower resident numbers of these species.

Marine turtles are protected under the *Nature Conservation Act 1992*, with the loggerhead listed as Endangered, and the green turtle listed as Vulnerable. The green and loggerhead are also listed as threatened under the EPBC Act 1999.

**Oxleyan pygmy perch and honey blue-eye**

Two nationally threatened 'wallum-habitat' associated fish species occur within the Moreton Bay Ramsar site: Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and Honey Blue-eye (*Pseudomugil mellis*). Both species are listed as Vulnerable under *Nature Conservation (Wildlife) Regulation 2006*, and Endangered under the IUCN red list. Under the Commonwealth's *Environmental Protection and*

**Table 7-7 Critical Service 2C - Southern Bay Mangroves and Saltmarsh**

| Summary Table | Critical Service (S2C) |
|---|---|
| Reason for Inclusion | Representative near-natural reference site for mangroves and saltmarsh communities. Underpinned by Ramsar Criteria 1, in the context that it contains representative habitat with a high degree of inter-connectivity between habitat types. |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Habitat types are in a near-natural condition. |
| Spatial Application (if relevant) | Southern Moreton Bay |
| Critical habitat components underpinning this service | Mainland littoral habitats, mangrove-colonised islands |
| Critical species underpinning this service | Mangrove and saltmarsh species |
| Critical processes underpinning this service | Tidal hydraulics – currents, waves and sea level rise<br>Freshwater flows – Source and delivery of sediment<br>Physical (geomorphologic) coastal processes that maintain mangrove islands<br>Energy and nutrient dynamics<br>Other biological processes (growth, reproduction, recruitment, and possibly competition?) |
| Natural Variability (if relevant) | Mangrove losses reported following storms<br><br>No studies have examined broad-scale changes in mangrove extent across the Southern Moreton Bay area. Large increases in mangrove extent were recorded in the Pimpama and Coomera catchments associated with changed agricultural practices and tidal inundation patterns over the last 60 years (WBM 2001). Landward increases in mangrove extent have resulted in the loss of saltmarsh in many areas within the Pimpama and Coomera catchments.<br><br>Overall, there has been a large reduction in saltmarsh over the last 50 years as outlined in the text above in the Southern Moreton Bay area from a range of natural and anthropogenic factors. |
| Principal threats | Mangroves/saltmarsh - Clearing; reclamation and filling; and sea-level rise; Competition between species types.<br>The combination of sea level rise with limited coastal land area for saltmarsh migration places these habitats at particular risk. |
| Data quality underpinning this critical service | Level 1-3 (Dowling 1986; Hyland and Butler 1989; WBM 2001; EPA 2005a) |
| Information gaps | More systematic information is required on background variability in mangrove and saltmarsh habitat extent and linkages to controlling processes. |
| Recommended monitoring | Examination of long-term changes in mangroves and saltmarsh based on aerial photograph interpretation and review of existing information |

*Biodiversity Conservation (EPBC) Act 1999*, Oxleyan pygmy perch is listed as Endangered, whereas honey blue-eye is listed as Vulnerable.

Table 7-12 lists localities where Oxleyan pygmy perch and honey blue-eye have previously been recorded, and the habitat attributes of the sites in which these species were recorded. There are several mainland and island waterbodies within the Ramsar site in which Oxleyan pygmy perch has been recorded. Honey blue-eye by contrast has not been recorded on the Moreton Bay islands, but has been recorded in several waterways that discharge into Pumicestone Passage.

Honey blue-eye and Oxleyan pygmy perch are both typically found in the coastal lowland "wallum" ecosystem and are often found in the same waterways (Arthington and Marshall 1993; Arthington 1996). Both species are thought to be restricted to acidic (pH 4.4 - 6.8) freshwater lakes, pools and small streams with dense, aquatic vegetation (such as emergent sedges and submerged sedges), along the margins (Allen and Ivantsoff 1982; Arthington and Marshall 1993; Arthington 1996; Kuiter *et al.* 1996; Pusey *et al.* 2004). Both species are found in clear and tannin-stained waters (Arthington and Marshall 1993) with sandy or muddy bottoms (Allen 1989), typically where there is little or no flow (Arthington and Marshall 1993; Arthington 1996). Oxleyan pygmy perch are restricted to freshwaters (Arthington 1996, Pusey *et al.* 2004), whereas honey blue-eye occurs in slightly brackish and freshwater environments (Semple 1991).

Both species are considered as nationally threatened. In response, recovery plans have been prepared for both species which provide basic life history and population distribution information, identify key threats and recommendations for management of the species and their habitats (Arthington and Marshall 1993; Arthington 1996).

It should be noted that the mainland waterbodies that Oxleyan pygmy perch and honey blue-eye have been recorded are, in most cases, brackish reaches within the Moreton Bay Ramsar site. Within the context of the Ramsar site boundaries, these mainland waterbodies are therefore unlikely to represent critical habitat for these essentially freshwater species.

Table 7-13 provides the summary of key attributes related to this critical service.

**Table 7-12 Localities Known to Support Oxleyan Pygmy Perch and Honey Blue-eye and Habitat Conditions**

| | Oxleyan Pygmy Perch | Honey Blue-eye |
|---|---|---|
| Mainland Localities | Searys Ck, Carland Ck, Noosa River & tributaries, Coondoo/Tiana Ck, **Mellum Ck**, trib of Blue Gum Ck, **Burpengary Ck**, Marcus Ck [D], Coochin Creek [E] | Big Tuan Ck, Lake Cooloola, Noosa River, Marcus Ck, Scrubby Ck, Kangaroo Ck, Schnapper Ck, Carland Ck, **Mellum Ck**, **Tibrogargan Ck** [D] |
| Island Localities | **Spitfire Ck** and **Jabiru Ck** (Moreton Island) [A]; **Bribie Island** [A]; **Eighteen Mile Swamp** [G]; **Blue Lake** [H]; **Blue Lake Overflow** [G]; **Little Canalpin Ck** [F] | - |
| Localities not recorded by Arthington (1996); Arthington and Marshall (1993) | Waraba Ck, Tibrogargan Ck, Coonowrin Ck, Coochin Ck, Obi Obi Ck; Mooloola R., Tingalpa Ck, Currumbin Ck [D] | Seary Ck, Lake freshwater, Kin Kin Ck, Castaways Ck, Obi Obi Ck, Mooloola River, Coochin Ck, Coonowrin Ck, Waraba Ck, Tingalpa Ck, Currumbin Ck [D]; North and South Stradbroke, Bribie, Moreton Islands |
| Water Quality[A,B] | pH 4.2 to 7.2<br>Conductivity <330 µS/cm<br>DO > 2 mg/L<br>Clear, tannin stained waters | pH 4.4 to 6.8<br>Conductivity <900 µS/cm<br>DO > 6.8 mg/L<br>Clear, tannin stained waters |
| Habitat | Wallum habitat, often with Melaleuca<br>Structurally complex habitats:<br>• 60-80% aquatic plant cover (typically sedges)<br>• Undercut banks<br>• Leaf litter or fallen timber | Wallum habitat<br>High aquatic plant cover, typically sedges<br>Low flow environments (<0.3 m/sec) |

A = Pusey, *et al.* (2004); B = EPBC database; C = Arthington (1996); D = Arthington and Marshall (1993); E = unpublished AGFA records; F = WBM (2002a); G = WBM (2002a); H = BMT WBM (2007); **Bold** – waterbodies located in, or have a direct connection to, the Ramsar site

**Table 7-13 Critical Service 3**

| Summary Table | Critical Service (S3) |
|---|---|
| Reason for Inclusion | Key services provided by the site in regards to threatened fauna complies with Ramsar Nomination Criteria 2 in that the site supports vulnerable fauna and Ramsar Nomination Criteria 4 in respect to provision of critical refuge. |
| Type of Service | Supporting – Nationally threatened species, contributes to biodiversity |
| Description of Service (quantify if possible) | The site supports records of, and habitat suitable for, threatened aquatic fauna species. Dugong, two species of marine turtle, and two 'wallum-habitat' fish species are identified as critical elements. |
| Spatial Application (if relevant) | This service applies to the whole site. Refer to text for important localities and habitats for these species. |
| Critical habitat components underpinning this service | Seagrass (dugongs and green turtles), reefs (loggerhead turtles), wallum freshwater wetland habitats (Oxleyan pygmy perch, honey blue-eye). |
| Critical species underpinning this service | **Food**<br>Freshwater littoral and pelagic micro- and macro-invertebrates - Oxleyan pygmy perch, honey blue-eye<br>Seagrass (*Halophila* species and *Halodule uninervis*) - Dugongs and green turtles<br>Soft sediment epifauna and infauna – Loggerhead turtles<br>Reef biota (algae, sponges, soft coral) – Loggerhead turtles<br>Jellyfish – Loggerhead turtles<br>**Habitat**<br>Emergent macrophytes - Oxleyan pygmy perch, honey blue-eye |
| Critical processes underpinning this service | Maintenance of biophysical habitat extent, diversity and interconnectivity<br>Maintenance of tidal and wave regimes that drives biophysical habitat patterns and processes<br>Maintenance of water quality conditions, particularly with respect to its influence on estuarine vegetation communities (i.e. seagrass, algae etc.)<br>Maintenance of groundwater and surface flow regimes to wallum wetland habitats |
| Natural Variability (if relevant) | Patterns in abundances of all fauna species are known to vary across a range of spatial and temporal scales. |
| Principal threats | Habitat loss due to development - Oxleyan pygmy perch, honey blue-eye<br>Water quality degradation - Oxleyan pygmy perch, honey blue-eye, dugong, green turtle<br>Fishing (by-catch) – Turtles<br>Boat strike (including jetskis) – Dugongs, turtles<br>Water extraction – Wallum wetland fish species<br>Disease, possibly linked to *Lyngyba* – Turtles<br>Entanglement and ingestion of marine debris – Turtles<br>Toxicants – Turtles, possibly other marine fauna. |
| Data quality underpinning this critical service | Service – Level 2-3 (population survey data outdated, insufficient scale)<br>Components – Level 2 (outdated, insufficient scale)<br>Processes – Level 1-2 (water quality); 2 (freshwater flows); 2 (tidal data) |
| Information gaps | **Marine**<br>Present-day and historical marine vegetation mapping done at relevant spatial scale (minimum 1:25,000) and temporal (at least every 5 years, preferably with analysis of seasonal changes); |

| Summary Table | Critical Service (S3) |
|---|---|
| | Information on factors controlling temporal changes in seagrass, mangrove and saltmarsh;<br>Natural variability in dugongs and turtles, and factors controlling these changes;<br>Sustainability of dugongs and turtles given existing pressures and management arrangements; and<br>Health/condition status of turtles, and identification of factors causing disease.<br>**Freshwater**<br>Environmental flow requirements of wallum fish species<br>Impacts of introduced species on wallum fish species<br>Up-to-date assessment of the distribution, population status and site-specific threats to wallum-habitat fish species, including an assessment of any changes of population status. |
| Recommended monitoring | Fauna population monitoring at an appropriate spatial and temporal scales<br>Marine vegetation monitoring<br>Continuation and expansion of EHMP to include key habitats |

## 7.4 Service 4 ~ Wetland-Dependant Terrestrial Fauna

Photos of little tern (*Ray Viljoen*), beach stone-curlew (*Ray Viljoen*) and water mouse (*Bruce Cowell*)


There are records for nine threatened wetland-dependant terrestrial fauna within the Moreton Bay Ramsar site. These are: Illidge's ant blue butterfly *Acrodipsas illidgei,* wallum froglet *Crinia tinnula*, wallum rocketfrog *Litoria freycineti*, wallum sedgefrog *L. olongburensis*, beach stone-curlew *Esacus neglectus*, water mouse *Xeromys myoides,* Cooloola sedgefrog *Litoria cooloolensis*, Australian painted snipe *Rostratula australis,* little tern *Sterna albifrons*. A tenth, the Australasian bittern *Botaurus poiciloptilus*, has not been recorded currently for the site but could be present due to suitable habitat. The following provides a profile of ecological characteristics, habitat usage in Moreton Bay, and potential threatening process for each of the species.

**Illidge's Ant Blue Butterfly**

Illidge's ant blue butterfly *Acrodipsas illidgei* is listed as Endangered under the IUCN Red List, and is also listed as *Vulnerable* at a State scale under the provisions of the NCA.

Illidge's ant blue butterfly appears to be restricted to a small number of coastal localities from the Mary River Heads, south-eastern Queensland to Brunswick Heads, northern New South Wales (Sampson 1993; Sands and New 2002). Whilst single specimens have been recorded in non-coastal environments (Toowoomba - Lane 1991 and Braby 2000; and near Leyburn - Sands and Sands 2005), there is insufficient information relating to these records to add to the knowledge of the butterfly's ecology (D. Sands, pers. comm. 2008).

Site localities within Moreton Bay are: Hayes Inlet (1974; DeBaar in Sands and New 2002); Southport (Samson 1989); Redland Bay (Hagan 1980); Coomera Island (1999; Breitfuss and Dale 2004); and Fisherman's Islands (D. Sands, pers. comm. 2008).

Large and undisturbed mangal communities are considered to be the primary habitat for this butterfly. The vast majority of known habitats all characterised by the presence of well-spaced, mature mangrove trees bearing senescing limbs and dead branchlets which support the *Crematogaster* sp. ant (prey of Illidge's ant blue larvae). In these habitats, tree phenology and architecture appears to be important (D. Sands, pers. comm. 2008).

Adults of the Illidge's ant blue feed on the nectar of flowers (e.g. eucalypts, mangroves, *Parsonsia* spp.) (D. Sands, pers. comm. 2008). After mating, females deposit their eggs singly or in small groups at the edge of hollows in dead twigs or under bark of old trees of *Avicennia marina* when occupied by a common Black ant (*Crematogaster* sp.; *laeviceps* group) (Smales and Ledward 1942; Samson 1989).

Detection of Illidge's ant blue butterfly is highly problematic, even for highly experienced personnel, as the density of adults is very low and the butterfly has the propensity to remain settled on the upper branches of mangroves and flies infrequently (D. Sands, pers. comm. 2008). It is quite likely that new habitats will eventually be discovered if persistent searches of other potential habitats are undertaken, particularly on the islands of Moreton Bay (D. Sands, pers. comm. 2008). It is highly probable that Moreton Bay supports in excess of 1% of the population of Illidge's ant blue (D. Sands, pers. comm. 2008) but a lack of definitive data about the bioregional population limits its application.

**Acid Frogs**

For the purposes of this report, wallum or acid frogs (after Ingram and Corben 1975) include wallum froglet *Crinia tinnula*, wallum rocketfrog *Litoria freycineti*, wallum sedgefrog *L. olongburensis*¸ and Cooloola sedgefrog *Litoria cooloolensis*. The wallum froglet, wallum rocketfrog, wallum sedgefrog are listed as *Vulnerable* under the provisions of the NCA. The wallum sedgefrog is the only species listed nationally as *Vulnerable* under the EPBCA. All four species are listed as threatened by the World Conservation Union (IUCN 2006).

Wallum froglets *Crinia tinnula* occur primarily in heathland, paperbark (*Melaleuca*) swamps and sedge swamps in areas of sandy soil which support waters that are typically tannin-stained, highly acidic (i.e. <5.5 pH) and non-turbid (Cogger 2000; Straughan and Main 1966; Ingram and Corben 1975; Meyer *et al.* 2006). Other habitats include adjoining eucalypt forest and woodland in areas of sandy soil overlaying clay and sandstone (Hines *et al.* 1999). Waterbodies used for breeding are typically oligotrophic (low nutrient), naturally acidic (pH 3.0-5.5 as derived from dissolved organic acids leached from humus), and free of predatory fish (Hines *et al.* 1999). Primary breeding habitat is associated with shallow ephemeral swamps and soaks, though also known to breed in artificial habitats such as dams and flooded ditches (Hines *et al.* 1999; Anstis 2002).

In Queensland, the frogs are restricted to the coastal lowlands and offshore islands ("wallum" landscapes of Coaldrake 1961) of the south-east (Czechura 1995; Meyer *et al.* 2006). Site localities within Moreton Bay include Bribie, Moreton and North Stradbroke Islands (both public and private land tenure) (Neilson 2000; Greenloaning Biostudies 2000; EPA 2008b). National Parks on all three islands are listed as supporting important populations of wallum froglet (Meyer *et al.* 2006). Other localities include wallum habitats adjoining Pumicestone Passage and several small islands within the southern sector of Moreton Bay (EPA 2008b).

Wallum sedgefrogs *Litoria olongburensis* are known from a variety of ephemeral and semi-permanent, low-nutrient, well-vegetated swamps of coastal wallum (Liem and Ingram 1977; Emhann 1997; Hines *et. al.* 1999). Within these habitats, areas of sedges, reeds, grasses and/or Bungwell fern (*Blechnum indicum*) which are inundated with shallow acid, low-nutrient waters (e.g. up to 1.5m in depth) are regarded as important breeding habitat attributes (Liem and Ingram 1977; Hines *et. al.* 1999; Meyer *et al.* 2006; DEWHA 2008a). Wallum sedgefrogs are typically more common in and around ephemeral acid swamps, though also known to occur along slow-flowing creeks and acid lakes in wallum landscapes (Liem and Ingram 1977; Ehmann 1997; DEWHA 2008a). Aquatic sites at the base of sedges area also important microhabitats for amplexus and egg laying (Ehmann 1997;

Meyer *et al.* 2006). Fish are largely absent from habitat occupied by the species (E. Meyer pers. comm. 2002 in DEWHA 2008a).

The wallum sedgefrog is primarily restricted to the coastal lowlands of south-east Queensland and north-east New South Wales (Tyler 1997; Meyer *et al.*. 2006). The main localities for wallum sedgefrog within the study area are similar to the wallum froglet, on Bribie, Moreton and North Stradbroke Islands (both public and private land tenure) (EPA 2008b). National Parks on all three islands are listed as supporting important populations of wallum sedgefrog (Meyer *et al.* 2006). Other localities include fragmented wallum habitats adjacent Pumicestone Passage (mainland) (EPA 2008b).

The wallum rocketfrog *Litoria freycineti* is a ground dwelling species associated with coastal wet heath, though also occurs around sedge swamps, slow moving streams, perched lakes and within nearby *Melaleuca* and *Banksia* woodlands on sandstone and sandy soils (Ingram and Corben 1975; Hines *et al.* 1999; Meyer *et al.* 2006). The wallum rocketfrog breeds after rain in spring and summer in ephemeral swamps and pools and males call from wet ground near water, amidst sedges and eggs are laid in shallow water (Straughan and Main1966; Anstis, 2002; Barker *et al.* 1995; Meyer *et al.* 2006).

The wallum rocketfrog occurs in lowland coastal south-east Queensland and eastern New South Wales from Fraser Island south to Jervis Bay (Hines *et al.* 1999; Meyer *et al.* 2006). The main localities for wallum rocketfrog within the study area are similar to those of wallum froglets and wallum sedgefrogs as already discussed.

The Cooloola sedgefrog is typically more abundant around perched lakes with emergent sedges and reeds (Ehmann, 1997; Meyer *et al.* 2006). The lakes in which *L. cooloolensis* breeds are typically oligotrophic and acidic (pH<5.5). (Ehmann, 1997; James 1996; Meyer 2004; Meyer *et al.* 2006). As with the wallum sedgefrog, there are a small number of records of Cooloola sedgefrogs breeding in disturbed habitat and have also been recorded from dams within disturbed habitat, though, whether these sites provide suitable breeding habitat is unknown (Meyer *et al.* 2006).

The Cooloola sedgefrog is known only from Fraser Island and the Cooloola sandmasses, with a disjunct population on North Stradbroke Island (Hines *et al.* 1999; Meyer *et al.* 2006). On North Stradbroke Island, most sites are on leased or unallocated state land (Meyer *et al.* 2006). Monitoring suggests that populations on leased land are stable, though numbers are known to have declined dramatically following the introduction of the *Gambusia holbrooki* in 2002 (Neilson 2000; E. Meyer unpub. data; in Meyer *et al.* 2006). Site records include Brown Lake; Blue Lake, Ibis Central and Ibis West Lagoons within mining leases, Duck Lagoon, Native Companion Lagoon, Welsby Lagoon, Shag Lagoon, Tortoise Lagoon, Lake Kounpee, Lake Yarraman, Spanner Lake, Swallow Lagoon, Eighteen Mile Swamp, Yarraman Swamp, Flinders Swamp, Kounpee Swamp and Creaking Tree Swamp (Ingram and Corben 1975; Neilson 2000; Queensland Museum 2008; Meyer *et al.* 2006; EPA 2008b).

The Moreton Bay Area (including Bribie, Moreton and North Stradbroke Islands) provides important habitat for all three wallum-dependent acid frog species. Given the extent of wallum habitat within Moreton Bay, the study area is likely to support significantly more than 1% of the total population of each of these species (E. Meyer, pers. comm. 2008). In the case of the wallum sedgefrog, this figure could well exceed 10% (E. Meyer, pers. comm. 2008). However, specific data to support the Nomination Criteria have not been collected.

Given the importance of the Moreton Bay Area for acid frogs, the loss of habitat (in particular that of the wallum sedgefrog) should not exceed 5% of the area occupied by these species. In addition, water quality within areas of suitable habitat must be maintained at current levels (or better). Of particular importance in this regard is the maintenance of acidic and oligotrophic conditions in areas of breeding habitat (i.e., wallum swamps and lakes). Wallum swamp and lake waters should therefore remain acidic (within the pH range 3-5) while nitrate levels should not exceed 0.7 mg/L (E. Meyer, pers. comm. 2008). Levels of other toxicants including monomeric Aluminium and surfactants must also remain low. Also important, in terms of habitat suitability, is the maintenance of parapatry between acid frog and congeneric sibling species (i.e., the beeping froglet *Crinia parinsignifera*, common sedgefrog *Litoria fallax* and striped rocketfrog *Litoria nasuta*) in undisturbed wallum habitat.

**Beach Stone-Curlew**

Beach stone-curlew *Esacus neglectus* is listed as *Vulnerable* under the provisions of the NCA.

Beach stone-curlews occur exclusively within coastal environments using a variety of sheltered and open beaches (sandy, muddy or rocky), often around mouths of rivers and beaches associated with mangroves (Marchant and Higgins 1993). Beach stone-curlews forage within exposed intertidal areas and feed predominately on crabs and other marine invertebrates (Clancy 1986; Marchant and Higgins 1993).

Beach stone-curlews characteristically roost amongst mangroves, grassy treed areas within foredunes, or where there is suitable vegetation cover above the high tide mark (Clancy 1986; Geering *et al.* 2007). Nest sites are typically located landward side of sandy beaches, often within low foredunes in the same area year after year (September to November) (Marchant and Higgins 1993). This species is mainly nocturnal or crepuscular[9] and adult birds appear to be sedentary (Marchant and Higgins 1993; Geering *et al.* 2007). Beach stone-curlews feed predominately on crabs and other marine invertebrates in the intertidal zone (Clancy 1986; Marchant and Higgins 1993).

Beach stone-curlews are distributed along coastal environments throughout Eastern and Northern Australia, from the Manning River in New South Wales to Onslow in Western Australia (Marchant and Higgins 1993). The species was considered to be ‘not common’ on North Stradbroke Island by Vernon and Martin (1975) and more recently, rare in Moreton Bay and restricted mainly to outer islands with extensive areas of mangroves or long sandy beaches (Agnew and Stewart 1998).

The main localities for beach stone-curlew within the study area include Bribie, Moreton and North Stradbroke Islands (EPA 2008b). Other site records derive from Fisherman Islands, Peel Island, Southport Spit, South Stradbroke Island, and Pumicestone Passage (GCCC 2008; EPA 2008b).

Whilst beach stone-curlews can still be found in coastal locations where human activity is relatively high, the lack of young birds in such areas suggests that reproduction is being affected by human disturbance (Freeman 2003). Breeding success may also be significantly reduced from predation by cats, dogs and feral pigs and disturbance resulting form recreation activities (e.g. beach-combing,

[9] Active at dawn and/or dusk

dog-walking, boating and 4WD vehicles (Roberts 1957; Garnett 1992; Marchant and Higgins 1993; Garnett and Crowley 2000).

**Water Mouse**

The water mouse *Xeromys myoides* is listed as *Vulnerable* under the provisions of the NCA and EPBC Act (where it is listed as false water rat).

The water mouse has been recorded in coastal saltmarsh, mangrove and adjacent freshwater wetland habitats in the Queensland, Northern Territory and New Guinea. In Queensland, the water mouse has been recorded on the mainland from the Proserpine region, at Mackay, an area south of Gladstone, and from south-east Queensland between Hervey Bay and the Coomera River (50km south-east of Brisbane) (EPA 2008b). Non-mainland sites include Fraser Island, Bribie Island, North Stradbroke Island and South Stradbroke Island (EPA 2008b).

The species has been recorded in various coastal and freshwater vegetation assemblages. In southeast Queensland (including Moreton Bay), these include sedgeland (an often well defined zone to about 1m and composed mainly *Juncus* and *Baumea* spp.), chenopod shrubland (including succulents and dwarf shrubs growing on soils that dry out and crack between inundations), *Sporobolus virginicus* grassland (marine couch meadows found closest to the extreme high water spring tide mark and associated with freshwater drainage), and mangrove communities (with variation in structural type and complexity and comprising of one or more mangrove species) (Van Dyck and Gynther 2003; EPA 2008b).

The water mouse is likely to require relatively large areas of intertidal flats where it forages by following tidal waters to the low water mark and forage until advancing waters inundate the mangrove community (Van Dyck 1997). The diet of the water mouse largely comprises marine intertidal crustaceans, pulmonate snails, marine gastropods and other invertebrates (Van Dyck 1997; Gynther and Janetzki 2008).

The water mouse is probably entirely nocturnal, sheltering during the day and between tidal cycles in constructed nesting mounds adjacent to foraging habitat. Nesting structures recorded in south-east Queensland include:

- free-standing termitarium-like mounds (often in sedgeland and *Sporobolus* grassland, though also in mangroves),
- excavated nests within supralittoral banks (often built amongst peat and roots in bank), and
- mounds built against tree bases (often surrounding a natural cavity within living or dead trees and within the mangrove zone or at/near marine/terrestrial boundary) (Van Dyck and Gynther 2003).

Nests often occupy naturally elevated ground and utilise the bases of fallen trees or logs for consolidation of the nest structure (Van Dyck 1997; Van Dyck and Durbidge 1992; Van Dyck and Gynther 2003). Once constructed, nests are continuously added to, with the larger mounds or nests having potential to provide significant historical information about populations and habitats over time (Van Dyck 1997).

EPA (2008b) identifies that in south-east Queensland, high density water mouse populations occur within the Great Sandy Strait (including Tin Can Bay), Pumicestone Passage and southern Moreton Bay (including the western shores of North and South Stradbroke Islands). A large percentage of the water mouse population in the Moreton Bay area occurs in intertidal habitats within the Moreton Bay Ramsar site (EPA 2008b). Within Moreton Bay, the species has been recorded at the following locations: Pumicestone Passage (Gallagher Point, White Patch, Bukllock Creek CP, Donnybrook), North Stradbroke Island (Amity, Chiggil Chiggil, Rainbow Channel, Canalpin Creek, Myora Springs, Two Mile, Deanbilla, Stockyard), Steiglitz, Jacobs Well, Pimpama River Conservation Area, Coomera River, South Stradbroke Island (Van Dyck 1997; Van Dyck and Gynther 2003; GCCC 2008; EPA 2008b). Habitats along the western side of North Stradbroke Island and those within the southern part of the bay (Macleay Island to Coomera) appears to be a stronghold for the water mouse.

The water mouse is a relatively recent discovery to science, so no known reduction in historical range can be accurately compared to current distribution estimates (EPA 2008b). It is highly probable that Moreton Bay supports in excess of 1% of the population of Water Mouse (I. Gynther, pers. comm.. 2008).

**Australian Painted Snipe**

Australian painted snipe *Rostratula australis* is listed as *Vulnerable* under the provisions of the NCA and EPBC Act.

The Australian painted snipe is a secretive, crepuscular species that occurs on well vegetated shallow, permanent or seasonal wetlands, usually freshwater but occasionally brackish (Marchant and Higgins 1993; Geering *et al.* 2007). This species is has also been recorded in the following habitats: inundated grasslands, saltmarsh, dams, rice crops, sewage farms and bore drains (Marchant and Higgins 1993; Geering *et al.* 2007). Australian painted snipes require dense vegetation cover for roosts (often tall grass) and forage on soft muds and in shallow water for seeds and invertebrates, including crustaceans and molluscs invertebrates (Marchant and Higgins 1993; Geering *et al.* 2007). Occurrence is erratic and unpredictable (often in response to local rainfall), seldom remaining long in any locality (Marchant and Higgins 1993; Geering *et al.* 2007).

Australian painted snipes have a patchy distribution throughout Australia, with most records being in the south-east (Marchant and Higgins 1993) and within its range, inland swamps with temporary water regimes are considered a stronghold (Geering *et al.* 2007). Records are erratic, the species being absent from areas in some years and common in others. Nests are located on the ground in swamps and grassland and nesting in Queensland mainly occurs during and after the wet season, e.g. December to May (Marchant and Higgins 1993; R. Jaensch, pers. comm..2008). A breeding stronghold occurs within the Murray-Darling region, though breeding recorded throughout eastern and northern Australia (Marchant and Higgins 1993; Geering *et al.* 2007).

Within the study area, this species has been recorded from North Stradbroke Island and mainly freshwater and brackish wetlands (e.g. Eighteen Mile Swamp - Vernon and Martin 1975; Black Snake Lagoon - Lewis Environmental Consultants 1995; Lytton, Luggage Point and Nudgee wetlands EPA 2008b).

**Little Tern**

The little tern *Sterna albifrons* is listed as *Endangered* under the provisions of the NCA.

Little terns inhabit sheltered coastal environments of estuaries, river mouths, inlets and harbours, particularly those which support sand spits and exposed sandbanks (Higgins and Davies 1996). Little terns feed singly or in small groups on fish taken from the water surface, although often roosting in large flocks on beaches or sand spits with other terns (Smith 1990; Higgins and Davies 1996). Nesting is colonial (often traditional sites) with preferred nesting habitat characterised by sandy substrate on flat or gently sloping topography, usually within 150m of water, preferably between the high tide mark and littoral vegetation (Smith 1990; Higgins and Davies 1996). An abundance of shells, small pebbles & sparse clumping vegetation cover may be critical factors in breeding success (Smith 1990).

Internationally, the little tern has a wide but patchy distribution in Europe, Africa, Asia and Australia (Higgins and Davies 1996). The subspecies *Sterna albifrons sinensis* (Little Tern (western Pacific)) is the only form of the species that occurs in Australia (TSSC 2007). There appears to be three separate populations of subspecies *sinensis* in Australia: a Northern Australian population (it is unclear whether the breeding birds are sedentary, migratory or both); an Asian population (non-breeding spring-summer migrants to Australia); and a South-eastern Australian population (spring-summer breeding migrants to southern Australia, including south-eastern Queensland (north to Bundaberg)) (NSW NPWS 2003; TSSC 2007). The small size of the south-east Australian breeding population is likely to be masked by the presence of relatively large numbers of migrants from breeding sites in Asia in summer (Garnett 1992).

At least two populations are likely to occur in south-east Queensland (both Asian and Australian breeding populations), though birds can not be distinguished from each other (Agnew and Stewart 1998). Within inshore and offshore waters of North Stradbroke Island, little terns were considered a common summer migrant, being most numerous March to May (Smyth and Corben 1984). Within Moreton Bay, little terns are considered common, particularly in summer when migrant birds are present (Agnew and Stewart 1998).

The south-eastern Australia breeding population is estimated to be around 1,000 breeding birds, and based on 1998 data, 62 birds bred in Queensland (TSSC 2007). Garnett and Crowley (2000) reported 40 known breeding colonies in Queensland, though only 27 known to have been used recently.

Significant counts of little terns have been recorded in the northernmost section of Pumicestone Passage. On sandbanks near the Caloundra bar, counts of greater than 11,000 birds, principally *Sterna albifrons sinensis*, have been recorded (Chan and Dening 2007). The north-eastern beaches and sand spit of the South Stradbroke Island are also support important roost sites (Sonnenburg 2006; Searle 2006).

**Australasian Bittern**

Australasian bittern *Botaurus poiciloptilus* is listed as is listed as *Endangered* (IUCN 2007).

The Australasian bittern inhabits terrestrial and estuarine wetlands, though preferring permanent freshwater wetlands which support a combination of tall, dense vegetation (e.g. bullrushes *Typha* spp. and spikerushes (*Eloacharis* spp.) and short dense vegetation including sedges, rushes and reeds (Marchant and Higgins 1990; Garnett and Crowley 2000). This shy and cryptic bird, roosts, feeds and breeds within dense vegetation cover (Marchant and Higgins 1990). Garnett and Crowley (2000) considered that their comparatively specialised habitat requirements, this species may be more sensitive to overall habitat loss than are many wetland species.

The Australian population is estimated to be around 2,500 birds, most of which are in the Murray Darling basin and adjacent coastal areas (Garnett and Crowley 2000; IUCN 2007). Whilst there are no current records for the site, birds may possibly occur within large densely vegetated wallum swamps of Moreton and North Stradbroke Islands which appear potentially suitable. The combination of the species' cryptic habits and the difficulty of accessing and surveying favoured habitats means that this species is may have been overlooked by general fauna surveys of potential habitat.

Table 7-14 outlines a summary of the key attributes of the critical service.

**Table 7-14 Critical Service 4**

| Summary Table | Critical Service (S4) |
|---|---|
| Reason for Inclusion | Key services provided by the site in regards to threatened fauna comply with the Ramsar Nomination Criteria 2, in that the site supports endangered and vulnerable fauna, Criteria 4, in respect to support for animal species at critical life stages in their life cycles. |
| Type of Service | Supporting – threatened fauna species. |
| Description of Service (quantify if possible) | The site supports records of, and habitat suitable for, nine threatened wetland-dependant terrestrial fauna as outlined in the text. A tenth species, the Australasian bittern has not been recorded currently but may utilise the site due to suitable habitat. |
| Spatial Application (if relevant) | This service applies to the whole site, though important localities and habitats are the outer sand islands (Bribie, Moreton and North Stradbroke Islands), estuarine environments of Pumicestone Passage and southern Moreton Bay, and inshore waters. Refer to species accounts for important localities. |
| Critical habitat components underpinning this service | • Mangrove forests and associated intertidal areas (Illidge's ant blue butterfly, beach stone-curlew and water mouse)<br>• Freshwater and wallum wetland habitats (acid frogs, water mouse, Australasian bittern and Australian painted snipe)<br>• Nearshore and offshore open waters and rivers (little tern)<br>• Supralittoral wetlands, including salt marsh and sedgelands (water mouse and Australian painted snipe) and adjacent forest (Illidge's ant blue butterfly and beach stone-curlew)<br>• High tide roost sites, including open beaches (beach stone-curlew and little tern). |
| Critical species underpinning this service | Food - crustaceans and molluscs invertebrates of freshwater/brackish wetlands (Australian Painted Snipe), invertebrates of freshwater wetlands (acid frogs), intertidal crustaceans, pulmonate snails, marine gastropods and other invertebrates (water mouse, beach stone-curlew), nectar of flowers, including mangroves, eucalypts, *Parsonsia* spp. (Illidge's ant blue butterfly), small surface active schooling fish (little tern).<br><br>Habitat - mangroves supporting *Crematogaster* sp. Ant (Illidge's ant blue butterfly); shallow wallum wetlands (permanent or ephemeral) which support highly acidic, non-turbid, oligotrophic waters (acid frogs); shallow wallum wetlands with emergent macrophytes (wallum sedgefrog); broad intertidal areas within mangrove forests (beach stone-curlew, water mouse); and densely vegetated wetlands (Australian painted snipe). |
| Critical processes underpinning this service | Maintaining the service over time is most dependant on the following:<br>• Water Quality. In regards to all three wallum-dependent acid frog species - maintenance of water quality of island wetlands (esp. pH, nutrients and dissolved oxygen). In regards to little tern - maintenance of water quality (light, salinity, turbidity, suspended solids, nutrients).<br>• Hydrology (freshwater wetlands). In regards to all three wallum-dependent acid frog species - maintenance of the water table (water depth and groundwater interaction in lakes, swamps and creeks) and groundwater interactions with surface water. "Perched" wetland systems are dependent of direct rainfall recharge and sub-surface infiltration from surrounding dunal systems. |

| **Summary Table** | **Critical Service (S4)** |
|---|---|
| | • Hydrology (tidally influenced wetlands). In regards to beach stone-curlew and water mouse – maintenance of natural patterns of tidal inundation and freshwater flows to intertidal and supralittoral wetland systems.<br>• Climate. In regards to all three wallum-dependent acid frog species - precipitation and evaporation rates will determine supply and water levels in terrestrial wetland environments. The level of rainfall is important in terms of the high dune system supply which subsequently links into the permanent lakes and swamps.<br>• Fire Regime. In regards to all wallum-dependent acid frog species - natural fire regime in relation to island wetlands is maintained.<br>• Biological/Biophysical Processes. In regards to Illidge's ant blue butterfly, all three wallum-dependent acid frog species, beach stone-curlew, Australian painted snipe and water mouse - maintenance natural vegetation patterns, extent, health, and interconnectivity is critical to their long term condition. In regards to all threatened taxa - maintenance of key biological processes occurring at the site such as growth, reproduction, recruitment, feeding and predation. |
| Natural Variability (if relevant) | Patterns in abundances of all fauna species are thought to vary across a range of spatial and temporal scales. There are significant constraints to assessment of Illidge's ant blue butterfly, Australian painted snipe and water mouse due to their highly cryptic nature. Potentially the most detailed data set relates to migratory shorebirds, though such data is not currently in a form which enables detailed analysis. Population data for the remaining species is not comprehensive. |
| Principal threats | Habitat loss, fragmentation and degradation due to development (all species), water quality degradation (all species), changes to freshwater inflows to wallum wetlands (acid frogs), groundwater extraction (acid frogs, Australasian bittern, and Australian painted snipe). |
| Data quality underpinning this critical service | Service – Level 2-3 (population survey data outdated, insufficient scale).<br>Components – Level 2 (outdated, insufficient scale).<br>Processes – Level 1-2 (water quality); 2 (freshwater flows); 2 (tidal data). |
| Information gaps | • Natural population variability for all species and factors controlling these changes.<br>• Sustainability of beach stone-curlew pairs (and breeding success) (particularly related to impacts of recreational activities) and water mouse populations (in relation to development or degradation of habitat adjoining the site).<br>• Extent of populations of acid frogs and water mouse outside/adjoining study area boundaries.<br>• Systematic information to assess background variability in wetland community structure and linkages to controlling processes; environmental flow requirements of acid frogs; impacts of introduced species (acid frogs, beach stone-curlew, little tern) and congeneric competitors (to acid frogs).<br>• Locations and sustainability of little tern nesting sites (primarily in southern parts of site). Longer-term variability in patterns of usage of little tern roost sites. |
| Recommended monitoring | Acid frogs - Identify key populations and for those populations, monitor presence/absence, breeding evidence (tadpoles and metamorphs), and maintenance of parapatry between acid frog and congeneric sibling species during optimum breeding conditions until markers/trends of population variability are evident. Quarterly monitor water quality for key population sites (salinity, pH range 3-5, dissolved oxygen, nitrate levels (maintain <0.7 mg/L) and other toxicants (e.g. monomeric Aluminium and surfactants)). Assess impacts of fire on habitat of key frog populations from fires.<br>Beach stone-curlew – Monitor habitat usage and breeding activity within key habitat areas (annual).<br>Little tern – Identify locations and sustainability of nesting sites (primarily in southern parts of site) (yearly). Monitor abundance and pattern of usage at key roosts within northern Pumicestone Passage and northern sector of South Stradbroke Island (annual).<br>Water mouse – Identify full extent habitat within and outside the site and monitor nest activity and diversity of nest types as surrogate for species distribution and abundance (annual and during breeding period). |

## 7.5 Service 5 ~ Wetland Flora Communities and Species

Photos of Swamp Orchid (© Shane Ruming), Freshwater wetland North Stradbroke Island (Source: BMT WBM Photo Library) and Lesser Swamp Orchid (© Shane Ruming)

The Moreton Bay Ramsar site supports a diverse array of vegetation communities. While none of the wetland communities present within the site are listed nationally, one and four wetland RE's present are listed at the State-level as Endangered and Of Concern respectively (EPA 2007c, 2008a; refer Table 7-15). The Endangered wetland RE is riverine gallery rainforest (RE 12.3.1), and is represented in Bribie Island National Park. One Of Concern wetland RE is estuarine open forest (RE 12.1.1), and is represented in Bribie Island National Park and in the southern Bay. The three remaining Of Concern RE's are all palustrine in nature, including two open forest wetlands (RE's 12.3.4 and 12.3.11) and one sedgeland swamp (RE 12.3.8). These wetlands are predominantly located on the Bay islands.

Numerous endangered and vulnerable flora species are known to occur within Moreton Bay; including five nationally-listed species that are wetland-dependent (refer Table 7-16). Particularly noteworthy species include the endangered swamp daisy (*Olearia hygrophila*) that is endemic to North Stradbroke Island, known only from two locations on the island; and three endangered swamp orchid species (*Phaius australis, P. bernaysii* and *P. tancarvilleae*) that are rarely seen on the mainland but are more frequently encountered on the Bay islands (SGAP 2005).

Categories of critical processes underlying this service were identified as hydrologic (tidal regime; freshwater inundation regime; groundwater), geomorphologic (age of the underlying sand deposits; sedimentation; erosion) and biologic (reproduction). Variations in processes within these three categories have the potential to substantially alter the flora of Moreton Bay. For example, hydrologic changes such as variation in water quality may impact flora species that are sensitive to nutrient levels, and changes in the depth of the water table may significantly impact the survival of wetland flora; geomorphologic changes may impact flora communities due to changes in substrates; and changes to reproductive processes may significantly impact the persistence of species over time.

Currently, flora communities and species of conservation significance are under threat from a range of processes, principally invasion by exotic weed species and changes to hydrology and water quality. Additional threats on a more localised scale include damage to vegetation by feral animals such as pigs and goats, inappropriate fire regimes and destruction of plants by recreational activities (QPWS 2007).

Knowledge of the biology and ecology of important plant species, such as *O. hygrophila*, is extremely limited (Bostock and Thomas 1992). In particular, research has neglected, been unable to definitively address groundwater dependencies for communities and species in Moreton Bay, or understand species tolerance to salinity and desiccation (refer Marshall et. al. 2006 in relation to recent studies of groundwater dependant ecosystems on North Stradbroke Island).

Quantifying specific limits of acceptable change should - at a minimum - aim to maintain the biodiversity and integrity of natural ecosystems, and ensure that Endangered and Vulnerable flora communities and species within the site persist into the future. Further, species of significance should maintain their current conservation status (i.e. not be upgraded from Rare to Vulnerable, Vulnerable to Endangered, Endangered to Critically Endangered). In order to more precisely quantify limits of acceptable change through the estimation of thresholds, it is necessary to address various shortcomings in the current knowledge. This includes conducting systematic flora surveys and mapping significant flora. This would assist in specifying acceptable percentages regarding reductions in spatial extent for vegetation communities or in population numbers for flora species. Additionally, systematic surveys and mapping would assist in prioritising targeted areas for conservation and management actions, as well as monitoring strategies. Research on aspects such as groundwater dependency, tolerance to desiccation and reproductive dynamics would enable the development of relatively accurate predictions of future extents of vegetation communities and viability of populations.

Table 7-17 contains a summary of the key attributes of this critical service.

**Table 7-15 Threatened wetland ecological communities occurring within the Moreton Bay Ramsar site**

| RE | Status* | Description | Protected areas |
|---|---|---|---|
| 12.3.1 | Endangered | Gallery rainforest (notophyll vine forest) on alluvial plains | Bribie Island NP |
| 12.1.1 | Of concern | *Casuarina glauca* (Swamp Oak) open forest on margins of marine clay plains; may also include *Melaleuca quinquenervia* (Broadleaved Paperbark) and/or mangroves | Bribie Island NP, Broadwater CP, Southern Moreton Bay Islands CP, Coombabah CP |
| 12.3.4 | Of concern | *Melaleuca quinquenervia, Eucalyptus robusta* (Swamp Mahogany) open forest on or near coastal alluvial plains | Bribie Island NP |
| 12.3.8 | Of concern | Freshwater swamps with *Cyperus* spp. and *Schoenoplectus* spp.; associated with floodplains | Moreton Island NP |
| 12.3.11 | Of concern | Open forest to woodland of *Eucalyptus siderophloia* (Grey Ironbark), *E. tereticornis* (Queensland Blue Gum) and *Corymbia intermedia* (Pink Bloodwood) on alluvial plains | Bribie Island NP |

*Conservation status under the *Vegetation Management Act 1999*

**Table 7-16 Nationally Endangered wetland flora species occurring within the Moreton Bay Ramsar site**

| Scientific name | Common name | EPBC* | NCA* |
|---|---|---|---|
| *Olearia hygrophila* | Swamp Daisy | E | E |
| *Persicaria elatior* | Knotweed | E | V |
| *Phaius australis* | Lesser Swamp Orchid | E | E |
| *Phaius bernaysii* | Yellow Swamp Orchid | E | E |
| *Phaius tancarvilleae* | Swamp Orchid | E | E |

*EPBC = *Environment Protection and Biodiversity Conservation Act 1999*

NCA = *Nature Conservation Act 1992*

E = Endangered

V = Vulnerable

**Table 7-17 Critical Service 5**

| **Summary Table** | **Critical Service (S5)** |
|---|---|
| Reason for Inclusion | • Supports Vulnerable or Endangered species (Criterion 2).<br>• Supports a plant species at a critical stage of its life cycle (Criterion 4). |
| Type of Service | Supporting |
| Description of Service (quantify if possible) | Supports one Endangered and four Of Concern wetland RE's, as well as five nationally Endangered wetland plant species. |
| Spatial Application (if relevant) | Applicable to various habitats across the site as a whole, but predominantly the Bay islands. |
| Critical habitat components underpinning this service | With respect to the Ramsar Wetland Types, the following are the key habitat types for the critical flora species and communities: intertidal forested wetlands (Type I), permanent streams and creeks (Type M), freshwater marshes and pools (Types Tp and Ts) and freshwater tree-dominated wetlands (Type Xf). |
| Critical species underpinning this service | *Acacia baueri* subs. *baueri, Maundia triglochinoides, Olearia hygrophila, Persicaria elatior, Phaius australis, Phaius bernaysii, Phaius tancarvillea* and *Thelypteris confluens*. |
| Critical processes underpinning this service | • Hydrologic: tidal regime, freshwater inundation regime, groundwater<br>• Geomorphologic: sedimentation, soil erosion<br>• Biologic: reproduction |
| Natural Variability (if relevant) | Communities and species will continue to exist under normal hydrological regimes, geomorphologic processes and climatic conditions. |
| Principal threats | • Weed invasion<br>• Changes to hydrology and water quality |
| Data quality underpinning this critical service | • Flora communities: Level 2, quantitative based on current RE mapping (EPA 2008a) and a range of general papers and studies.<br>• Flora species: Level 3, semi-quantitative based on online species searches (as opposed to systematic surveys) and a range of non-specific papers and studies. |
| Information gaps | • Systematic surveys of flora and mapping of significant species is lacking.<br>• Research to understand groundwater dependencies for communities and species is very limited.<br>• Research to identify species tolerance to salinity and desiccation is lacking. |
| Recommended monitoring | Systematic flora surveys would quantify the representation of wetland communities and species of conservation significance within the Ramsar site. This would assist in prioritising targeted areas for conservation and management actions, and in specifying limits of acceptable change more accurately (i.e. in terms of percentage area for RE's or population numbers for species). |

## 7.6 Service 6 ~ Shorebird Populations

Photos of various shorebird species (source: BMT WBM Photo Library)

The significance of Moreton Bay, including Pumicestone Passage, as a site of national and international significance for migratory shorebirds has been widely described (Thompson 1990a; Driscoll 1993; Watkins 1993; Hulsman *et al.* 1993; Driscoll 1997; Bamford and Watkins 2003; EPA 2005b; Geering *et al.* 2008; Bamford *et al.* 2008). Moreton Bay is also significant for a large waterbird population (Nichols and Maher 1999).

Moreton Bay supports a high abundance of shorebirds. During the summer months, Moreton Bay habitats support over 3500 resident and between 40,000 to 50,000 migratory shorebirds (Thompson 1990a; Driscoll 1993; Watkins 1993; Driscoll 1997; EPA 2005b). This equates to approximately 10% of maximum number of shorebirds migrating to Queensland over the summer period (Driscoll 1993; Watkins 1993; Driscoll 1997).

Moreton Bay also supports a high diversity of shorebirds. Ten resident and 32 migratory shorebird species are regularly recorded in Moreton Bay (Thomson 1990; EPA 2005b). Nationally, 18 species are considered resident, at least 36 migratory shorebird species are regularly recorded, and a further 21 are considered vagrant species (occasionally recorded-less than five records annually) in Australia (Priest *et al.* 2002; Birds Australia 2008).

Moreton Bay supports significant numbers of individual waterbird species, e.g. Eastern curlew *Numenius madagascariensis* (3000 to 5000 birds, approximating 20% percent of the species' population) and grey-tailed tattler *Tringa brevipes* (>10,000 birds, approximating 50% percent of the species' population) (Driscoll 1997; Finn *et al.* 2002; EPA 2005b). Bamford *et al.* (2008) considers Moreton Bay to be the third most significant site for Eastern curlew within the East Asian–Australasian Flyway.

Existing data demonstrates that the 1% species population threshold has been exceeded for the following species: bar-tailed godwit *Limosa lapponica*, whimbrel *Numenius phaeopus*, Eastern curlew *Numenius madagascariensis*, terek sandpiper *Xenus cinereus*, grey-tailed tattler *Heteroscelus brevipes*, curlew sandpiper *Calidris ferruginea,* pied oystercatcher *Haematopus longirostris*, Pacific golden plover *Pluvialis fulva*, and lesser sand plover *Charadrius mongolus* (Lane 1987; Thomson 1993; Driscoll 1997; Finn *et al.* 2002; QWSG 2008 unpublished data; Geering *et al.* 2007; Birds Australia 2008; Bamford *et al.* 2008).

In respect of migratory shorebirds, four main roost types and key habitat types have been identified (Thompson 1990a and 1992). These are:

- Open sandy islands or beaches – Moreton, Bribie and North Stradbroke Islands. Only two similar roosts known on, or adjacent to, the western side of Moreton Bay. These types of roosts are used by most species.

- Salt and clay pans - within and adjacent to mangrove communities. Birds may find cover under mangrove trees or shelter within clumps of samphire and sedge. These roosts are used by most species.

- Inland freshwater marshes - restricted to the western side of the Bay and used by some species at all stages of the tidal cycle.

- Mangroves - the preferred roosting sites for grey-tailed tattler, whimbrel, and terek sandpiper, though often used by other also used by others less frequently, e.g. curlew sandpiper and common greenshank *Calidris nebularia*.

112 roost sites have been identified in Moreton Bay, though only 15 are considered to be suitable roosts above the highest astronomical tide (HAT) (Lawler 1995; Miller 1997; Nichols and Maher 1999). A significant number of these roosts are considered threatened by development and by their definition beyond the boundary of the marine park (Nichols and Maher 1999; EPA 2005b). The largest roost sites occur at the Port of Brisbane and Manly Boat Harbour (adjacent to western side of Ramsar site), Mirapool on Moreton Island, and within Pumicestone Passage (i.e. Toorbul) (Driscoll 1997). In response to loss of more natural roost sites, there are a variety of sites where shorebirds are using artificial structures and substrates. Notable amongst these sites, are the purpose built roosts, i.e Kakadu Beach (Bribie Island), Empire Point (near Raby Bay) and at the Port of Brisbane (Fisherman Islands, Brisbane River mouth).

Shorebird feeding habitat varies throughout Moreton Bay, with the primary differences relate to intertidal substrate type, i.e. being predominately finer, muddier sediment associated with the western side of the bay in contrast to the sandier sediment along shores on the eastern side of the bay. Notable, though of limited extent, are smaller areas of coarse coral and rock rubble around the islands of central Moreton Bay (Mud, St. Helena and Green islands), Wellington Point and Redcliffe Peninsula These feeding substrate differences influence the relative numbers and shorebird species which occur throughout the bay (Driscoll 1997). Feeding substrates along the western side of the bay exhibit greater levels of variation as they are influenced to a greater extent by human influence (e.g. sewage outfalls, direct stormwater discharges, sediment, etc.) (Thomson 1990 and 1992; Driscoll 1997).

The expansive flats at the southern end of Moreton Island and the western side of North Stradbroke Island to Russell Island hold the highest concentrations of waders anywhere in the Bay (Driscoll 1997). Whilst areas of intertidal flats adjoining the outer islands are less common than those adjoining mainland areas, they are the preferred habitat of several species (e.g. Eastern curlew, bar-tailed godwit *Limosa lapponica*) and support a higher proportion of adult birds for some species (Thomson 1990b; Finn 2008).

Major feeding areas within the western side of the bay include: Pumicestone Passage (i.e. Tripcony Bight and between Donnybrook and Toorbul), Deception Bay, Hays Inlet and shoreline between Nudgee south to Redland Bay (Driscoll 1997). Within the southern part of the bay, feeding habitat is characterised by relatively narrow intertidal flats associated with an extensive network of channels and waders occur in much lower densities (Driscoll 1997).

Threats to shorebirds and their habitats in Moreton Bay include:

- Water pollution – includes any pollution (point and/or diffuse source) which might negatively impact on invertebrate prey populations, e.g. sediment inputs which can smother intertidal substrates, increases water turbidity leading to reductions in epibenthic algae and seagrass; organic nutrient inputs (e.g. sewage discharge, urban nutrient runoff) leading to eutrophication (resulting in excessive macro-algal growth) and alteration of intertidal invertebrate species composition; and episodic pollution events such as oil spills (particularly relevant to habitats adjacent to Brisbane River mouth). It should be noted that some polychaete worms and bivalve molluscs have benefited from nutrient enrichment, which in turn has provided food to support greater densities of curlew sandpiper and great knot, but other species such as grey-tailed tattler, which prefer to forage in areas of seagrass, have declined dramatically (e.g. Bramble Bay and Luggage Point; see Thomson 1993; Harding and Wilson 2008).

- Alterations to hydrodynamics – permanent changes to tidal regimes (current speed and direction) can impact on current velocity (increases and decreases) which in turn affect intertidal and roost habitats (through changes in erosion and deposition rates).

- Roost habitat loss – Whilst the form and location of many roost sites are subject to natural changes over time (e.g. Eastern banks), Moreton Bay has previously experienced an unquantified but considerable loss of habitat as a result development of the coastal zone (e.g. marina and canal developments, and reclamation for industrial lands) (EPA 2005b). Whilst a large proportion of roost sites are currently within protected land tenure, there are sites which occur on privately owned lands which are not subject to the same level of protection.

- Human associated disturbance – In southeast Queensland, management of anthropogenic disturbances is regarded as a key issue for shorebird conservation management, particularly at high tide roost sites (Nichols and Maher 1999). Shorebirds are particularly vulnerable to disturbance from direct impacts at nesting areas to indirect impacts on food sources and at roost sites, and activity can impact on shorebirds more than 200m away (Thompson 1992). Disturbance to shorebirds (generated human activity and by companion animals) can result from poor separation between coastal recreational activities and/or urban development and roost sites (e.g. Mirapool, Manly Boat Harbour). Disturbance to both migratory and resident shorebirds (roosting and breeding) can occur as a direct result of human activities, e.g. recreational activities such as 4WD vehicles on beaches (Moreton and North Stradbroke Islands) and boating around feeding and roost sites (e.g. Days gutter, Amity banks). For resident shorebirds, this disturbance and also lead to reduced breeding success through nest destruction or abandonment, or succumbing to predators associated with humans, such as dogs, black rats *Rattus rattus*, silver gulls *Larus novaehollandiae* or ravens *Corvus* spp. (Priest *et al.* 2002). Nests of a variety of resident shorebirds (e.g. pied oystercatcher and red-capped plover) are frequently disturbed by vehicles on ocean beaches in south-east Queensland (EPA 2005b). As many of these species occur at low densities in an essentially linear habitat, local extinctions could easily become regional ones (Garnett and Crowley 2000; EPA 2005b).

**Table 7-18 Critical Service 6**

| Summary Table | Critical Service (S6) |
|---|---|
| Reason for Inclusion | Key services provided by the site in regards to migratory shorebirds complies with Ramsar Nomination Criteria 3, 4 and 5 in regards to shorebird abundance and diversity, provision of over-wintering and flyway staging habitat, and Criteria 6, in regards to exceeding the 1% species population threshold for nine shorebird species. |
| Type of Service | Supporting – migratory shorebirds |
| Description of Service (quantify if possible) | The site supports:<br>• high shorebird diversity and represents almost 90% of the migratory shorebird species regularly occurring in Australia and approximately 55% shorebird species resident in Australia.<br>• high shorebird abundance with a variety of counts (individually &/or collectively) which provide evidence that in excess of 20,000 shorebirds occur within habitats of the site each year. Population counts for the site equate to approximately 10% of maximum number of shorebirds migrating to Queensland over the summer period.<br>• nine shorebird species (eight migratory and one resident species) for which the 1% species population threshold is exceeded.<br>• critical overwintering habitat and a flyway staging area (both northern and southern migration routes) for migratory shorebirds. |
| Spatial Application (if relevant) | Intertidal sand/mud flats, rocky shores and mangrove communities throughout the site, intertidal areas of coarse rubble associated with central bay islands (Mud, St. Helena and Green islands) and western shores (Wellington Point and Redcliffe Peninsula), high tide roost sites throughout the site (natural and artificial). |
| Critical habitat components underpinning this service | Expansive intertidal flats; a diversity of feeding substrates (e.g. soft muds and sands, substrates supporting seagrass, coral and rock rubble); and a diversity of disturbance-free high tide roost sites (e.g. above and below HAT, clay pans, saltmarsh, exposed sand banks, mangroves, rocky shores) which are spatially proximate to suitable feeding grounds. |
| Critical species underpinning this service | Food - A diversity and abundance of epi/infauna of the intertidal flats, e.g. polychaete worms, bivalve molluscs, and crustacea.<br>Habitat – Mangroves (roost sites and nutrient inputs to associated intertidal areas); seagrass associated with intertidal areas (preferred feeding habitat for Grey-tailed Tattler; often supports a richer prey base for shorebirds generally). |
| Critical processes underpinning this service | • Tidal influences - maintenance of natural patterns of tidal inundation. Tidal inundation influences intertidal feeding habitat characteristics, i.e. overall extent, bioproductivity and daily availability to shorebirds. Tidal and wave regimes influence the biophysical processes in the development and maintenance of feeding and roost habitats.<br>• Freshwater flow regimes – Pine, Brisbane, Pimpama and Coomera Rivers contribute the bulk of fluvial sediment to the western side of the bay. These sediments influence intertidal habitat suitability for shorebirds with comparatively higher influence on intertidal areas adjacent to and nearby river mouths.<br>• Biological Processes - Primary and secondary bioproductivity of seagrass, algae and micro- and macro-invertebrates within intertidal habitats are crucial processes in supporting adequate shorebird food requirements.<br>• Water quality – Required for maintenance of high primary and secondary bioproductivity on intertidal feeding areas. |
| Natural Variability (if relevant) | 76% of the shorebirds regularly occurring within the site are migratory, though a small proportion remains in the bay during the non-breeding period (austral winter). The populations of migratory species fluctuate seasonally and the reasons for such changes are not well understood. Fluctuations may be influenced by local factors and/or influenced by external factors (impacts to breeding habitat and sites essential for migration within the East Asian-Australasian Flyway).<br><br>Declines in shorebirds abundance and species composition have been recorded within the site (e.g. Fisherman Islands; Driscoll 1996 and 1998), though the sampling periods have been relatively short and do not provide conclusive evidence as to any particular factor, i.e. links to habitat loss and/or habitat alterations and/or an overall decline in the bay's shorebird population. Whilst local databases are data rich, data is not currently in a form which can be readily analysed. |
| Principal threats | • Water quality degradation – Point and/or diffuse source pollution which negatively impacts on epibenthic algae, seagrass, and invertebrate prey populations. This includes: sediment, organic nutrient inputs (e.g. sewage discharge, urban nutrient runoff), toxins (including persistent herbicides and biocides), and episodic pollution |

| Summary Table | Critical Service (S6) |
|---|---|
| | events such as oil spills.<br>• Alterations to hydrodynamics – Changes to tidal regimes (current velocity and direction) which influence changes in erosion and deposition patterns, particularly in relation to establishment and maintenance of intertidal habitats.<br>• Anthropogenic disturbances - Disturbance to shorebirds on feeding grounds and at roost sites generated human activity and companion animals.<br>• Roost habitat loss – Whilst a large proportion of roost sites are currently within protected land tenure, there are sites which occur on privately owned lands which are vulnerable and not subject to the same level of protection. In addition, there is an imperative to maintain a suitable geographic spread of a combination of non-HAT and HAT roost sites which are spatially proximate to suitable feeding grounds.<br>• External factors - Loss of roost and feeding habitat and birds within the Flyway. |
| Data quality underpinning this critical service | Service – Level 2-3 (potential inaccuracies in collected data, limited capacity to interrogate data).<br><br>Components – Level 2 (outdated, insufficient scale).<br><br>Processes – Level 1-2 (water quality); 2 (tidal data). |
| Information gaps | • Indices/trends for shorebird abundance and diversity over time, patterns of roost and feeding habitat usage.<br>• Natural population variability for all species and factors controlling these changes.<br>• The proportion of the site's shorebird population which is associated with feeding and roosting outside the Ramsar site boundary.<br>• Information on factors controlling temporal changes in seagrass, mangrove and saltmarsh.<br>• Information on natural population variability of invertebrate prey and factors controlling temporal changes.<br>• Current distribution and categorisation of roost habitats (e.g. size, level of disturbance, position in relation to HAT and feeding grounds) within and adjacent to study area boundaries.<br>• Data on shorebird numbers and changes in populations within other parts of the Flyway. |
| Recommended monitoring | • Early and late summer monitoring events at key roost sites and feeding grounds (to be conducted annually) to target bar-tailed godwit, Eastern curlew and Pacific golden plover (species which currently exceed the 1% threshold and which may provide useful surrogate for numbers of other shorebirds using the site and of habitat usage).<br>• Annual audit of roost sites (condition and use).<br>• Monitor habitat usage and breeding activity (annual) within key habitat areas on outer bay islands |

## 7.7 Service 7 ~ Fisheries

Photos sourced from BMT WBM Photo Library

The Moreton Bay Ramsar site supports high fisheries resource values, including:

- Provision of shelter and food resources for fish, crustaceans (crabs, prawns) and other shellfish (including oysters) of high commercial and recreational fisheries value;
- High value commercial and recreational fishing industries;
- Indigenous cultural values (noting that these values are addressed as part of Service 8 and are not addressed further below).

**Habitats**

The site supports a wide diversity of habitats utilised by species of direct fisheries values, including mangroves, saltmarsh, seagrass, unvegetated sand and mud flats, estuarine creeks, offshore channels and reef environments. In general terms, fisheries productivity of an estuary is thought to be a function of its geomorphic conditions, which is a function of the degree of infilling (e.g. Roy *et al*. 2001; Saintilan 2004). From an estuary geomorphology perspective, Moreton Bay is classified as a wave-dominated estuary that is comprised of four types of depositional environment or estuary zones (Rochford 1951; Roy *et al*. 2001):

- **Marine tidal delta**, which extends along the Eastern Bay. The geomorphology of this zone is dominated by wave action and is well flushed by marine waters. Structural habitat complexity is lower than found in fluvial delta environments in Western Moreton Bay, but nonetheless, this zone contains significant fish habitat resources in the form of seagrass beds (i.e. Amity Banks) and 'unvegetated' sandy banks;
- **Central mud basin**, which includes deeper areas between the marine tidal deltas of Eastern Moreton Bay, and fluvial delta environments of Western Moreton Bay. This zone is not well represented in the Ramsar site;
- **Fluvial delta**. The central western foreshore of Moreton Bay contains numerous fluvial deltas associated with the rivers and creek systems draining the Moreton Bay catchment. Southern Moreton Bay is dominated by fluvial deltas of the Logan, Coomera and Pimpama Rivers. Fluvial

delta zones typically contain the most complex physical settings and habitat types of the four estuary zones, including mud flats, mangroves, saltmarsh, seagrass, and creek channels;

- **Riverine channel and alluvial plain**. This zone is situated in areas where the alluvial plains are intersected by the river channel. This zone typically has limited structural habitat complexity, and has highly variable salinities that are a function of tidal flows and river discharges. This habitat zone type is not well represented within the Moreton Bay Ramsar site, the possible exception being upstream sections of the Coomera River.

At broad spatial scales (regional), the fluvial delta environments of Western and Southern Moreton Bay can be considered to represent structurally complex environments compared to other three estuary zones in the broader Moreton Bay region. These nearshore environments also have relatively high species richness of macroinvertebrates and fish compared to other environments in the Bay (e.g. Stephenson *et al.* 1970; Davie and Hooper 1998).

The western side of Moreton Bay contains a range of mangrove-lined creeks and rivers (and associated saltmarsh communities) of varying complexity and size, several of which are protected as Fish Habitat Areas. From north to south, the major tidal creeks and rivers within the site include Caboolture River, Burpengary Creek, Hays Inlet, Pine River, Cabbage Tree Creek, Nundah Creek, Nudgee Creek, Jubilee Creek, Brisbane River and Boggy Creek, Crab Creek, Tingalpa Creek, Eprapah Creek; Logan-Albert River; Pimpama River and Coomera River. By contrast, the sand islands that form the eastern edge of Moreton Bay do not contain rivers or major creek systems.

The mangroves, saltmarsh and tidal channels found on these fluvial delta environments and creek environments provide important fisheries habitat and foraging areas. For example, saltmarsh communities within the study site are inundated tidally during high water spring events, and are known from case-studies elsewhere to provide functional habitats and foraging areas for a range of fish (typically small-bodied non-commercial species) and nektobenthic crustaceans (including Penaeid prawns and non-commercial crab species) of indirect and direct fisheries value (e.g. Morton *et al.* 1987; Mousalli and Connolly 1998, Muzumder *et al.* 2006). Intertidal environments provide shelter and/or foraging areas for fish and nektobenthos during high tide, whereas adjacent sub-tidal creek channel environments provide low tide refugia and feeding areas (Crowley and Tibbetts in Tibbetts and Connolly 1998)[10].

Extensive seagrass meadows occur within the site. Within nearshore areas, the most extensive meadows occur (from north to south) at Pumicestone Passage, adjacent to Fisherman Islands south of the Brisbane River mouth, Wynnum, Cleveland, and shoal environments throughout southern Moreton Bay. These meadows are strongly influenced by light limitation due to turbidity (Abal and Dennison 1996; Abal *et al.*. 1998). Extensive seagrass beds also occur along the western edge of Moreton Island, most notably the Eastern Banks marine delta complex and around Peel Island.

Recent studies have examined the importance of mangroves, seagrasses and saltmarsh as autotrophic nutritional sources for fish in adjacent unvegetated environments (Melville and Connolly 2003, Guest and Connolly 2004, Melville and Connolly 2005). Despite being devoid of seagrass, Melville and Connolly (2003) demonstrated that organic matter, particularly from seagrasses, was important as the base of food webs for fish species of commercial significance on adjacent

[10] The authors also note however that conditions (possibly stochastic) encountered during movements may increase feeding opportunities and reduce predation rate.

unvegetated mudflats in Moreton Bay. Benthic microalgae also contributed a relatively high proportion of the nutrition of the species examined.

There are few empirical data describing the values of the Ramsar sites' reefs as a fisheries habitat. Advice from DPI Fisheries (Brad Zeller, pers. comm. 2008) indicates that several species of direct fisheries value utilise these reefs, most notably pink snapper at Peel Island.

**Hydraulic Habitats and Flows**

Flows of fresh water can have important effects on the physical and biological characteristics of estuaries and nearshore waters (Loneragan and Bunn 1999). River discharges provide nutrients and organic matter to estuaries, contributing to their high production (Loneragan and Bunn 1999).

It is known that many important life-history aspects of estuarine fish and crustaceans appear to be linked to flows (including migratory patterns, spawning, and movements of fish between different habitat types). However, globally, there is very little information on actual flow requirements of estuarine fish (Gillanders and Kingsford 1992; Loneragan and Bunn 1999; Connolly *et al.*. 2006).

Based on the analyses of commercial catch data and total flows in the Logan River estuary, Loneragan and Bunn (1999) demonstrated an increase in production of some fisheries with increased flow. They found that total (annual) flows explained 69% of total (annual) flathead catch in the estuary, and that this relationship was statistically significant. Loneragan and Bunn (1999) also found a positive link between freshwater discharge in the Logan River and fisheries production in the Logan River estuary, largely based on commercial catch data of prawns (bay, king, school, greasy, tiger and banana) and crabs (mud crabs and blue swimmer crabs). This is due, in part, to nutrients and organic matter being transported to the estuary during flows (Loneragan and Bunn 1999).

**Key Species**

Estuarine fish communities can show enormous variation over a range of spatial and temporal scales. This has been demonstrated even at small spatial and temporal scales for estuarine fish communities in the area (Stephenson 1980c; Sumpton and Greenwood 1990; Quinn 1992; Laegdsgaard and Johnson 1995; Tibbetts and Connolly 1998; Loneragan and Bunn 1999). Because of this, it is very difficult to make generalisations regarding the processes that control patterns in community structure.

Numerous estuarine fish species commonly occur in the site that are of value to commercial and/or recreational fishers, including but not limited to those listed in Table 7-19.

Key fish species of commercial and recreational significance within the site include snub-nosed garfish, river garfish, flat tailed mullet, sea mullet, fantail mullet, sand flathead, dusky flathead, tailor, spotted mackerel, golden lined whiting, eels, diver whiting, yellow finned bream and tarwhine. Numerous nektobenthic crustacean species of recreational and commercial interest also occur in the site, including banana, king, endeavour, tiger, school and greasy back prawns; mud, blue swimmer, red-spot, spanner and coral crabs; and Callianisidae shrimps. Other species of commercial significance include bait worms, squid, cuttlefish, rock oysters and beche-de-mer.

Fish and shellfish use different habitat types during different stages of their ontogenetic development (Table 7-19). Most require a combination of estuarine habitats to complete their life-cycle. For example, juvenile mullet are commonly found in freshwater reaches of tidal creeks and around shoals, whereas adults are typically more common in riverine channel habitats. Other species only occupy estuaries during their juvenile phase, such as king prawns, snapper and tarwhine, whereas other species, such as Australian bass, migrate from their primary freshwater habitat into the estuary to spawn. Species such as school prawns, luderick, yellowfin bream, flathead and whiting spend most of their life-cycle in estuaries, only moving to nearshore areas to spawn (Kailola *et al.*. 1993). These estuary residents are among the most important species from a commercial and/or recreational fisheries perspective.

Table 7-19 shows that important fisheries species commonly found within the Ramsar site are not found exclusively in any one habitat type during any part of their life-cycle. Rather, these species have relatively plastic habitat requirements, and are typically found in a variety of habitat types. Banana prawns were the only habitat specialists recorded in the study site, and are typically found in mangrove during their juvenile stages (Staples *et al.*. 1985). In general terms, most of the species listed in the table below spend their juvenile stages in shallow nearshore waters, particularly around seagrass and mangroves, whereas most species tend to spawn in inshore waters, particularly near the surf zone. Adults of most species tend to occur across a variety of habitats.

**Table 7-19 Key fisheries species present in the Moreton Bay Ramsar site, and their primary habitats at different stages of their life-cycle (Data: Kailola *et al.*. 1993)**

| Species | Estuary | | | | | Coastal/Oceanic | | |
|---|---|---|---|---|---|---|---|---|
| | Mangroves* | Seagrass* | Shoals* | Channels and Mud basin* | Freshwater* | Inshore* | Offshore | Reef/seawall* |
| **TELEOSTI** | | | | | | | | |
| Long-finned eel | | | | | Juv., Ad. | | Spw. | |
| Dusky flathead | Juv., Ad. | Spw.,Juv., Ad. | Spw., Juv., Ad., | Ad., Juv. | | Spw. | | |
| Sand whiting | Juv., Ad. | Juv., Ad. | Juv., Ad. | Juv., Ad. | | Spw. | Spw., Ad. | |
| Diver whiting | | Juv. Ad | | Ad. | | Spw. | | |
| Tailor | | Juv., Ad. | Juv., Ad. | Juv.,Ad. | | Spw., Juv., Ad. | | |
| Yellowfin bream | Juv., Ad. | Juv., Ad. | Juv., Ad. | | | Spw., Ad. | | Ad. |
| Mulloway | Ad. | Juv., Ad | Juv. Ad | Juv., Ad. | | Ad. Spw. | | |
| Luderick | Juv. Ad. | Juv. Ad. | Ad. | Ad. | | Ad. Spw. | Ad. | Ad. |
| Sea mullet | Juv. Ad. | Juv. | Juv. | Juv., Ad. | Juv. | Spw. | Spw. | |
| Flat-tail mullet | Juv. Ad. | Ad. | Ad. | Ad. | Spw. | Ad. | Ad. | |
| Tiger mullet | Juv. Ad. | Ad. | Ad. | Ad. | Spw. | Ad. | Ad. | |
| **CRUSTACEA** | | | | | | | | |
| Blue swimmer crab | Juv., Ad. | Juv., Ad. | Juv., Ad. | Ad. | | Ad., Spw. | Ad. | |
| Mud crab | Juv., Ad. | Juv. | Juv. | | | | Spw. | |
| King prawn | Juv. | Juv. | Juv. | Juv. | | Ad. | Ad., Spw. | |
| Greasyback prawn | Juv. | Juv. | Juv., Ad. | Juv., Ad. | | Spw. | | |
| School prawn | | Juv. | Juv., Ad. | Juv., Ad. | | | Spw. | |
| Banana prawn | Juv., Ad. | Ad. | Juv., Ad. | Ad. | | Ad., Spw | | |

Note: Juv. = Juvenile, Ad. = Adult, Spw. = Spawning; * denotes habitat type found in the Ramsar site

### Fishing Activities

Commercial fisheries in Moreton Bay include inshore and ocean beach net, otter and beam trawl, crab (pot), line and several collection based fisheries (i.e. bait worm, aquarium and development *beche-de-mer* collection). Commercial harvest methods occur within the Moreton Bay Ramsar site: gill, seine, fixed netting; beam trawling, otter trawling; line fishing; crab potting; pearl and rock oyster culture; and the above mentioned collection based fishing methods. Recreational fishing methods include line fishing; bait collecting; cast netting; crabbing; limited prawn netting and spear fishing. Limited charter (line) fishing occurs within the site, being mostly situated in offshore areas outside the site. Indigenous fishing is considered in Service 9 below.

Within the broader Moreton Bay Marine Park, commercial vessels landed approximately $24.1 million gross value of product (GVP) annually in the three year period ending 30 June 2006 (Environmental Protection Agency 2007). Over this same period, approximately 410 commercial fishing licenses were assessed annually in the Marine Park (Environmental Protection Agency 2007). Note that the Marine Park includes large areas outside the Ramsar site. Williams (2002) found that the total Moreton Bay catch represented ~12% of the State's total catch in the period 1988-2000.

Within the broad South East Queensland region, recreational fishing was reported to have generated $194 million in related expenditure annually in 2000-2001 (Environmental Protection Agency 2007). There are insufficient data to assess the current status of fish catch and effort with the site, and its impacts on fish stocks.

Access is a key control on fishing activities. The term access includes physical access constraints (which can vary over time in response to weather conditions, seasonal factors etc.), and regulatory constraints associated with fisheries management regulations (i.e. closed areas, seasonal closures, gear limitations etc.). Social factors also have a major influence on fishing activities, including disposable income, time constraints, holiday periods etc.

**Table 7-20 Critical Service 7**

| Summary Table | Critical Service (S7) |
|---|---|
| Reason for Inclusion | Meets Ramsar criteria 3, 4 and 8 |
| Type of Service | Supporting – Biodiversity and ecosystem functioning<br>Cultural – Indigenous cultural values and tourism<br>Provisioning – Food for indigenous, recreational and commercial fisheries |
| Description of Service (quantify if possible) | The site provides important habitat for species of direct economic significance, as well as regionally important fisheries. |
| Spatial Application (if relevant) | Whole of site. Most fish stocks do not reside exclusively within the site, hence factors external to the site are likely to control stock sizes. |
| Critical habitat components underpinning this service | Mangroves; Saltmarsh; Intertidal flats; Supratidal channels and flats; Seagrass and algal beds; Coral and Rocky Reefs; Shallow surf bars and banks; Open expanses of shallow oceanic waters |
| Critical species underpinning this service | Seagrass, mangroves, saltmarsh (habitats)<br>Harvested species including:<br>• Finfish - Bream, flathead, whiting, luderick, mullet, tailor, mackerel, sharks, baitfish, eels, and pink snapper<br>• Prawns - King, tiger, endeavour, banana, greasyback and school prawns<br>• Other decapod crustacea - Blue swimmer, mud, red spot, spanner and coral crabs and callianasid shrimp (yabbies)<br>• Others - Squid, cuttlefish, gastropods, rock oysters, bivalves and beche-de-mer. |
| Critical processes underpinning this service | Maintenance of biophysical habitat extent, diversity and interconnectivity<br>Maintenance of freshwater flow regimes<br>Maintenance of tidal and wave regimes that drives biophysical habitats patterns and |

| Summary Table | Critical Service (S7) |
|---|---|
| | processes<br><br>Maintenance of water quality conditions, particularly with respect to its influence on estuarine vegetation communities (i.e. seagrass, algae etc.) |
| Natural Variability (if relevant) | Patterns in fish and shellfish community structure may vary across a range of spatial and temporal scales. Fisheries productivity (catch) varies in response to this and other factors (i.e. regulations, weather conditions etc). |
| Principal threats | Over-harvesting<br><br>Incremental habitat loss due to human population growth<br><br>Water use and modifications to freshwater flow regimes<br><br>Water quality degradation<br><br>Lyngbya blooms |
| Data quality underpinning this critical service | Service – Level 3 (fish catch data)<br><br>Components – Level 2 (outdated, insufficient scale)<br><br>Processes – Level 1-2 (water quality); 2 (freshwater flows); 2 (tidal data) |
| Information gaps | Present-day and historical marine vegetation mapping done at relevant spatial scale (minimum 1:25,000) and temporal (at least every 5 years, preferably with analysis of seasonal changes);<br><br>Information on factors controlling temporal changes in seagrass, mangrove and saltmarsh;<br><br>Natural variability in fish and shellfish stocks, and factors controlling these changes;<br><br>Specific environmental flow requirements of estuarine vegetation and fisheries species;<br><br>Priority areas for habitat rehabilitation and possible offsets areas;<br><br>Sustainability of current recreational and commercial fisheries management practices<br><br>Values and functions of proposed no-take 'green zones' in the future Marine Park Zoning |
| Recommended monitoring | Fish stock monitoring based on DPI&F state-wide LTMP, CFISH (Commercial Fisheries Information System) and RFISH (Recreational Fishing Information System) programmes |

## 7.8 Service 8 ~ Indigenous Cultural Significance

BMT WBM commissioned Converge Heritage + Community Pty Ltd (previously trading as ARCHAEO Cultural Heritage Services Pty Ltd) to conduct a desktop assessment of indigenous cultural values associated with the Moreton Bay Ramsar areas. This assessment forms part of the ECD with the full report prepared by Converge Heritage + Community contained in Appendix C.

As identified in Section 3 of this report, Resolution IX.21 of the Ramsar Convention, entitled "Taking into account the cultural values of wetlands" was adopted at Ramsar's ninth conference. This important change to global policy statements of the Ramsar Convention provides a strong mandate for taking into consideration the indigenous cultural values of the Moreton Bay Ramsar areas in the current study.

The scope of the cultural heritage assessment undertaken as part of the ECD is limited to being desktop, and will be based only on documentation that is already in the public arena. Specifically, consultation with indigenous groups is not part of the scope. This assessment provides:

- Contextual information;
- A discussion of the relationship between indigenous groups and land;
- A summary of available information about cultural connections with Ramsar areas;
- Case studies that demonstrate that significant cultural values may be associated with Moreton Bay Ramsar areas;
- Available information on how cultural values are being sustained; and
- An assessment of the limits of acceptable change if cultural values in Ramsar areas are to be protected and managed.

As outlined in Section 3 (refer section on cultural resources) and Appendix C, while environmental, ethnographic and archaeological evidence may indicate the richness of the Moreton Bay environment during the past 6,000 or so years that would have been an important and sustaining resource for Aboriginal groups, these observations only give partial insights into the relationship between those Aboriginal groups and the land in which they lived and indeed continue to live. Often, the ethnographic reports provide a commentary on what the observer has found interesting, thus emphasizing a perspective that tends to focus on resources, rather than placing on the public record, an understanding of the complex cultural and social network that existed, and continues to exist amongst Aboriginal people of Southeast Queensland.

Approximately one third of Queensland's Aboriginal and Torres Strait Islander population lives in Southeast Queensland (South East Queensland Regional Plan 2005). Many of these people have moved to the region. As contemporary residents, these people are often referred to as "historically associated", and may be regarded as stakeholders in the region similar to the non-indigenous population. In contrast, those Aboriginal people who are descendants of ancestors who lived in Southeast Queensland before non-indigenous settlement identify as Traditional Owners. Each of these groups is an important stakeholder in the community of Southeast Queensland, but Traditional

Owners have additional and different aspirations to non-indigenous and historically associated indigenous stakeholders. Through their lineage, Traditional Owners inherit responsibilities under traditional law and custom to manage their land (often referred to as country), as well as a connection to country that is a cultural and spiritual relationship. This is best summed up in the words of Southeast Queensland's Traditional Owners:

> *As the current Aboriginal Traditional Owners in South East Queensland we have inherited a responsibility to look after our country. This responsibility has been handed to us by our ancestors, whose spirits continue to guide our decisions. We in turn have a responsibility to manage our country to the best of our abilities and to teach our youth the values and skills and provide them with the knowledge that they will need to manage our country with and after us….*
>
> *Cultural resources are all the tangible and intangible things in our land and sea country that are essential to our wellbeing: land, water, plants and animals (biodiversity), coastal and marine things, the air (atmosphere), and community. As Aboriginal people, we have such a deep and integral connection and set of relationships with these 'natural' elements that we consider them as cultural entities., Our identity as well as our cultural, spiritual and material wellbeing is entwined with the country and its health; without strong and healthy country, our people cannot be strong and healthy (SEQTOLSMA 2008: 8)*

In the absence of consultation as part of this ECD study, two important points should be made. Firstly, the statements of SEQTOLSMA would suggest that those Traditional Owners relevant to the Ramsar areas of Moreton Bay will have strong views on what will be considered their country or cultural resource, and will wish to take part in management decisions. Secondly, a further consideration is that the Traditional Owners relevant to Ramsar areas may have valuable historical knowledge of what these areas were like in the past, and what management strategies would be preferred. These points are best demonstrated through some case studies that are provided below:

*Case Study 1 – Blue Lake, North Stradbroke Island*

In 2007, consideration was given by the Queensland Government to the potential to harvest fresh water from aquifers on North Stradbroke Island for the water grid being developed across Southeast Queensland. Consultation was commenced with the Minjerribah Moorgumpin Elders in Council, the Aboriginal Cultural Heritage Body for North Stradbroke Island. During initial consultation, the Elders expressed deep concern about the project, as it potentially could impact directly on water levels in Blue Lake, a natural freshwater lake on the island. The Elders were particularly worried about such impacts because of the high levels of cultural significance associated with the lake. What constitutes the lake's cultural significance cannot be reported here, without consultation with and the permission of the Elders. Suffice to say that the Elders were extremely relieved when the project was abandoned because of general public concern.

This case study illuminates Traditional Owners' responsibilities and connection with country. Other people in the North Stradbroke community were concerned about the environmental impact of water harvesting on Blue Lake, a known and much appreciated natural part of the island. But the Traditional Owners' concerns were amplified by their cultural connection to the lake which is a significant Aboriginal area in the meaning of the *Aboriginal Cultural Heritage Act 2003* (ACH) Act.

*Case Study 2 – Traditional Hunting Guidelines*

An excellent example of on-going traditional responsibilities and customs working today is provided by the Quandamooka people.

*The Quandamooka people of the Moreton Bay area are continuing their ages old traditional hunting, which provides an important part of their diet. Working with the Queensland Environmental Protection Agency (EPA), the Quandamooka people have developed Traditional Hunting Guidelines to ensure that hunting practices are sustainable. With the new zoning plan in Moreton Bay Marine Park the Quandamooka people are looking to progress the Traditional Hunting Guidelines into a Traditional Use of Marine Resources Agreement (TUMRA) which will be the new best practice. Quandamooka people have demonstrated their commitment to making the Agreement work through six years of sound management since the establishment of the traditional Hunting Guidelines (SEQTOLSMA 2008: 13).*

*Case Study 3 – Native Title's Rights and Interests*

Whether or not native title is relevant from the perspective of land tenure in the Ramsar areas of Southeast Queensland is not a discussion for this assessment. Rather, the point being made is that the rights and interests detailed in the various native title claims in the Moreton Bay area give an indication of Traditional Owners' perspectives about their traditional responsibilities and rights. While the native title process may result in these claimed rights and interests only being relevant where native title has not been extinguished, from the Traditional Owners' perspectives, it is likely that they would prefer these rights and interests to be relevant in all of their country.

Consistent in the native title rights and interests claimed in all of the claim applications that cover parts of the Ramsar areas are the following themes:

- Access to enter and remain on lands and waters;
- Use and enjoy land and waters, including traditional hunting and gathering;
- Protection and management of the resources of lands and waters;
- Capacity to exercise customary rights and discharge traditional responsibilities;
- Recognition as Traditional Owners

The themes enunciated by the claimed rights and interests show that there is no differentiation between land and water – both are country – and all country requires protection and management.

*Case Study 4 – SEQTOLSMA*

The Moreton Bay region is home for a number of Traditional Owner groups as listed in Appendix C. These include the Kabi Kabi families, Jagera and Turrbal families, Quandamooka (Ngugi, Noonucle, Gorenpul) families, Yugambeh (eight groups) and Ngarang-Wal/Kombumeri families.

Other Traditional Owner groups include the Jinibara and Mulinjarlie families, but these groups are sub-coastal and may not necessarily have Ramsar areas in their traditional countries.

In 2005, representatives of all but two of these groups commenced negotiations about forming a body "to establish more comprehensive and meaningful Traditional Owner involvement and ownership in improving the condition of the region's natural resources", and "to promote more comprehensive and effective engagement of Traditional Owners in cultural (natural) resource management" (SEQTOLSMA 2008, p. iv). The outcome is the development of an on-going body of Traditional Owner representatives who have now developed a plan, called OUR PLAN, for the future (SEQTOLSMA 2008). Actions relevant to Ramsar areas that have been nominated by OUR PLAN include: the development of a Memorandum of Agreement with SEQ Catchments; developing alliances and partnerships at all levels of government and with the wider community; and becoming fully engaged in planning, decision-making and delivery of on-ground works (SEQTOLSMA 2008: 26).

The foundation of SEQTOLSMA is an important initiative that has the capacity to provide a central body with which consultation and management planning can be developed. SEQTOLSMA does not reduce the responsibilities of Traditional Owners, and recognizes that within the organization, certain Traditional Owners speak for parts (their country) of Southeast Queensland. In regard to the Ramsar areas of Moreton Bay, no one Traditional Owner will speak for them all; rather specific areas will be associated with certain groups, as shown discussed in Appendix C. In large part, this arrangement also reflects the requirements of the Queensland *Aboriginal Cultural Heritage Act 2003* in regard to cultural heritage decision-making by Aboriginal Parties.

Taking these arrangements into account, SEQTOLSMA offers an opportunity for the development of overarching management planning for Ramsar areas, with the additional capacity for relevant Traditional Owners to have input into those areas that are within their countries.

While there has been little to no assessment to date that is available in the public record about the indigenous cultural values of the Ramsar area in Moreton Bay, hints are provided by the initiatives detailed in the case studies above. These case studies also underline that the Traditional Owners of Southeast Queensland are continuing their traditional responsibilities.

In the absence of guidance from Traditional Owners on this matter, it is reasonable to predict the following:

- Each of the Ramsar areas (eg. areas within the broader site boundaries) will hold significant cultural values to the relevant Traditional Owner group/s. These values may include physical and non-physical cultural heritage areas and objects, oral knowledge, such as stories, animals and plants, and the natural environment itself;

- The values of each of the Ramsar areas may be different to the others, e.g., the environmental, spiritual and cultural nature of Pumicestone Passage may have been different to those of North Stradbroke Island, and thus require differences in traditional management;

- Traditional Owners are already taking an active role in managing Ramsar areas as part of their management of the wider Moreton Bay area, and that they will wish to increase this role if offered the opportunity; and

- The Traditional Owners have already formed an encompassing organization (SEQTOLSMA) which may prove to be a vehicle through which consultation and planning for the future could be organized. Only through consultation with the individual Traditional Owner groups could this be ascertained.

A summary table has not been prepared for this service based on the discussion outlined above. Further articulation of the values and cultural significance of the site are seen as only able to be set and measured through consultation with Traditional Owners. Limits of acceptable change will only become apparent, if indeed they do, after a detailed understanding about cultural values and how they are being sustained is achieved.

## 7.9 Service 9 ~ Research and Education

Boondall Bird Hide and field survey photos sourced from www.nudgeebheec.eq.edu.au
Field photo (far right) BMT WBM Photo Library

The size and accessibility of the Bay (being situated at the doorstep of a capital city) makes it an ideal resource for research and education activities.

The Bay and its flora and fauna have been, and continue to be, the subject of numerous scientific studies and investigations by leading academics in Australia and around the world. As demonstrated by this ECD, the Bay provides a wide range of issues and habitats for natural science and social science researchers and industry research activities.

Queensland University, CSIRO and the Department of Primary Industries and Fisheries have research stations in the Moreton Bay region (although situated outside the boundaries of the Ramsar site). Many other research institutions use Moreton Bay for research and education.

Major studies and investigations have been undertaken by the Queensland Environmental Protection Agency with respect to the coastal wetlands (as part of the SEQ Coastal Wetlands Study) in the region. A range of other studies have also been undertaken to support various plans and strategies such as survey and mapping of rocky intertidal areas, shorebird roosting sites, seagrass areas and offshore reef mapping.

In terms of recent research activities undertaken by State agencies, of particular note are the EPA's Queensland Turtle Conservation Project (see Limpus *et al.*. 2006), recent studies of groundwater ecosystems on the Bay islands by the Department of Natural Resources and Water (see Marshall *et al.*. 2006) and various research projects on Bay fisheries by the Department of Primary Industries and Fisheries.

Well-documented environmental impact studies of the Bay's habitats, fauna and hydrology provide an insight into the natural variability present within the systems of the Bay as well as their resilience to change. These documents build upon the significant knowledge provided by the research and scientific community, often augmenting these studies with the collection of data and analysis at more localised scales.

The wetlands of Moreton Bay are also an integral component of a number of environmental education facilities in the region. Some examples include the following:

- Boondall Wetlands lies on the western edge of Moreton Bay between Nudgee Beach, Boondall and Shorncliffe and includes more than 1000 hectares of tidal flats, mangroves, saltmarshes, melaleuca wetlands, grasslands, open forests and woodlands. Brisbane City Council manages and operates the Boondall Wetlands Environment Centre which offers a range of displays and activities on the environmental and cultural heritage of the reserve for park visitors and organised groups. The mangrove boardwalk at Wynnum North is also a significant educational resource.

- The Department of Education (Education Queensland) operates environmental education centres at Nudgee Beach, Moreton Bay (at Wynnum) and Jacobs Well for educating children on coastal and environmental matters. The Bay is an important environmental and historical education resource for these centres. The Environmental Protection Agency also has educational facilities on St Helena and Moreton Islands.

The third component of this service relates to environmental monitoring activities. Since 2000, the Healthy Waterways Partnership's Ecosystem Health Monitoring Program (EHMP) has undertaken monthly monitoring of over 250 estuarine and marine sites including sites throughout Moreton Bay. Data are collected for a range of water quality and biological parameters. The results of this monitoring are reported annually via the Ecosystem Health Report Card and Technical Report (EHMP 2007).

Monitoring being undertaken under the auspices of the EHMP is augmented by strong and long-standing volunteer monitoring programmes in Moreton Bay. Two examples include:

- *Wader Birds.* The Queensland Wader Study Group (QWSG) is a special interest group within Birds Queensland. It was formed to further research on both migratory and resident waders (shorebirds) in Queensland, and to work for their conservation. The QWSG undertakes regular counts of waders around Moreton Bay that provides a measure of the abundance of the birds and provides the long term population trend data used in planning and management.

- *Seagrass.* Seagrass Watch is an initiative that uses trained volunteers to help monitor seagrass meadows along the Queensland coast. Originally developed by the Queensland Department of Primary Industries and Fisheries, Seagrass Watch has now spread to neighbouring countries in Asia and the Pacific. Seagrass Watch has been operating for a number of years in the Bay, undertaken by conservation groups and their volunteers using funding from the Natural Heritage Trust (NHT) and other sources. There are current plans to extend this programme to also include Mangrove Watch and Saltmarsh Watch components.

Over the next five years, science priorities relating to Moreton Bay have been identified as part of the Healthy Waterways Strategy 2007-2012. These priorities are to:

- understand processes in receiving waters (freshwater, storages, estuaries and Moreton Bay);

- understand challenges specific to coastal and beach ecosystems (e.g. coastal algal blooms, population growth in coastal areas);

- understand movement, cycling and transformations of nutrients and toxicants and look at relative importance of inputs versus remobilisation to focus management actions;

- understand "cause and effect" relationships between management actions, Water Quality Objectives and Environmental Values; and

- understand climate change implications for water quality, ecosystem health, and efficacy of management actions.

While the maintenance of all the critical components and processes outlined above are important, those that underpin maintaining the diversity of wetland habitats present in the site and key representative habitats (Services 1 and 2), the maintenance of important species (Service 3,4,5) and the maintenance of significant shorebird populations (Service 6) are seen as most critical to supporting the research and education service outlined here.

**Table 7-21 Critical Service 9**

| Summary Table | Critical Service (S9) |
|---|---|
| Reason for Inclusion | Moreton Bay's location, condition and conservation significance make it a vitally important resource in the context of research and education. In addition to countless studies by the academic community, the Bay and its wetlands are important components of environmental education programmes and facilities in the Region and the subject of millions of dollars of funding from State and local government for environmental monitoring under EHMP over the past 8 years. |
| Type of Service | Cultural |
| Description of Service (quantify if possible) | Key aspects of this Service recognise the importance of the site for:<br>Research activities by universities, colleges and science organisations such as CSIRO<br>Environmental Education Facilities and Curricula (Boondall, Nudgee, etc)<br>Environmental Monitoring (EHMP and volunteer monitoring programmes by the Queensland Wader Study Group and community conservation groups). |
| Spatial Application (if relevant) | This service applies to the whole site. |
| Critical habitat components underpinning this service | While many habitats have been studied, research undertaken with respect to seagrass, mangroves and saltmarsh is especially noteworthy. |
| Critical species underpinning this service | While many species and habitats have been studied, the research undertaken on turtles and shorebirds in Moreton Bay is especially noteworthy. |
| Critical processes underpinning this service | Broad-Scale Processes as outlined in Critical Service 1 and Critical Service 2. |
| Natural Variability (if relevant) | Not Applicable. |
| Principal threats | Not Applicable. Moreton Bay has been an important site for research and education activities over the past 30 years and continues to be so.<br>The global and national emphasis on climate change and related impacts to coastal areas is seen as a driving force for research and education over the next 5 – 10 years and will likely dominate the focus of future studies involving the Bay and its resources. However it is expected that long term monitoring and research programmes relating to water quality, habitat quality and important species/populations in the Bay will continue. |
| Data quality underpinning this critical element | Not Applicable |
| Information gaps | A range of science priorities for Moreton Bay have been identified as part of the 2007-2012 Healthy Waterways Strategy (Moreton Bay Action Plan component). In addition to these priorities, the information gaps and monitoring recommendations of this ECD are seen as essential for monitoring the ecological character of the Ramsar site. |
| Recommended monitoring | No specific recommendations.<br>However, developing a system or database to record previous and current research and monitoring data related to key wetland assets of the site remains a priority. In particular, improved management of data from shorebird counts and surveys is a high priority. |

## 7.10 Service 10 ~ Tourism and Recreational Uses

Photos supplied from the EPA Photo Library

Tourism and recreation in Moreton Bay is largely built upon the attraction of the area's natural assets, with activities undertaken in the area being predominantly nature-based. No data are available on visitation to, and activities undertaken specifically within the Ramsar site, but a recent study estimates the annual visitation to Moreton Bay at 1,666,805, inclusive of domestic overnight and day-trip and international visitors (refer Table 7-22 below). The source of these visitors is 24% domestic overnight, 74% domestic day-trip and 2% international visitors, with the peak months of tourist activity in the school holiday periods of December/January, April and September. For the purposes of the ECD, it is acceptable to assume that the majority of visitors will use an area within the Ramsar boundary at some point during their visit, either undertaking activities or passing through the site.

**Table 7-22 Estimates for visitor arrivals using Bureau of Tourism Research (grouped for 1999-2002)**

| | Domestic Overnight* | Domestic Day-trip* | International Visitors* | Total Visitation* |
|---|---|---|---|---|
| Caboolture | 131,000 | 408,500 | 5,158 | 544,658 |
| Redcliffe | 33,000 | 268,500 | 5,217 | 306,717 |
| Brisbane | 75,250 | 236,250 | 17,823 | 329,323 |
| Redland | 158,750 | 318,250 | 11,257 | 488,257 |
| **Total Moreton Bay** | **397,000** | **1,231,000** | **38,805** | **1,666,805** |

*All figures are the average per year over 4 years.
Source: Adapted from Whitemore and De Lacy (2005). Note that the area covered is larger than the Moreton Bay Ramsar site.

The high percentage of visitation by domestic day-trip visitors indicates that most visitors are from the local region (Brisbane and SEQ generally) (Table 7-22). The proximity of the Moreton Bay Ramsar site to Brisbane signifies an important consideration for management of the site as the regional population continues to increase. It also denotes a significant economic contribution to the region, providing an estimated 18,000 jobs through tourism within Moreton Bay electorates[11] (Whitmore and De Lacy 2005), with 5,500 jobs within the Moreton Bay and islands area (EPA 2007a). Expenditure from visitation to the Moreton Bay and islands region is estimated at approximately $500 million annually (based on 2006 data; EPA 2007a).

While the wide variety of tourism and recreational activities undertaken within the Moreton Bay Ramsar site are predominantly nature-based, occurring in both terrestrial and aquatic environments, there are specific components and processes that impact on the quality of the experience, and which continue to attract visitors and return visitors to the region. Further, many activities are primarily

[11] Note this figure is for a larger area than the Moreton Bay Ramsar site.

undertaken in specific environments (e.g. four wheel driving on the eastern sandy beaches of Bribie, Moreton and North Stradbroke Islands, canoeing/kayaking in inshore areas) indicating that some ecosystem components and process may be more important for tourism and recreation in particular locations within the Ramsar site. Activities and supporting ecosystem components and processes are described in Table 7-23.

**Table 7-23 Underlying services, components and processes for the wetland service (tourism and recreation) in the Moreton Bay Ramsar site**

| Activity | Ecosystem Components | Ecosystem Processes |
|---|---|---|
| Boating / sailing / canoeing / kayaking | Pleasant weather conditions<br>Good water quality | Climate<br>Water quality |
| Diving / snorkeling | Good water quality<br>Pleasant weather conditions<br>Rich and diverse marine fauna<br>Healthy wetland habitats | Water quality<br>Climate<br>Flora / fauna<br>Biological maintenance |
| Recreational Spear fishing /<br>Line fishing | Abundant target fish species | Flora / fauna<br>Biological maintenance<br>Species interaction |
| Swimming / surfing / surf-lifesaving | Good water quality<br>Pleasant weather conditions | Water quality<br>Climate |
| Wildlife-watching | Rich and diverse wildlife<br>Near pristine wetland habitats | Climate<br>Biogeochemical and nutrient cycling<br>Water quality<br>Flora / fauna<br>Biological maintenance<br>Species interaction |
| Bush walking /<br>Camping / Picnics | Range of wetland types<br>Rich and diverse wildlife<br>Pleasant weather conditions<br>Near pristine wetland habitats<br>Cultural heritage items and places | Climate<br>Biogeochemical and nutrient cycling<br>Geomorphology<br>Water quality<br>Flora / fauna<br>Biological maintenance<br>Species interaction |
| Four wheel driving /<br>Sand toboganning | Pleasant weather conditions<br>Relevant wetland types (predominantly sandy beaches) | Climate<br>Geomorphology |

The high level of nature-based activities within the Moreton Bay Ramsar site is supported by the bulk of the site being situated within National Parks, Conservation Parks, Recreation Areas or Marine Park. These areas are managed under State legislation, and management and zoning plans which aim to conserve and manage the areas in a predominantly natural state.

Limits of acceptable change for tourism-related critical services are reported to "relate to thresholds that significantly reduce tourism economic activity" (e.g. loss of beaches, reduction in reef size, perceived adverse changes to 'eco-values') (Voice *et al.* 2006). That is, if tourism and recreational activities impact on other critical services (e.g. aquatic wetland fauna of conservation significance), the subsequent degradation or change in these critical services is likely to cause a change in tourism and recreation within the Ramsar site.

**Table 7-24 Critical Service 10**

| Summary Table | Critical Service (S10) |
|---|---|
| Reason for Inclusion | Uniqueness - diversity of activities and experiences in a range of locations, close to major city/capital city (e.g. “Moreton Bay is the only place in the world where you can see dugong within view of a city skyline.” (Whitmore and De Lacy 2005). |
| Type of Service | Cultural |
| Description of Service (quantify if possible) | Predominantly nature-based tourism and recreational activities undertaken in a range of wetland environments. The annual visitation to Moreton Bay is approximately 1,666,805. |
| Spatial Application (if relevant) | Whole Ramsar site, though certain activities are focused in specific environments within the site (e.g. four wheel driving on sandy beaches). |
| Critical habitat components underpinning this service | All – variety of activities undertaken in different environments.<br>Predominant habitats used are beaches, marine waters, estuarine waters, freshwater lakes, sand dunes and intertidal flats. |
| Critical species underpinning this service | Fauna - all, although predominately megafauna and wader birds.<br>Flora – all. |
| Critical processes underpinning this service | Refer Table 7-23. |
| Natural Variability (if relevant) | Limits of acceptable change for components and processes elsewhere in the ECD.<br>Combination of climate, maintenance of habitat quality, quality and supply of tourism/recreation product (e.g. supply, management of industry, disposable income, cost of activities) |
| Principal threats | Impacts from tourism and recreational activities to other critical services.<br>Subsequent impacts to tourism and recreational activities from degraded critical services. |
| Data quality underpinning this critical service | No reliable visitor statistics, including tourist expenditure and other economic contributions (Whitmore and De Lacy 2005).<br>Importance of Ramsar values to tourism and recreational experiences. |
| Information gaps | Reliable visitor statistics, including tourist expenditure and other economic contributions.<br>Carrying capacity of the Ramsar site for activities and locations.<br>The importance placed on the Ramsar site and values by visitors when undertaking tourism and recreational activities and experiences. |
| Recommended monitoring | Reliable visitor statistics, including tourist expenditure and other economic contributions.<br>Number of visitors participating in each activity/location and the resultant environmental impacts and potential indicators for monitoring.<br>Importance/awareness of Ramsar site and values for visitors. |

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# 9 GLOSSARY

**Acceptable change**, means the variation that is considered acceptable in a particular measure or feature of the ecological character of the wetland. Acceptable variation is that variation that will sustain the service, component or process to which it refers.

**Aquatic/marine fauna**, the context of this report relates to fauna species that spend all or the majority of their life cycle in or underwater. As such this grouping primarily relates to fish, marine reptiles, aquatic mammals such as dugong and cetaceans, and aquatic/marine invertebrates.

**Congener,** species within the same genus.

**Ecological character**, defined under Resolution IX.1 Annex A: 2005 of the Ramsar Convention as, the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.

**IBRA bioregion,** refers to Interim Biogeographic Regionalisation for Australia (IBRA). IBRA is a biogeographic regionalisation of Australia developed by the Australian Government's Department of the Environment, Water, Heritage and the Arts. It was developed for use as a planning tool, for example for the establishment of a National Reserve System.

**IMCRA bioregion,** refers to the Interim Marine and Coastal Regionalisation for Australia (Mesoscale) to the 200 meter isobath and derived from biological and physical data, (eg. coastal geomorphology, tidal attributes, oceanography, bathymetry and intertidal invertebrates). IMCRA is the marine equivalent of IBRA.

**National Framework document**, refers to the Draft National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands (DEWHA 2008b) and its successive documents as endorsed by the Natural Resource Management (NRM) Ministerial Council.

**Parapatry** speciation is a form of speciation that occurs due to variations in mating frequency of a population within a continuous geographical area.

**Ramsar criteria**, refers to the nine criteria for the listing of a site as internationally significant under the provisions of the Ramsar Convention.

**Regional ecosystems** are defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.

**Values**, means the perceived benefits to society, either direct or indirect that result from wetland functions. These values include human welfare, environmental quality and wildlife support.

**Wallum,** refers to freshwater wetlands and associated vegetation communities occurring on low nutrient sandy soils. While nutrient poor, these soils support a range of vegetation types including melaleuca (paperbark) woodland, sedgeland and heath (the dominant vegetation type on soils of this type). Acidic (pH < 6.0) swamps and lakes are typically found amidst heath vegetation and sedges where water collects above organic hardpan layers and provide essential breeding habitat for 'acid frogs' and other specially adapted species (Meyer *et al.*. 2005).

**Wetlands**, is used in this report in the context of the definition under the Ramsar Convention which includes, *areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*.

**Wetland-dependant terrestrial fauna,** in the context of this report relates to fauna species that occur within or otherwise are dependant on wetland habitats but do not spend the majority of their life cycle underwater (eg. non-aquatic species). As such this grouping primarily relates to birds, amphibians such as frogs, non-aquatic mammals such as water mouse, non-aquatic reptiles and terrestrial invertebrates.

**Wetland flora,** in the context of this report relates to flora species that are characterised as wetland or wetland-dependant species or populations.

**Wetland ecosystem components**, as defined in the ECD National Framework document, are the physical, chemical and biological parts or features of a wetland

**Wetland ecosystem processes**, as defined in the National Framework document, are the dynamic forces within the ecosystem between organisms, populations and the non-living environment. Interactions can be physical, chemical or biological.

**Wetland ecosystem benefits or services (includes the term ecosystem services)**, as defined in the National Framework document, are the benefits that people receive from wetland ecosystems. In general, benefits and services are based on or underpinned by wetland components and processes and can be direct (eg. food for humans or livestock) or indirect (eg. wetland provides habitat for biota which contribute to biodiversity).

# APPENDIX A: CONSULTATION DETAILS

**Project Committees**

This study was overseen and reviewed by two groups established by the Queensland EPA: the project Steering Committee and project Knowledge Management Committee.

These groups were comprised of the following persons:

**Project Steering Group**

| | |
|---|---|
| Gay Deacon, Chair | Queensland Environmental Protection Agency |
| Peter Macdonald | Queensland Environmental Protection Agency |
| Gayle Partridge | Australian Government Department of Environment, Water, Heritage and the Arts |
| John Beumer | Queensland Department of Primary Industries and Fisheries |
| Todd Kelly | Queensland Environmental Protection Agency |
| Paul Sanders | Queensland Department of Natural Resources and Water |
| Dave Rissik | Queensland Environmental Protection Agency |
| Di Tarte | Southeast Queensland Healthy Waterways Partnership |

**Project Knowledge Management Committee**

| | |
|---|---|
| Gay Deacon, Chair | Queensland Environmental Protection Agency |
| John Bennett | Queensland Environmental Protection Agency |
| Brad Zeller | Queensland Department of Primary Industries and Fisheries |
| Nicola Udy | Queensland Environmental Protection Agency |
| Sel Sultmann | Queensland Environmental Protection Agency |
| Roger Jaensch | Wetland International Oceania |
| Warren Lee Long | Wetland International Oceania |
| Rod Connolly | Griffith University |

Meeting dates for these groups during the project were as follows:

- Project Inception Meeting with EPA Project Team (March 2008)
- Steering Committee Meeting #1 – overview and collection of information sources (May 2008)
- Knowledge Management Committee Meeting #1 – workshop on critical services, processes and components (May 2008)
- Joint Meeting of the Steering Committee and Knowledge Management Committee – presentation of draft ECD document for comment (July 2008)
- A meeting to present the final documentation to the Steering Committee occurred in November 2008

**Scientific Expert Panel Process**

In light of the potential for positive alignment between significant conservation/management initiatives being developed for Moreton Bay, in parallel with the current project preparing the Ecological Character Description (ECD) for the Moreton Bay Ramsar Site, BMT WBM Pty Ltd and the Scientific Expert Panel (SEP) of the Southeast Queensland Healthy Waterways Partnership (the Partnership) were engaged by the EPA to conduct a number of meetings and workshops to discuss, collate and review the scientific understanding of Moreton Bay's ecological health/character and to identify opportunities for alignment of ecological monitoring (and associated environmental indicators for key ecological assets) in Moreton Bay. The three conservation/management initiatives included:

- the Southeast Queensland Healthy Waterways Strategy (and associated Ecosystem Health Monitoring Program [EHMP]) administered by the Partnership;
- the Ramsar Convention (and associated Ecological Character Description [ECD] in preparation by BMT WBM); and
- the draft Moreton Bay Marine Park Zoning Plan (and the associated monitoring plan currently being implemented by the EPA).

The approach adopted to collate this understanding and identify opportunities was to develop an overall Conceptual Framework (hereafter, 'the Framework') for Moreton Bay with a specific focus on the ecological assets underpinning its ecological health/character identified in the draft ECD and other relevant assessment documents. Key aspects of the Framework identified were:

- Identification of critical or key whole-of-Bay processes that affect the Bay's ecological health/character;
- Identification and agreement of the key ecological assets (eg. habitats and species) that were salient to all three conservation/management initiatives;
- Development of conceptual models for the key ecological assets (i.e. key attributes, threats and indicators of ecosystem health/character including where practicable defining limits or thresholds of acceptable change); and
- Based on the three steps above, assess the extent that key ecological assets were already being monitored and develop new or revised monitoring priorities that were relevant to the management and monitoring objectives of the EHMP, the ECD (in terms of the site's status as a Ramsar site) and the proposed Marine Park Zoning Plan.

The methodology used for developing the Conceptual Framework involved a series of (3) half-day meetings and (2) devoted full day workshops to discuss and address the key aspects of the Conceptual Framework. All meetings were organised and minuted by the Partnership's secretariat staff.

The meetings were convened by John Bennett (EPA and SEP member) and Eva Abal (SEP) as co-chairs at the offices of the Partnership. BMT WBM's role in the process was to prepare inputs for the meetings (agendas, workshop notes and presentations), present the information for discussion by the group and to document and 'write up' technical outputs in the form of conceptual models and diagrams which were distributed for comment and review by participants prior to meetings. A separate report (BMT WBM 2008b) was produced out of this process documenting the proceedings and discussions.

Meeting and workshop dates for the participants were as follows:

- July 2008 – Inception Meeting
- 17 July 2008 – 1st Workshop
- 28 July 2008 – 2nd Workshop
- 12 August 2008 – Meeting
- September 2008 – Meeting

Participants in the Meetings and Workshop (in addition to the BMT WBM study team) were as follows:

**SEP Sub-Committee**

| | |
|---|---|
| John Bennett, Chair | Queensland Environmental Protection Agency |
| Gay Deacon | Queensland Environmental Protection Agency |
| Eva Abal | SEP, SEQ Partnership |
| Brad Zeller (Altern. Michelle Winning) | Queensland Department of Primary Industries and Fisheries |
| Nicole Udy | Queensland Environmental Protection Agency |
| Dave Rissik | Queensland Environmental Protection Agency |
| Thomas Schlacher | Sunshine Coast University |
| Rod Connolly | Griffith University |
| Tim Stevens | Private Capacity (now GHD Pty Ltd) |
| Jackie Robinson | University of Queensland |

Outputs identified through this SEP review process relevant to the ECD included:

- An overview of the key ecosystem processes underpinning Bay function (and associated 'overview' conceptual model);

- Understanding of how these processes interact and create connectivity between the inshore and offshore habitats of the Bay;
- Recognition of the key threats and stressors operating within and adjacent to the Bay;
- Identification of the key habitats and species of the Bay; and
- Development of conceptual models for the key habitats and species that include:
    - identification of key indicators of habitat/species extent and condition;
    - identification of the key attributes and controls on ecosystem health and character; and
    - identification of stressors and threats (direct and indirect) to the habitats/species.

As outlined in Sections 4 and 5 of the report, from this process, a range of indicators, information gaps and monitoring priorities were identified that are directly relevant to the ECD study.

**Other Expert Input and Peer Review**

The study team also made contact with specific experts and organisations outside the SEP process. In this context, we recognise and appreciate the assistance of the following individuals and organisations:

- Dr Col Limpus, Queensland Environmental Protection Agency
- Dr Janet Lanyon, University of Queensland
- Dr Don Sands, formerly of the CSIRO
- Dr Ian Gynther, Queensland Environmental Protection Agency
- Dr Steve Van Dyck, Queensland Museum
- Dr Ed Meyer, formerly University of Queensland
- Dr Glen Ingram, formerly Queensland Museum
- David Geering, Queensland Wader Study Group
- Jill Denning, Queensland Wader Study Group
- John Birbeck, Caloundra City Council
- Jason Searle, Gold Coast City Council

External Peer Review of the draft ECD Report was also undertaken by Wetland International Oceania (Roger Jaensch and Warren Lee Long) under contract with BMT WBM Pty Ltd.

# APPENDIX B: POLICY AND PLANNING CONTEXT

This Appendix outlines the range of statutory plans, strategies and areas and non-statutory instruments relevant to the management of the Ramsar Site.

## Principal Management Plans

### Marine Park (Moreton Bay) Zoning Plan

The purpose of the *Marine Parks (Moreton Bay) Zoning Plan 1997* is to provide for the ecologically sustainable use of Moreton Bay Marine Park and to protect its natural, recreational, cultural heritage and amenity values. This is similar to the objectives of the Ramsar Convention, being for the conservation and wise use of the area. The marine park zoning plan operates through the delineation of zones within the declared marine park and regulates activities within these zones through the issue of permits and/or regulatory provisions.

The 1997 zoning plan, developed under the *Marine Parks Act 2004,* expires on 1 September 2008 (EPA 2008b). A review of this plan is currently being undertaken and will consider the objectives of the *Marine Parks Act 2004.*

Table B-1 provides a summary of the zones and their purposes under the current and draft proposed zoning plan. In general, the current marine park zoning plan protects and conserves valuable intertidal and marine habitats such as mangroves, seagrass and coral communities within various protection and habitat zones. The proposed draft zoning plan is seeking to improve the level of protection afforded to a range of representative habitats within the Bay by increasing the area and number of marine national park (green) zones.

**Table B-1 Current and proposed Moreton Bay Marine Parks zones and their purposes**

| Zones | Purpose, Prohibitions and Comments |
|---|---|
| ***Marine Parks (Moreton Bay) Zoning Plan 1997*** | |
| General Use Zone | o Purpose: to provide for the general use and public enjoyment of the zone in ways that are consistent with the conservation of the marine park.<br>o These areas allow all activities, though some require a permit to occur within the marine park.<br>o This zone constitutes the majority of the marine park. |
| Habitat Zone | o Purpose: to conserve significant habitats within the marine park and the cultural heritage and amenity values of the marine park, to maintain the productivity and diversity of ecological communities within the marine park, and to provide for reasonable public use and enjoyment of the zone consistent with the conservation of the marine park.<br>o Most activities are allowed in these zones, but activities such as shipping operations and mining are prohibited. |
| Conservation Zone | o Purpose: to conserve the zone's cultural and natural resources and amenity values, to conserve the zone's natural condition to the greatest possible extent, to allow members of the public to enjoy the relatively undisturbed nature of the zone, and to ensure use of the zone's natural resources is ecologically sustainable.<br>o Recreational activities are permitted but commercial trawling is prohibited. |
| Buffer Zone | o Purpose: to provide for the protection of the zone's biological diversity and natural condition to the greatest possible extent, while allowing the public to appreciate and enjoy the undisturbed nature of the zone and for the trolling for pelagic fish. |
| Protection Zones | o To provide for the permanent preservation of the zone's biological diversity and natural condition to the greatest possible extent, while allowing the public to appreciate and enjoy the undisturbed nature of the zone.<br>o All forms of fishing and extracting are prohibited. |
| ***Moreton Bay Marine Park Draft Zoning Plan*** | |
| General Use Zone | o Purpose: the zoning applied to areas where a higher level of protection could not be achieved or was not required given the percentage of each habitat type protected in other zones.<br>o Most activities can occur with or without a permit under an ecologically sustainable management framework. |
| Habitat Protection Zone | o Purpose: to provide significant habitat, especially those supporting threatened species, protect areas adjacent to land based national parks, and provide an environmental buffer against threatening processes, while allowing for prevention of substantial economic impacts from phasing out of commercial netting (e.g. allowing areas supporting low levels of trawling).<br>o Activities which disturb the seabed are prohibited. |
| Conservation Park Zone | o Purpose: to broadly complement the level of protection provided to adjacent land based protected areas while supporting existing recreational use and some limited commercial fishing, to protect special and unique areas where Marine National Park Zones would have resulted in unacceptable social or economic impacts, and to allow continued entry and use of areas of high recreational value, in particular for recreational fishing.<br>o Most forms of large scale extractive use, direct disposal, private structures and development are prohibited.<br>o Limited recreational and commercial line fishing and crabbing may still occur. |
| Marine National Park Zone | o Purpose: to protect the full range of habitat types and an example of each biodiversity feature, to maintain the ecological viability and integrity of populations, species and communities, to protect species of conservation concern as well as species vulnerable habitats and lifestages, to protect the natural values of the marine environment to ensure greater resilience against future changes or threats, and to provide for adaptive management through assessment of effectiveness of zoning.<br>o All forms of extractive use, direct disposal into the area, coastal development and most maritime infrastructure are prohibited to provide whole-of-ecosystem protection. |

Source: Information on *Moreton Bay Marine Park Draft Zoning Plan* taken from EPA (2008a).

**South-east Queensland Regional Coastal Management Plan**

The application of the South East Queensland Regional Coastal Management Plan (SEQRCMP) (EPA 2006) extends to the coastal zone between and including Maroochy Shire to Coolangatta, and operates in conjunction with the *State Coastal Management Plan.* It aims to achieve sustainable coastal management in SEQ, and to avoid or minimise future adverse impacts on coastal resources.

Within the SEQRCMP, specific regional direction is provided on 17 State Coastal Plan policies, and in addition, includes two regionally specific policies[12] (EPA 2006). Most policies within the Plan are relevant to the Ramsar site, either providing direction on the wise use of the coastal zone for social or economic purposes, or for the conservation of sensitive areas within the coastal zone, including those in Moreton Bay. Applicable policies include:

- *Policy 2.1.10 Tourism and Recreational Activities* – Intense tourism and recreational pressures are important community and economic assets in the SEQ area. The Policy requires the avoidance or minimisation (in order of preference) of potential adverse impacts, including cumulative impacts, on protected species, particularly threatened and migratory species. Further, the Policy requires that planning for tourism and recreation in the SEQ region makes provision, where relevant, for seasonal variations in faunal activity and migrations.
- *Policy 2.8.1 Areas of state significance (natural resources)* – This Policy covers areas within the Ramsar site including significant coastal wetlands, Nature Conservation Act Protected Areas[13] and significant coastal dunes. The Policy recognises that areas of state significance (natural resources) play a critical role in maintaining a healthy functioning coast, and that they must be protected from land uses and activities that may have adverse impacts on their continued integrity and functioning (i.e. wise use).
- *Policy 2.8.2 Coastal Wetlands* –This Policy applies to the conservation and management of coastal wetlands, including land within 100m of a coastal wetland. This policy identifies areas within the Moreton Bay Ramsar site as having large and intact coastal wetland ecosystems with high ecological integrity and functioning. However, it does not cover all areas within the Ramsar site boundary. It also considers that wetlands in some areas within Moreton Bay are experiencing pressures from direct and cumulative impacts including Pumicestone Passage and parts of Bribie Island, parts of the Hays Inlet and Brisbane northern wetland complex, and part of the Carbrook wetland complex south of Beenleigh-Redland Bay Road.
- *Policy 2.8.3 Biodiversity* – This Policy focuses on areas of Coastal Biodiversity Significance including wetlands (significant and coastal) and areas of shorebird habitat. Areas within or immediately adjacent to the Ramsar site boundary are also designated as areas of terrestrial Coastal (State) Biodiversity Significance. The Policy requires future planning consider various aspects of management impacting on the conservation and wise use of the Ramsar site including:

  - to ensure development does not result in further loss, degradation or fragmentation of areas of coastal biodiversity significance and value; and

  - to identify areas that are degraded between areas of biodiversity significance and require rehabilitation to reinstate habitat values and ecological functioning.

[12] Policy 2.1.15 - *Non-tidal artificial waterways* and Policy 2.4.7 - *Algal Bloom Management*.
[13] As identified under the SEQRCMP.

- *Policy 2.8.4 Rehabilitation of Coastal Resources* – The SEQRCMP requires rehabilitation and enhancement of coastal resources to improve values and functioning of the coastal zone. General areas defined for priority rehabilitation and enhancement include coastal wetlands, endangered regional ecosystems and dunal systems (refer Policies 2.8.1 and 2.8.2) and shorebird nesting, roosting and feeding sites (Policy 2.8.3).

A range of other statutory plans, strategies and areas and non-statutory management plans and instruments apply in the Moreton Bay region and to areas or values within the Ramsar site.

**Other Statutory Plans**

**Protected Areas Management Plans**

There are a number of terrestrial-based protected areas within the boundaries of the Moreton Bay Ramsar site. Some of these protected areas have management plans to provide for their conservation and wise use, while others have no formal management plans or strategies currently in place.

***Moreton Island National Park, Cape Moreton Conservation Park and Moreton Island Recreation Area and Management Plan***

The Plan (EPA 2007) aims to maintain and manage protected areas on Moreton Island as relatively undisturbed coastal landscapes where people will continue to access and enjoy the island's regionally unique, nature-based recreational activities. It also aims to make conservation of the island's natural communities, species and cultural heritage a key focus of management on the island. The Plan has been developed to ensure that management considers international agreements including the Ramsar Convention, protected areas legislation, native title, cultural heritage, and local plans (under the jurisdiction of Brisbane City Council). While only applying to a proportion of the Moreton Bay Ramsar site, the Plan aims to maintain and manage values protected by the Ramsar Convention.

***Carbrook Wetlands Conservation Park, Serpentine Creek Conservation Park***

The Carbrook Wetlands Conservation Park and Serpentine Creek Conservation Park Management Plan (QPWS 1999a) identifies the wetlands systems within these parks as good examples of their type within the South East Queensland bioregion. Desired outcomes, and policies, guidelines and actions are set out in the plan to address management of the protected area including its plants and animals (including wetlands, especially Carbrook Wetland including Native Dog Creek), scenic and aesthetic, scientific and educational, and recreational values.

***King Island Conservation Park***

The King Island Conservation Park Management Plan (QPWS 1999b) highlights the importance of the Park as an area of extensive tidal flats, rubble banks and seagrass beds which are important to migratory wader birds as feeding grounds. The management plan aims to maintain the island in its natural condition and to allow no developed facilities. It notes that the Park will be managed in accordance with the Ramsar Convention, and consistently with the surrounding marine park zoning requirements.

### *Buckely's Hole Conservation Park*

The Buckely's Hole Conservation Park Management Plan (Department of Environment and Heritage 1998) identifies the Park as being a place of significance for migratory birds, and as providing nature-based recreational opportunities such as bird-watching and bushwalking. The Plan aims to ensure:

- the lagoon and its surrounds are maintained for the continued use by water birds;
- threatened fauna is monitored and their requirements are included in ongoing management programs;
- nature-based recreational and educational day use opportunities are provided; and
- Aboriginal groups and the local community are provided with the opportunity to be involved in the management of the Park.

### *Other Protected Areas*

Other *Nature Conservation Act* protected areas within the Moreton Bay Ramsar site do not currently have management plans, but are managed by QPWS in accordance with the management principles for that class of protected area under the Act:

Bribie Island Recreation Area and Bribie Island National Park - The Bribie Island Recreation Area includes the Bribie Island National Park, and is managed pursuant to the *Recreation Areas Management Act 2006* for the purposes of nature conservation and nature-based recreation. Currently there is no conservation management plan for the area.

St Helena Island National Park - Queensland's first historic national park was the St Helena Island National Park. The aim of the National Park is to preserve the ruins and artefacts on the Island from further degradation, and to provide an educational tool to accurately present the park and its history to visitors.

Southern Moreton Bay Islands National Park - This protected region has an area of more than 1500 ha, and is comprised of Willes, Cobby Cobby, Kangaroo, Woogoompah and Coomera Islands. The southern islands area is managed for conservation of the natural environment, with marine park conservation and protection zones surrounding the islands.

### Environmental Values and Water Quality Objectives

Schedule 1 of the *Environmental Protection (Water) Policy 1997* identifies environmental values and water quality objectives for Moreton Bay and its coastal catchments. In particular the schedule sets quantitative objectives for key physico-chemical water quality parameters such as nutrients and sediments that, if achieved, will protect aquatic ecosystem values. A number of areas within the Bay are provided the highest level of ecosystem protection, known as High Ecological Value (or HEV) areas. These areas are to be retained in their current condition (in terms of water quality, biotic quality) to the greatest extent practicable. The environmental values and water quality objectives of the schedule must be considered in decision-making under the Environmental Protection Act in relation to regulated activities that involve discharge of contaminants to waterways as well as in other statutory plans and strategies.

### South East Queensland Regional Plan

The purpose of the South East Queensland Regional Plan 2005-2026 (Office of Urban Management (OUM) 2005) is to provide a sustainable growth management strategy for SEQ to the year 2026, including the protection and enhancement of the region's natural environment, biodiversity and natural resources. It is a statutory plan to which all other planning in SEQ, such as local government planning schemes, state plans and policies, must align. The Plan applies to those local government areas (LGAs) in the SEQ region and Queensland waters adjacent to these LGAs, including all of the Moreton Bay Ramsar site.

The vision of the SEQ Regional Plan includes that ecological and culturally significant landscapes are valued, celebrated and protected. The Plan's regional land use pattern identifies "areas of regionally significant conservation, natural resource, landscape, …. and recreational value", with the majority of the Ramsar site being included in the Regional Landscape and Rural Production Area.

Regional policies set out the desired regional outcomes, principles and policies to address growth management in SEQ, and guide planning and decision-making at State and local levels. Desired regional outcome 2 recognises the quality and diversity of the natural environment of SEQ, including features such as rich and diverse native flora and fauna, diverse coastline and marine waters encompassing coastal wetlands (e.g. Pumicestone Passage and Carbrook Wetlands), unique sand islands (Moreton, Stradbroke and Bribie Islands), and the dugong, turtle and fish habitats of Moreton Bay. A number of policies have been developed to implement these principles, including the protection, conservation, management, rehabilitation and/or restoration of coastal wetlands.

**Fisheries Management Plans (East Coast Trawl) and (Coral Reef Fin Fish)**

These fisheries management plans apply to all of Queensland's waters and provide for the use, conservation and enhancement of the community's fisheries resources by managing the east coast trawl fishery and reef line fishery in a way that seeks to apply and balance the principles of ecologically sustainable development, and promote ecologically sustainable development.

The *Fisheries Management (East Coast Trawl) Plan 1999* requires the use of bycatch reduction devices (BRDs) and turtle excluder devices (TEDs) throughout the fishery, and sets regulated periods for defined waters including within the Moreton Bay area and Ramsar site.

**Fish habitat areas**

Fish habitat areas are statutory areas defined under the *Fisheries Act 1994* and its regulations for the protection of important fish habitats across the State of Queensland. Several declared areas are within the Moreton Bay Ramsar site and coincide with its boundaries. Declaration of a fish habitat area provides particular powers for the chief executive administering the Fisheries Act to regulate development and activities within them.

**Water Resource Plans**

Water Resource Plans (WRPs), required under the *Water Act 2000*, are developed to plan the allocation and sustainable management of water to provide a balance between sustainability for river ecosystems and certainty of supply for water users, but also to ensure there is adequate provision for the natural processes that underpin river health. WRPs in the SEQ region must be consistent with the SEQ Regional Plan (see above). All WRPs include environmental outcomes (e.g. needs of specific species), river flow objectives and performance indicators for different flow levels, and monitoring and reporting requirements.

The *Water Resource (Logan Basin) Plan 2007* (Logan WRP) sets out the objectives for the Logan River and its tributaries, which feed southern Moreton Bay including the area within the Ramsar site. In particular it plans for ecological outcomes for water in particular areas within or flowing into the Ramsar site (refer Table B-2).

**Table B-2 WRP ecological outcomes for areas within the Logan catchment**

| Estuary | Ecological Outcome |
|---|---|
| Logan and Albert Rivers estuary | To minimise changes to the delivery of fresh water, sediment, nutrients and organic matter to the estuary and southern Moreton Bay; and<br>To minimise changes to the brackish water habitat in the estuary. |
| Canungra Creek, Christmas Creek, Running Creek, Palen Creek and Upper Logan River subcatchment areas, Albert River and parts of its tributaries, Burnett Creek and part of its tributaries and Teviot Brook and part of its tributaries | To minimise changes to the low flow regime of the watercourses; and<br>To minimise changes to the medium and high flow regime important to river forming processes. |
| Carbrook wetlands | To minimise changes to the flooding regime. |

Likewise, the *Water Resource (Moreton) Plan 2007* (Moreton WRP) sets out the objectives for the wider Moreton Bay catchment to the north of the Logan River catchment. This includes the wider Brisbane area, and the catchment of Pumicestone Passage. In particular it plans for ecological outcomes for estuaries within or flowing into the Ramsar site (refer Table B-3).

**Table B-3 WRP ecological outcomes for areas within the Moreton catchment**

| Estuary | Ecological Outcome |
|---|---|
| Stanley River and tributaries, upstream of the impounded area of Woodford Weir | To minimise changes to flows that support river-forming processes; and<br>To minimise changes to the low flow regime. |
| Boondall Wetlands | To provide freshwater flows necessary to maintain the long-term pattern of inflows to, and ecological functions of, the wetlands. |
| Estuarine reaches | To minimise changes to brackish water habitats. |
| Moreton Bay and Pumicestone Channel | To minimise changes to the natural movement and delivery of sediment, and the delivery of fresh water, natural nutrients and organic matter. |

The *Water Resource (Gold Coast) Plan 2006* (Gold Coast WRP) sets out the objectives for the Coomera River and its tributaries, which feed southern Moreton Bay and the Broadwater including the area within the Ramsar site. In particular it plans for ecological outcomes for water in particular areas within or flowing into the Ramsar site (refer Table B-4).

**Table B-4 WRP ecological outcomes for areas within Gold Coast river catchments**

| Estuary | Ecological Outcome |
|---|---|
| Coomera River Estuary | To minimise changes, as far as practicable, to freshwater flows into the Coomera River estuary and to minimise changes to the freshwater inflows to Coombabah Lake. |
| For Coomera River within the area known as Canungra Land Warfare Centre, including, in particular, Back Creek, and | To minimise changes to the flow regimes of the waters. |

| | |
|---|---|
| other waters of high ecological value, including, in particular, Tallebudgerra Creek and Currumbin Creek | |
| Moreton Bay and the Broadwater | To minimise changes, as far as practicable, to the volume and seasonality of freshwater flows into these waterways. |

**Local Government Planning Schemes**

The Moreton Bay Ramsar site includes land and waters within the local government areas of the Gold Coast City Council, Redland City Council, Brisbane City Council, Moreton Bay Regional Council and Sunshine Coast Regional Council.

Each of these Local Governments administers a planning scheme prepared under the *Integrated Planning Act 1997* (IPA) that regulates new development in the local government area such as the change on intensification of a use of land, subdivision of land and related operational and building works.

In addition to the range of strategies and measures administered under planning schemes through IPA, local governments also administer local laws prepared under the *Local Government Act 1993* for the regulation of activities such as vegetation clearing, access restrictions, and control of domestic animals that are not administered through the development provisions of the IPA.

Local Governments play an important role in defining the pattern of urban settlement in Southeast Queensland and in the regulation of construction and operation of development that is relevant to the values of the Ramsar site.

**Non-statutory plans**

**SEQ Healthy Waterways Strategy – Moreton Bay Action Plan**

The SEQ Healthy Waterways Strategy 2007 – 2012 (SEQ HWP 2007) has been developed and is implemented by the SEQ Healthy Waterways Partnership. The Partnership is a voluntary alliance of local governments, State government agencies and community and industry representatives.

The Strategy and, in particular, the Moreton Bay Action Plan within it, covers the whole of Moreton Bay including Pumicestone Passage, the southern Broadwater, and to the mouths of all rivers, and aims to sustain and enhance the ecosystem health of the Bay. The purpose of the Plan is similar to that of the Ramsar Convention, addressing particular activities within Moreton Bay to ensure that the Bay's ecosystem health is protected and where necessary stabilised and restored, while allowing for sustainable resource use.

The Plan recognises there is an existing policy and regulatory framework in place for protecting critical habitats and species, and management of human activities to ensure their sustainability, particularly at Commonwealth and State level (i.e. *EPBC Act* and *Marine Parks Act*), and specifically in recognition of Ramsar-listed sites as areas of national environmental significance under the *EPBC Act*.

The Plan focuses on four themes:

- appropriate levels of protection of critical habitats and species;

- management of commercial and recreational activities within the Bay to minimise their impact on the Bay's ecosystems;
- improved understanding of Moreton Bay's ecosystems and the condition and trends in any changes to that ecosystem; and
- high community awareness of the values of the Bay and commitment to their long-term protection.

A series of Management Outcomes for each of the themes, Management Action Targets and a subsequent series of actions have been determined.

**The Future in Balance - SEQ Catchments**

Formed through the regional arrangements for natural resource management between the Australian and Queensland Governments under the National Heritage Trust, the SEQ Catchments Natural Resource Management (NRM) body administers the regional NRM plan entitled, the *Integrated Natural Resource Management Plan for South East Queensland* (also know as *The Future In Balance*) (NRM SEQ 2004). While a strategic document to guide planning and investment in NRM activities in the region, the Plan aims to incorporate and build on existing plans, influence those that are emerging, conform to Australian and Queensland guidelines, and coordinate implementation of required actions.

The Plan framework sets out targets, actions and organisations, and identifies the major natural assets of the region and threats impacting on them. The SEQC Regional Investment Strategy identifies six natural resource assets to be managed or protected, with the most relevant assets for meeting the principles in the Ramsar Convention being coastal and marine, water and biodiversity. Aspirational (30-50 years), Resource Condition (10-15 years) and Management Action (1-5 years) targets are outlined for each of the assets.

**Shorebird Management Strategy – Moreton Bay**

In response to the need to protect migratory shorebird species found in Moreton Bay listed under the Japan Australia Migratory Bird Agreement (JAMBA) or the China Australia Migratory Bird Agreement (CAMBA), the EPA and QPWS developed the *Shorebird Management Strategy – Moreton Bay* (EPA 2005b). Within Moreton Bay, five main approaches have been adopted for the conservation of shorebirds:

- Protecting shorebird habitat;
- Protecting shorebirds from disturbance;
- Protecting critical shorebird sites;
- Community education; and
- Research and monitoring.

In particular the actions within the Strategy for the above approaches are relevant to maintenance of the ecological character of the Ramsar site (eg. maintenance and enhancement of shorebird habitats).

# APPENDIX C: INDIGENOUS CULTURAL HERITAGE REPORT

The full report prepared by *Converge Heritage + Community Pty Ltd* is included here. A summary of the key aspects of the report as it relates to identification of critical services related to indigenous cultural heritage is contained in Section 7.

## 1. Introduction

BMT WBM commissioned Converge Heritage + Community to conduct a desktop assessment of indigenous cultural values associated with the Moreton Bay Ramsar areas. This assessment forms part of an audit of existing environmental values being undertaken by BMT WBM.

Resolution IX.21 of the Ramsar Convention, entitled "Taking into account the cultural values of wetlands" was adopted at Ramsar's ninth conference. Through this resolution, Ramsar signatory governments have agreed "… that in the application of the existing criteria for identifying Wetlands of international importance, a wetland may also be considered of international importance when, in addition to relevant ecological values, it holds examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning" (paragraph 12). Further, the resolution outlines cultural characteristics as follows:

a. Sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland.

b. Sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetlands.

c. Sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples.

d. Sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland (paragraph 15).

This important change to global policy statements of the Ramsar Convention provides a strong mandate for taking into consideration the indigenous cultural values of the Moreton Bay Ramsar areas in the current audit being conducted by BMT WBM.

The scope of this assessment is limited to being desktop, and will be based only on documentation that is already in the public arena. Specifically, consultation with indigenous groups is not part of the scope. This assessment provides:

- Contextual information;
- A discussion of the relationship between indigenous groups and land;
- A summary of available information about cultural connections with Ramsar areas;
- Case studies that demonstrate that significant cultural values may be associated with Moreton Bay Ramsar areas;

- Available information on how cultural values are being sustained; and
- An assessment of the limits of acceptable change if cultural values in Ramsar areas are to be protected and managed.

## 2. Legislation and Professional Standards

Legislation specific to cultural heritage that is relevant to this assessment is as follows:

*Aboriginal Cultural Heritage Act 2003 (ACH Act)*

The paramount legislation in Queensland, with regard to Aboriginal cultural heritage, is the Aboriginal Cultural Heritage Act 2003, which states that a person who carries out an activity must take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage (the "cultural heritage duty of care") (Section 23[1]). The Act defines cultural heritage as a significant Aboriginal area, object, or evidence, of archaeological or historic significance, of Aboriginal occupation (Section 8). A "significant Aboriginal area" is an area of particular significance to Aboriginal people because of either or both of the following: Aboriginal tradition; the history, including the contemporary history, of any Aboriginal party for the area (Section 9).

The ACH Act states that it is an offence for a person to harm, remove or possess cultural heritage if the person "knows or ought reasonably to know that the object is Aboriginal cultural heritage" (Section 26).

Sections 34-37 of the Act provide directions on how an Aboriginal party for an area is determined. If the area is within the external boundaries of a registered native title claim, then the native title party for that area (also known as the applicant) will be the Aboriginal party. If there is currently no registered claim, but a registered claim once existed, then until a new registered claim is in place, the Aboriginal party for that area will be the native title party of the previous registered claim. Finally, if there is no registered claim and never has been one, then the Aboriginal party is a person "with particular knowledge about traditions, observances, customs or beliefs associated with the area, and has responsibility for the area under Aboriginal tradition.

The application of the ACH Act when defining Aboriginal parties is important to the Ramsar areas of Moreton Bay, some of which are within the external boundaries of registered claims, while others either have never been claimed, or once were within a registered claim that no longer exists.

The Act has established a database and register. While these sources of information are far from complete, they contain information about places, usually archaeological sites, which have been recorded during previous surveys.

In addition to the requirements of legislation, professional standards are established by Resolution IX.21 of the Ramsar Convention (discussed above), and the Burra Charter. The Burra Charter (Marquis-Kyle and Walker 1999) continues to guide cultural heritage management in Australia. First adopted in 1979 by Australia ICOMOS (International Council on Monuments and Sites), the charter was initially designed for the conservation of and management of historical heritage. However, after the addition of further guidelines that defined cultural significance and conservation policy, use of the charter was extended to indigenous studies.

The charter defines conservation as 'the processes of looking after a place so as to retain its cultural significance' (Article 1.4). A place is considered significant if it possesses aesthetic, historic, scientific or social value for past, present or future generations (Article 1.2). The definition given for each of these values is as follows (Articles 2.2 to 2.5).

Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria may include consideration of the form, scale, colour, texture and material of the fabric; the smells and sounds associated with the place and its use.

Historic value encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all of the terms set out in this section.

A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives in situ, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment.

Scientific research value of a place will depend upon the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information.

Social value embraces the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group.

Article 2.6 of the Guidelines notes that other categories of cultural significance may become apparent during the course of assessment of particular sites, places or precincts. A range of cultural significance values may apply. Article 5 of the Burra Charter states that "conservation of a place should identify and take into consideration all aspects of its cultural significance without unwarranted emphasis on any one aspect at the expense of others" (Marquis-Kyle and Walker 1999).

## 3. Context

### 3.1 Environmental Context

Moreton Bay covers roughly 1 400 square kilometres between Peel and Bribie Islands and is about 50 km long and 25 km wide. Moreton and Stradbroke Islands protect the bay and the mainland shore from ocean waves, with the wave climate dominated by wind-waves rather than swell. Wind-wave direction is mainly from the southeast, northeast and southwest (Stephens 1992). In the north-east, however, swell-waves develop via the channels of the North Entrance tidal delta. The Brisbane River is the only major river that feeds into the bay. Smaller streams, including the Albert and Logan Rivers to the south and the Pine and Caboolture Rivers in the northwest, also feed into the bay.

To the west of the bay, between Redland Bay and Lytton Hill, the shoreline is rocky and dominated by Tertiary basalt. The coastline in the region is fringed by intertidal sand flats and coral reefs (Stephens 1992). The Brisbane River delta extends from Hamilton to Lytton Hill and is comprised of coastal sediments. The Redcliffe Peninsula, in contrast, consists of a series of laterised Tertiary sandstone and basalt headlands. Deception Bay is a coastal plain with estuarine mudflats and beachridges, with the sand supplied by the North Entrance marine tidal delta. Bribie Island is a barrier island comprised of Pleistocene and Holocene beachridges, whereas Moreton and North Stradbroke Islands are dune islands containing prominent bedrock headlands. These islands also consist of dunes of both Pleistocene and Holocene age.

The sedimentary environments of Moreton Bay have been formed by fluvial, tide and wave influences since the last glacial maximum (Lang *et al.*. 1998). Seismic stratigraphic surveys around the Bay have identified various sediments that have been deposited as sea levels have changed over time. The analyses of these sediments have allowed scientists to reconstruct the bay environment from the late Pleistocene through to the present day.

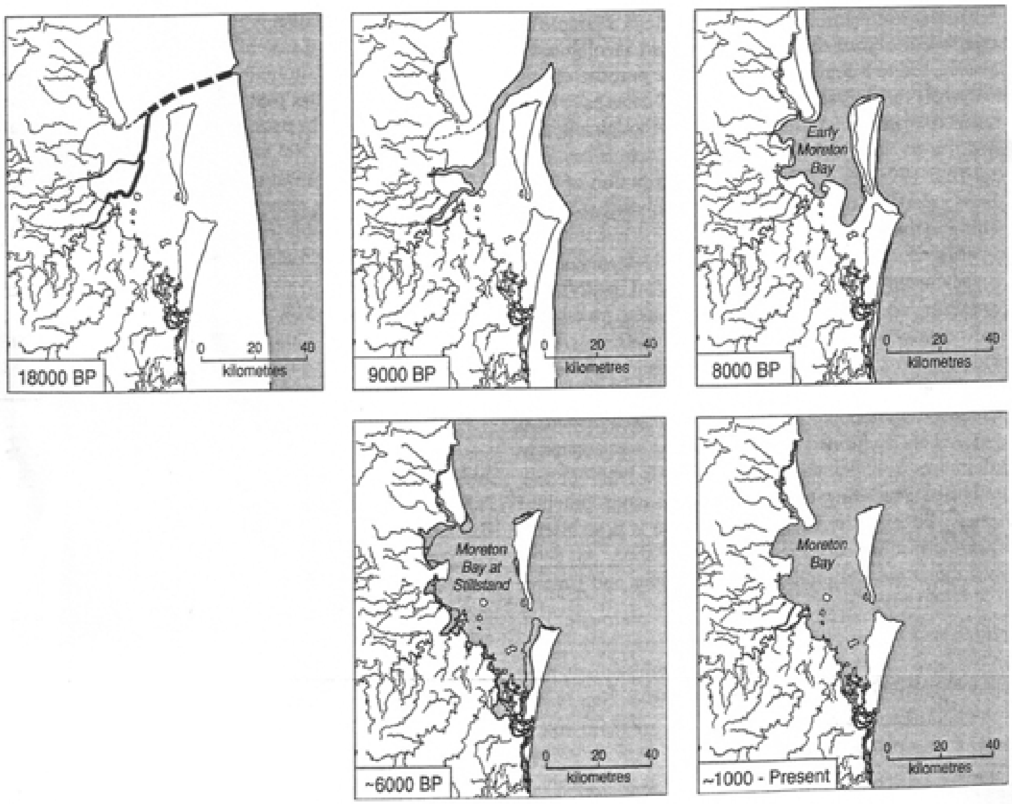


**Figure 1: Development of Moreton Bay during the Holocene Period (Hall, 1999: 171).**

Seismic testing has revealed that during the last Ice Age (18000 – 10000 BP) the coastline of southeast Queensland was roughly 35 kilometres or more eastwards of its present-day location (see Figure 1). People living on the southern Moreton Islands were effectively living inland on a wide coastal plain and Moreton Island was part of the mainland. Moreton and Stradbroke islands, at this time, were essentially large subcoastal sand dunes overlooking a broad coastal plain to the east and subcoastal river valley to the west (Hall 1999).

Two substantial river systems were present during this time: to the south of Russell Island the palaeo-Logan River system; and to the north a large tributary of the Brisbane River (Willmott and Stevens 1992). The landscape may have been comparable to that which can still be seen inland of the Caloundra Currimundi coastline of northern southeast Queensland. Along major rivers and creeks, open Eucalypt forest would have predominated, with sections of riparian forest present along waterways. On the flat plains, heathlands, swamps and woodland areas would have predominated.

The present day Moreton Bay gradually formed as sea levels rose after the Last Glacial Maximum (-150m at 18 000 BP). Old river systems were gradually flooded with sea water. The marine environment was probably brackish, rather that salt, because of the low tidal influence and entry of fresh water into the system. Vegetation systems along, what once had been riverine environments, gradually died back due to the gradual incursion of salty water.

From 10 000 to 6 500 years BP, as the bay continued to fill, Moreton, Stradbroke, Macleay and Karragarra became islands, and Russell became an extended peninsula into what was becoming a huge bay - not unlike Deception Bay today. The riverine environment was replaced by vegetation and fauna suited to marine conditions. Sea water purity was high, sustaining substantial coral growth around Victoria Point, Peel Island and near the northern parts of North Stradbroke. Sea levels stabilised around 6000 years ago and Moreton Bay, at this time, was more extensive than it is today.

The Moreton Bay regional environment supports an abundance of plant and animal food species. Coastal lowlands or ‘wallum’ vegetation comprises over one-third of the Moreton Region’s area. This bioprovince is defined as being an “undulating lowland belt below the 30m contour which has an assured rainfall, similar soil morphology, Lack of soil fertility and similarly structured floristic communities” (Hall 1980: 80) and encompasses beaches, low dunes, estuaries, fringing forests, dune forests and various types of Wallum forest. Coastal lowland vegetation is commonly in a state of flux as external conditions, such as climatic variation and mobile landscapes, constantly change. Such a dynamic environment creates a diversity of habitats for flora and fauna.

The coastal lowland environment sustains more than 50% of the 60-odd species of terrestrial land mammals listed for the Moreton Region (Hall 1980: 80). Wallum vegetation, in particular, supports a large and diverse range of bird species, including thousands of sea birds and wading birds, reptiles and mammals. Significantly, marine resources are plentiful in Moreton Bay. A wide range of fish species, including mullet, bream, tailor, whiting, flathead and jewfish are present, as well as other marine animals such as dugong, turtles and porpoise.

In summary, Moreton Bay has been an area of considerable change through the past 10,000 years, from part of the mainland to its present marine environment. Throughout this time, changes to the landscape wrought by fluctuating sea levels, inundation, and climate change would have been associated with accompanying changes to vegetation and animal populations.

### 3.2 Human Context

Humans are thought to have occupied coastal Southeast Queensland since at least the late Pleistocene (up to 20 000 years Before Present [BP]). This estimate is based on archaeological evidence from the Talgai (Morwood 1987) and Wallen Wallen Creek sites (Neal and Stock 1986). Within Moreton Bay itself, however, evidence suggests a more recent occupation of Moreton Bay, with a number of sites dated from between 2000 and 200 years BP (late Holocene) (Hall 1999). A large-scale midden complex, found on the southwest coast of Moreton Island, has been dated to around 2200 years BP and sites in Deception Bay and Sandstone Point to around 3000 years BP (Hall 1989). A comparative dense number of middens were noted along the shores of Pumicestone Passage both on Bribie Island and on the mainland, but no archaeological dating has been done

(Stockton 1974). Interestingly, to date, very few sites have been discovered in the region that date to between 2000 and 6000 years – a period when sea levels in the bay had stabilised and the environment is thought to have been very similar to that of today (Hall 1999) (Figure 2). One exception is the Brisbane Airport Site, with material dating from 1170 to 5837 years BP.

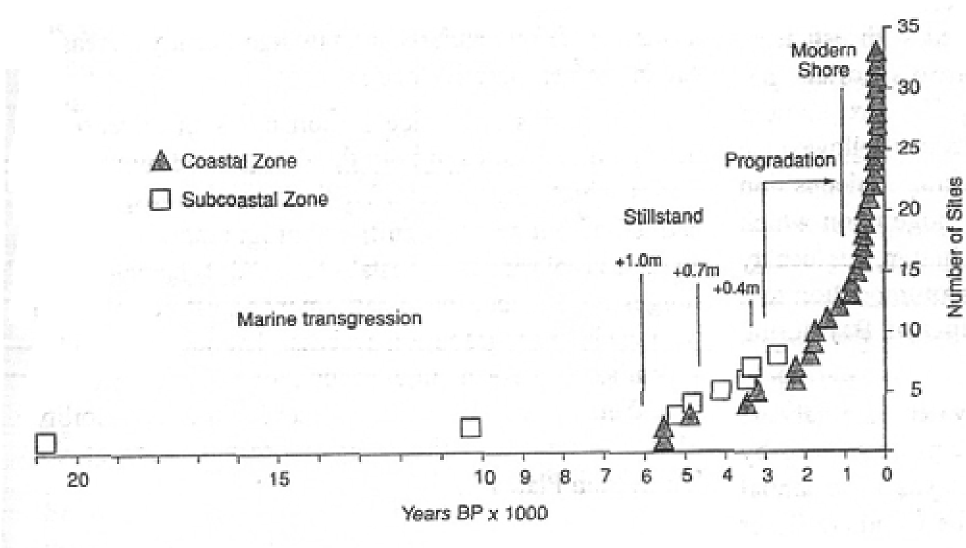


**Figure 2: Moreton region sites through time by environmental zone. (Hall 1999: 173)**

Evidence from these excavations and other archaeological sites discovered in Moreton Bay indicates that fishing, the collection of shellfish and the gathering of local food plants were important activities for Aboriginal peoples living in the region. As Ulm notes:

> *Over the past 40 years, archaeological investigations in southeast Queensland have focused almost exclusively on the coastal strip…. Although little of the region has been systematically surveyed, over 1,500 coastal midden sites have been documented, 62 of which have been excavated. Of these 62 sites, 27 are said to contain fish remains, although … only 21 have been radiometrically dated (Ulm 2002: 79).*

During the many millennia of occupation, it should be understood that Aboriginal lifeways would have impacted on the natural environment of Moreton Bay, e.g., for example, techniques such as fire stick land management, to keep vegetation clear and managed may have played a role in determining the mosaic of vegetation and thus by implication the spread of fauna populations. Whatever this impact, early ethnographic observations after non-indigenous occupation commenced in the 1820s present a picture of an abundance of fauna populations in a mosaic of landscapes. Examples are provided.

Fish abounded in Moreton Bay. In particular, numerous observations highlight the presence of schools of sea mullet during the late 1800s.

> *I have seen schools so vast that the bay was a solid mass of them….it is impossible for anyone to form an estimate as to the quantity, but I should say that a hundred boats might have been filled out of a wing of this seething mass (Welsby in Thomson 1967: 86).*

A suite of methods were used by Aboriginal groups to fish in Moreton Bay. Stake and brush traps were used on tidal flats. At Woody Point near Redcliffe, Flinders noted that "upon the shoal near the house, there was more than one enclosure of a semi-circular form, and the sticks and branches of which it was made were set and interwoven so close that a fish could not pass between" (Steele 1072: 19).

Nets were commonly referred to in the early records of Moreton Bay. Flinders commented on netting, and his assistant Uniacke wrote that the "nets used for fishing are made by the men from the bark of the kurrajong (hibiscus heterophyllus), a shrub which is very common in the swamps" (Steele 1972: 95). Other bark including that of the native cotton tree (*Hibiscus tiliaceous*) which went by the local name of "Talwalpin" (Watkins 1981: 44) and wattle bark, were twisted together and gum was then used to glue the resulting string to a framework made of sticks. These small "heart shaped" nets about 1.2 metres across were usually used in pairs, and were probably the most well known and consistently described nets known as "tow rows" (Colliver and Woolston 1975: 96; Petrie 1904: 73). Gaiarbau, a traditional person from the Jinibara group described his experiences of using these nets to catch mullet in Deception Bay:

> *One man kept watch in the top of a tree, probably a quarter of a mile away. He remained hidden from view behind a shield of vines and leaves cut from the adjacent scrub, for if had not been screened the mullet would have seen him and not come into shallow water. The rest of the men were placed at a distance beyond him, sitting down and waiting for his signal. As soon as he saw fish he put one hand up. Gradually he would lower it, and when he brought it right down to his side the fishermen would know that the mullet had come past his tree. Then he would raise the other hand, and slowly lower it as they got beyond this sight. The signaling was taken up by another man who was in the water fairly close to the waiting fishermen. If this man stood up, then the others knew that the school was in the deep water, and they remained sitting and let that school pass, and waited patiently until a school came along that was in the water shallow enough for their purpose. If the tree watcher sat down they would know that a school of mullet was coming into shallow water. But if he saw that the fish were in deep water he would not lower his arm below half way, so that the next man could see how the fish were traveling. The latter kept a wet sand-ball, as big as a cricket ball, in his hand. When the conditions were right, he would throw the sand-ball underhand about 10 yards out into the sea. The purpose of this was to cause the mullet to stop. He would then throw a second ball about five yards out to induce them to come in and see what caused the splash, and then he would throw a third sand-ball into water knee deep. All this time he was squatting down in the water so as not to be prominent. In the meantime the fishermen who had been alerted would all sneak up to within about 20 yards of him and quietly enter the water in a half circle, closing in to complete a full circle as soon as the fish got into water that was shallow enough. They then proceeded to catch them. Each man carried two nets, one in each hand (Gaiarbau in Winterbotham n.d.: 51-52).*

Walters makes an important observation that the various forms of fishing observed in Moreton Bay were mostly associated with mudflats, mangrove fringes, inshore sandbars and sandflats, and surf beaches (Walters 1985: 55).

Fish traps and spears were also used in Moreton Bay, with a stone walled fish trap found at Toorbul Point (Walters 1986). The following ethnographic account describes a possible method used to herd fish into the traps.

> *During the Mullet and Tailor seasons, if a shoal was close in, Mrs Birt would row out, trailing a bunch of Bribie pine, torulosa she oak and vanilla lily, this she maintained was necessary to attract the porpoises, very doubtful, but occasionally they would follow the dinghy and frighten a portion of the shoal into the trap. This exercise had to be performed on a falling tide; when it fully receded there would still be a couple of feet in the trap, with the top of the rock enclosure just awash. The fish were then easily caught with either scoop or cast nets… ("Old Salt" in Walters 1986: 44-45).*

Dolphins are also thought to have been employed to herd fish towards nets, particularly when the shore was too steep or Lacked rocks for the construction of fish traps (Hall 1999).

Large dugong herds were also common in the bay. In 1891 Campbell reported a herd spread over 5km long and 300m wide. "It was altogether the largest herd of these animals I ever saw, and I am afraid to make any computation as to the number of it" (Thomsom 1967: 105). A fixed herd of 'three or four hundred' year-round was noted by Welsby. This number greatly expanded during the winter months, when herds from the north migrated down to the bay (Welsby in Thomson 1967: 105). Seagrass beds, nourished by decaying plant matter brought down the rivers during late summer, were abundant during winter and attracted large herds. Groups of Aboriginal men netted the dugong on the shallow flats adjacent to bay islands, or set up nets overnight in channels near seagrass beds (Draper 1978). Although fish were easier to catch, the dugong provided a much larger quantity of meat.

> *Should any of the tribes on the sea coast have been so fortunate as to catch a sea-hog – called youngun – which sometimes is of the size of a young bullock, intelligence of the event is immediately sent along the coast to invite the neighbouring tribes to the banquet; this lasts, between incessant eating and sleeping when quite gorged, two or three days, until the whole animal is consumed…. (Eipper 1841 in Steele 1972: 284).*

In 1853 Stobart described the capture of a dugong, and the ceremony associated with this event.

> *They had just caught a junger (a French Dugong), a species of sea calf which abounds here and which they reckon a great delicacy and affords a great feast for them…. There is a sort of ceremony takes place … when it is brought on shore…. The women and the younger boys and children are not allowed to be present nor the women even to see the animal at all, though they have portions … sent to them. They pitched the head unskinned on the fire, those who assisted at the killing of it have the first slices and the rest seemed more as guests (Stobart in Love 1985:59-60).*

A model of Aboriginal subsistence and settlement by Draper (1978) highlights the seasonal nature of Aboriginal traditional activities in Moreton Bay before the vast impact of non-indigenous settlement.

The model was developed using biogeographical and documentary data and is supported by more recent archaeological research. Winter in Moreton Bay was a time of abundant marine and littoral resources, when dugong, shellfish and fish were plentiful (Draper 1978). Historical and ethnographic evidence suggests that, during this season, Aboriginal peoples concentrated on fishing and collecting shellfish. For people living on large bay islands, such as Moreton, the fishing season started in April when fish began to migrate into the bay. Groups of men mounted co-operative ventures using hand nets and large quantities of mullet, bream and tailor were caught. Staple foods during this season included fish and fern roots, with the diet supplemented with shellfish and other food species. Large numbers of dugong also migrated into Moreton Bay during winter and were an important food resource for Aboriginal groups. Plant foods were harvested from nearby wallum vegetation beyond the coastal dunes. “Midyim” berries, in particular, were plentiful growing in sandhill areas.

Huts were set up along the coast to cater for the concentration and movements of fish (Draper 1978). The following account discusses the presence of these huts in Moreton Bay and the general subsistence and settlement patterns followed by Aboriginal groups.

> *We were informed that these people had several such villages on the island; and that they resorted to one or to another, according to the weather, the season of the year, and the contiguity of food. At present they are near the opening between Moreton and Stradbroke Islands, depending chiefly on the shoals of mullet for food. A few weeks ago, they went further into the interior, collecting honey. At some seasons they resort to places producing wild fruits; and in wet weather, to elevated situations, contiguous to those parts of the coast, abounding with oysters. In these last situations, their huts are said to be large enough for a man to stand up in (Backhouse in Steele 1975: 228).*

Such an abundant supply of food during the winter months provided an opportunity for groups to meet and perform ceremonies. Such large-scale gatherings were an important aspect of Aboriginal culture in southeast Queensland (Sullivan 1977). The winter mullet runs in particular enabled groups to meet and participate in social and ceremonial activities. Bora grounds were often the meeting place used by groups for such gatherings. As with the bunya nut festivals, bora ceremonies lasted for several weeks and involved the gathering of a number of Aboriginal groups, many of who travelled great distances to meet with their neighbours (Petrie, 1904).

In contrast to the abundant food supply, and subsequent large-scale ceremonial gatherings, that took place during the winter months, early summer was both a less productive and less social time of year because of the threat of fire and the hot dry conditions (Draper 1978). During these months, food and freshwater was more abundant along the coast, rather than in inland areas. Fern roots were a staple food during this period and were found in fresh water swamp areas. Bevelled-edged pounders are commonly found in archaeological sites in Moreton Bay, providing evidence for the processing of such roots. Following the summer storms (October to December) more resources became available and several bird species came into season. Swans were caught easily and duck species were plentiful. Stobart recounted, as he sailed in Pumicestone Passage, that “we came upon a flock of some hundred Black swans…. The ducks here too were in great abundance” (Stobart in Love 1985: 63-64). Flying foxes also gathered in large numbers. St. Helena Island was known to be a roosting place. Stobart reported see “an immense flight of them in the air above the trees” (Stobart in Love 1985: 63).

New growth stimulated by the rains attracted larger macropods. Late summer was therefore a time for hunting. Animals were hunted using spears or herded into nets. Snakes, lizards, tortoises, goannas and grubs were also sought after (Hall 1980).

In summary, environmental, ethnographic and archaeological evidence indicates that Moreton Bay, its surrounding islands and mainland formed an extensive, resource-rich and significant landscape in which Aboriginal groups have lived for the past 6,000 years. Before this time, Aboriginal populations would have coped with changes in sea levels and climate, resulting in changes and fluctuations in landscape, flora and faunal populations. The ethnographic sources also provide a basis for comparison with current flora and fauna populations and may be of value in demonstrating changes to the environment of Moreton Bay after non-indigenous settlement.

3.3 A Cultural Landscape

While environmental, ethnographic and archaeological evidence may indicate the richness of the Moreton Bay environment during the past 6,000 or so years that would have been an important and sustaining resource for Aboriginal groups, these observations only give partial insights into the relationship between those Aboriginal groups and the land in which they lived and indeed continue to live. Often, the ethnographic reports provide a commentary on what the observer has found interesting, thus emphasizing a perspective that tends to focus on resources, rather than placingon the public record an understanding of the complex cultural and social network that existed, and continues to exist amongst Aboriginal people of Southeast Queensland.

Approximately one third of Queensland's Aboriginal and Torres Strait Islander population lives in Southeast Queensland (South East Queensland Regional Plan 2005). Many of these people have moved to the region. As contemporary residents, these people are often referred to as "historically associated", and may be regarded as stakeholders in the region similar to the non-indigenous population. In contrast, those Aboriginal people who are descendants of ancestors who lived in Southeast Queensland before non-indigenous settlement identify as Traditional Owners. Each of these groups is an important stakeholder in the community of Southeast Queensland, but Traditional Owners have additional and different aspirations to non-indigenous and historically associated indigenous stakeholders. Through their lineage, Traditional Owners inherit responsibilities under traditional law and custom to manage their land (often referred to as country), as well as a connection to country that is a cultural and spiritual relationship. This is best summed up in the words of Southeast Queensland's Traditional Owners:

> *As the current Aboriginal Traditional Owners in South East Queensland we have inherited a responsibility to look after our country. This responsibility has been handed to us by our ancestors, whose spirits continue to guide our decisions. We in turn have a responsibility to manage our country to the best of our abilities and to teach our youth the values and skills and provide them with the knowledge that they will need to manage our country with and after us….*
>
> *Cultural resources are all the tangible and intangible things in our land and sea country that are essential to our wellbeing: land, water, plants and animals (biodiversity), coastal and marine things, the air (atmosphere), and community. As Aboriginal people, we have such a deep and integral connection and set of relationships with these 'natural' elements that we consider them as cultural entities., Our identity as well as our cultural, spiritual and material*

> *wellbeing is entwined with the country and its health; without strong and healthy country, our people cannot be strong and healthy (SEQTOLSMA 2008: 8)*

In the absence of consultation as part of this brief, two important points should be made. Firstly, the statements of SEQTOLSMA would suggest that those Traditional Owners relevant to the Ramsar areas of Moreton Bay will have strong views on what will be considered their country or cultural resource, and will wish to take part in management decisions. Secondly, a further consideration is that the Traditional Owners relevant to Ramsar areas may have valuable historical knowledge of what these areas were like in the past, and what management strategies would be preferred. These points are best demonstrated through some case studies that are provided below.

*Case Study 1 – Blue Lake, North Stradbroke Island*

In 2007, consideration was given by the Queensland Government to the potential to harvest fresh water from aquifers on North Stradbroke Island for the water grid being developed across Southeast Queensland. Consultation was commenced with the Minjerribah Moorgumpin Elders in Council, the Aboriginal Cultural Heritage Body for North Stradbroke Island. During initial consultation, the Elders expressed deep concern about the project, as it potentially could impact directly on water levels in Blue Lake, a natural freshwater lake on the island. The Elders were particularly worried about such impacts because of the high levels of cultural significance associated with the lake. What constitutes the lake's cultural significance cannot be reported here, without consultation with and the permission of the Elders. Suffice to say that the Elders were extremely relieved when the project was abandoned because of general public concern.

This case study illuminates Traditional Owners' responsibilities and connection with country. Other people in the North Stradbroke community were concerned about the environmental impact of water harvesting on Blue Lake, a known and much appreciated natural part of the island. But the Traditional Owners' concerns were amplified by their cultural connection to the lake which is a significant Aboriginal area in the meaning of the ACH Act.

*Case Study 2 – Traditional Hunting Guidelines*

An excellent example of on-going traditional responsibilities and customs working today is provided by the Quandamooka people.

> *The Quandamooka people of the Moreton Bay area are continuing their ages old traditional hunting, which provides an important part of their diet. Working with the Queensland Environmental Protection Agency (EPA), the Quandamooka people have developed Traditional Hunting Guidelines to ensure that hunting practices are sustainable. With the new zoning plan in Moreton Bay Marine Park the Quandamooka people are looking to progress the Traditional Hunting Guidelines into a Traditional Use of Marine Resources Agreement (TUMRA) which will be the new best practice. Quandamooka people have demonstrated their commitment to making the Agreement work through six years of sound management since the establishment of the traditional Hunting Guidelines (SEQTOLSMA 2008: 13).*

*Case Study 3 – Native Title's Rights and Interests*

Whether or not native title is relevant from the perspective of land tenure in the Ramsar areas of Southeast Queensland is not a discussion for this assessment. Rather, the point being made is that the rights and interests detailed in the various native title claims in the Moreton Bay area give an indication of Traditional Owners' perspectives about their traditional responsibilities and rights. While the native title process may result in these claimed rights and interests only being relevant where native title has not been extinguished, from the Traditional Owners' perspectives, it is likely that they would prefer these rights and interests to be relevant in all of their country.

Consistent in the native title rights and interests claimed in all of the claim applications that cover parts of the Ramsar areas are the following themes:

- Access to enter and remain on lands and waters;
- Use and enjoy land and waters, including traditional hunting and gathering;
- Protection and management of the resources of lands and waters;
- Capacity to exercise customary rights and discharge traditional responsibilities;
- Recognition as Traditional Owners

The themes enunciated by the claimed rights and interests show that there is no differentiation between land and water – both are country – and all country requires protection and management.

*Case Study 4 – SEQTOLSMA*

The Moreton Bay region is home for a number of Traditional Owner groups. These are as follows:

| Moreton Bay Region and Ramsar Areas | |
|---|---|
| North of the Pine River, Deception Bay, Pumicestone Passage and Bribie Island and the Sunshine Coast | Kabi Kabi (sometimes called Gubbi Gubbi) families |
| Between the Pine and Logan Rivers and over Brisbane, with the exception of the coastal strip around Cleveland and Mt Cotton | Jagera and Turrbal families |
| Moreton and North Stradbroke Islands, many of the island of southern Moreton Bay, the coastal strip around Cleveland and Mt Cotton, and the sea between | Quandamooka (Ngugi, Noonucle, Gorenpul) families |
| Southern end of Moreton Bay, including islands and coastal strip | Yugambeh (eight groups) and Ngarang-Wal/Kombumeri families. |

**Table 1: Traditional Groups of Moreton Bay**

Other Traditional Owner groups include the Jinibara and Mulinjarlie families, but these groups are sub-coastal and may not necessarily have Ramsar areas in their traditional countries.

In 2005, representatives of all but two of these groups commenced negotiations about forming a body "to establish more comprehensive and meaningful Traditional Owner involvement and ownership in improving the condition of the region's natural resources", and "to promote more comprehensive and effective engagement of Traditional Owners in cultural (natural) resource management" (SEQTOLSMA 2008, p. iv). The outcome is the development of an on-going body of Traditional Owner representatives who have now developed a plan, called OUR PLAN, for the future (SEQTOLSMA 2008). Actions relevant to Ramsar areas that have been nominated by OUR PLAN include: the development of a Memorandum of Agreement with SEQ Catchments; developing alliances and partnerships at all levels of government and with the wider community; and becoming fully engaged in planning, decision-making and delivery of on-ground works (SEQTOLSMA 2008: 26).

The foundation of SEQTOLSMA is an important initiative that has the capacity to provide a central body with which consultation and management planning can be developed. SEQTOLSMA does not reduce the responsibilities of Traditional Owners, and recognizes that within the organization, certain Traditional Owners speak for parts (their country) of Southeast Queensland. In regard to the Ramsar areas of Moreton Bay, no one Traditional Owner will speak for them all; rather specific areas will be associated with certain groups, as shown in Table 1. In large part, this arrangement also reflects the requirements of the ACH Act in regard to cultural heritage decision-making by Aboriginal Parties.

Taking these arrangements into account, SEQTOLSMA offers an opportunity for the development of overarching management planning for Ramsar areas, with the additional capacity for relevant Traditional Owners to have input into those areas that are within their countries.

## 4. Summary

Aboriginal people have lived in Southeast Queensland and the Moreton region for many millennia. While traditional customs such as hunting and fire stick management would have impacted to some extent on the environment of the area, groups and families were supported by a rich variety of resources. The traditional perspective of and relationship with the region is much more than acknowledgement of rich resources, and is a spiritual and social linkage that is important to the wellbeing of Traditional Owners. Ethnographic sources emphasize the richness of available resource, but do not usually give insight into the cultural connection between Traditional Owners and the country that contained these resources.

Traditional Owners have a responsibility to manage their country. Although the brief to this assessment precluded consultation with Traditional Owners, the case studies provided above underline that the Traditional Owners of Southeast Queensland are continuing their traditional responsibilities. In the absence of guidance from Traditional Owners on this matter, it is reasonable to predict the following:

- Each of the Ramsar areas will hold significant cultural values to the relevant Traditional Owner group/s. These values may include physical and non-physical cultural heritage areas and objects, oral knowledge, such as stories, animals and plants, and the natural environment itself;

- The values of each of the Ramsar areas may be different to the others, e.g., the environmental, spiritual and cultural nature of Pumicestone Passage may have been different to those of North Stradbroke Island, and thus require differences in traditional management.

- Traditional Owners are already taking an active role in managing Ramsar areas as part of their management of the wider Moreton Bay area, and that they will wish to increase this role if offered the opportunity.
- The Traditional Owners have already formed an encompassing organization (SEQTOLSMA) which may prove to be a vehicle through which consultation and planning for the future could be organized. Only through consultation with the individual Traditional Owner groups could this be ascertained.

## 5. Sustaining Cultural Values

This assessment has demonstrated that there has been little to no assessment to date that is available in the public record about the cultural values of Ramsar area in Moreton Bay. Although this lack of information gives little insight into how cultural values are being sustained, hints are provided by initiatives detailed in case studies above.

## 6. Limits of Acceptable Change

Limits of acceptable change can only be measured through consultation with Traditional Owners. Limits of acceptable change will only become apparent, if indeed they do, after a detailed understanding about cultural values and how they are being sustained is achieved.

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# APPENDIX D: LIST OF KEY SPECIES AND COMMUNITIES

| Group | Species/Communities | Justification |
|---|---|---|
| Seagrass | *Halophila ovalis; H. decipiens; H. spinolsa; Halodule uninervis; Syringodium isoetifolium; Cymodocea serrulata; Zostera capricorni* | Ecosystem services |
| Mangroves | *Aegiceras corniculatum; Avicennia marina; Bruguiera gymnorhiza; Ceriops australis; Excoecaria agallocha; Lumnitzera racemosa; Rhizophora stylosa* | Ecosystem services |
| Saltmarsh | Numerous species | Ecosystem services |
| Freshwater emergent macrophytes | Numerous species | Ecosystem services |
| Ramsar habitat type | Unforested peatland (Type U); Forested peatlands (Type Xp); Permanent freshwater lakes (Type O). | Uncommon habitat types in bioregion |
| swamp daisy | *Olearia hygrophila* | Threatened |
| swamp orchids | *Phaius australis, P. bernaysii* and *P. tancarvilleae* | Threatened |
| knotweed | *Persicaria elatior* | Threatened |
| Marine turtles | *Chelonia mydas; Caretta caretta* | Threatened |
| dugong | *Dugong dugon* | Threatened |
| Wallum specialist fish species | *Nannoperca oxleyana; Pseudomugil mellis* | Threatened |
| Frog species | *Adelotus brevis, Crinia tinnula, Litoria cooloolensis, Litoria freycineti, Litoria olongburensis* | Threatened |
| Mangrove specialist species | *Xeromys myoides; Acrodipsas illidgei* | Threatened |
| Avifauna | *Botaurus poiciloptilus, Esacus* | Threatened |

| | | |
|---|---|---|
| | *neglectus, Rostratula australis, Sterna albifrons* | |
| Vertebrates | Refer to Tables 9-1 to 9-6. | Species present |

**Table D-1 Shorebirds**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB | MB Status |
|---|---|---|---|---|---|---|---|
| Scolopacidae | *Actitis hypoleucos* | common sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Arenaria interpres* | ruddy turnstone | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris acuminata* | sharp-tailed sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris alba* | Sanderling | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris canutus* | red knot | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris ferruginea* | curlew sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris melanotos* | pectoral sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris ruficollis* | red-necked stint | C | M | 1 | 1 | INBM |
| Scolopacidae | *Calidris subminuta* | long-toed stint | C | M | 1 | 1 | INBM, V |
| Scolopacidae | *Calidris tenuirostris* | great knot | C | M | 1 | 1 | INBM |
| Scolopacidae | *Gallinago hardwickii* | Latham's snipe | C | M | 1 | 1 | INBM |
| Scolopacidae | *Heteroscelus brevipes* | grey-tailed tattler | C | M | 1 | 1 | INBM |
| Scolopacidae | *Heteroscelus incanus* | wandering tattler | C | M | 1 | 1 | INBM |
| Scolopacidae | *Limicola falcinellus* | broad-billed sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Limnodromus semipalmatus* | Asian dowitcher | C | M | 1 | 1 | INBM |
| Scolopacidae | *Limosa lapponica* | bar-tailed godwit | C | M | 1 | 1 | INBM |
| Scolopacidae | *Limosa limosa* | black-tailed godwit | C | M | 1 | 1 | INBM |
| Scolopacidae | *Numenius madagascariensis* | eastern curlew | R | M | 1 | 1 | INBM |
| Scolopacidae | *Numenius minutus* | little curlew | C | M | 1 | 1 | INBM |
| Scolopacidae | *Numenius phaeopus* | whimbrel | C | M | 1 | 1 | INBM |
| Scolopacidae | *Phalaropus lobatus* | red-necked phalarope | C | M | 1 | 1 | INBM, V |
| Scolopacidae | *Philomachus pugnax* | ruff | C | M | 1 | 1 | INBM, V |
| Scolopacidae | *Tringa flavipes* | lesser yellowlegs | C | M | 1 | 1 | INBM, V |
| Scolopacidae | *Tringa glareola* | wood sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Tringa nebularia* | common greenshank | C | M | 1 | 1 | INBM |
| Scolopacidae | *Tringa stagnatilis* | marsh sandpiper | C | M | 1 | 1 | INBM |
| Scolopacidae | *Xenus cinereus* | terek sandpiper | C | M | 1 | 1 | INBM |
| Rostratulidae | *Rostratula australis* | Australian painted snipe | V | V,M | 1 | 1 | PBR |
| Jacanidae | *Irediparra gallinacea* | comb-crested jacana | C | M | 1 | 1 | BR |
| Burhinidae | *Burhinus grallarius* | bush stone-curlew | C |  | 1 | 1 | BR |
| Burhinidae | *Esacus neglectus* | beach stone-curlew | V |  | 1 | 1 | BR |
| Haematopodidae | *Haematopus fuliginosus* | sooty oystercatcher | R |  | 1 | 1 | BR |
| Haematopodidae | *Haematopus longirostris* | pied oystercatcher | C |  | 1 | 1 | BR |
| Recurvirostridae | *Cladorhynchus leucocephalus* | banded stilt | C | M | 1 |  | ANBR,V |
| Recurvirostridae | *Himantopus himantopus* | black-winged stilt | C | M | 1 | 1 | BR |
| Recurvirostridae | *Recurvirostra novaehollandiae* | red-necked avocet | C | M | 1 | 1 | BR |
| Charadriidae | *Charadrius bicinctus* | double-banded plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Charadrius leschenaultii* | greater sand plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Charadrius mongolus* | lesser sand plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Charadrius ruficapillus* | red-capped plover | C |  | 1 | 1 | BR |
| Charadriidae | *Charadrius veredus* | oriental plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Elseyornis melanops* | black-fronted dotterel | C |  | 1 | 1 | BR |
| Charadriidae | *Erythrogonys cinctus* | red-kneed dotterel | C |  | 1 | 1 | BR |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB | MB Status |
|---|---|---|---|---|---|---|---|
| Charadriidae | *Pluvialis fulva* | Pacific golden plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Pluvialis squatarola* | grey plover | C | M | 1 | 1 | INBM |
| Charadriidae | *Thinornis rubricollis* | hooded plover | C | | 1 | | ANBR,V |
| Charadriidae | *Vanellus miles* | masked lapwing | C | | 1 | 1 | BR |
| Charadriidae | *Vanellus tricolor* | banded lapwing | C | | 1 | 1 | BR |
| Glareolidae | *Glareola maldivarum* | oriental pratincole | C | M | 1 | 1 | INBM,V |
| Glareolidae | *Stiltia isabella* | Australian pratincole | C | M | 1 | 1 | ANBR,V |
| **Species Richness** | | | | | **50** | **48** | |

INBM Interntaional non-breeding migrant

BR Breeding resident

ANBR Australian non-breeding resident

PBR Possible breeding resident (though no breeding records to date)

**Table D-2 Waterbirds**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Anseranatidae | *Anseranas semipalmata* | magpie goose | C | M | 1 | 1 |
| Anatidae | *Anas castanea* | chestnut teal | C | M | 1 | 1 |
| Anatidae | *Anas gracilis* | grey teal | C | M | 1 | 1 |
| Anatidae | *Anas rhynchotis* | Australasian shoveler | C | M | 1 | |
| Anatidae | *Anas superciliosa* | Pacific black duck | C | M | 1 | 1 |
| Anatidae | *Aythya australis* | hardhead | C | M | 1 | 1 |
| Anatidae | *Biziura lobata* | musk duck | C | M | 1 | 1 |
| Anatidae | *Chenonetta jubata* | Australian wood duck | C | M | 1 | 1 |
| Anatidae | *Cygnus atratus* | black swan | C | M | 1 | 1 |
| Anatidae | *Dendrocygna arcuata* | wandering whistling-duck | C | M | 1 | 1 |
| Anatidae | *Dendrocygna eytoni* | plumed whistling-duck | C | M | 1 | 1 |
| Anatidae | *Malacorhynchus membranaceus* | pink-eared duck | C | M | 1 | |
| Anatidae | *Nettapus coromandelianus* | cotton pygmy-goose | R | M | 1 | 1 |
| Anatidae | *Nettapus pulchellus* | green pygmy-goose | C | M | 1 | |
| Anatidae | *Oxyura australis* | blue-billed duck | C | M | 1 | 1 |
| Anatidae | *Stictonetta naevosa* | freckled duck | R | M | 1 | 1 |
| Anatidae | *Tadorna radjah* | radjah shelduck | R | M | 1 | |
| Anatidae | *Tadorna tadornoides* | Australian shelduck | C | M | 1 | |
| Podicipedidae | *Podiceps cristatus* | great crested grebe | C | | 1 | 1 |
| Podicipedidae | *Poliocephalus poliocephalus* | hoary-headed grebe | C | | 1 | 1 |
| Podicipedidae | *Tachybaptus novaehollandiae* | Australasian grebe | C | | 1 | 1 |
| Anhingidae | *Anhinga melanogaster* | darter | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax carbo* | great cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax melanoleucos* | little pied cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax sulcirostris* | little black cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax varius* | pied cormorant | C | | 1 | 1 |
| Pelecanidae | *Pelecanus conspicillatus* | Australian pelican | C | | 1 | 1 |
| Ardeidae | *Ardea alba* | great egret | C | M | 1 | 1 |
| Ardeidae | *Ardea ibis* | cattle egret | C | | 1 | 1 |
| Ardeidae | *Ardea intermedia* | intermediate egret | C | | 1 | 1 |
| Ardeidae | *Ardea pacifica* | white-necked heron | C | | 1 | 1 |
| Ardeidae | *Ardea sumatrana* | great-billed heron | C | | 1 | |
| Ardeidae | *Botaurus poiciloptilus* | Australasian bittern | C | | 1 | 1 |
| Ardeidae | *Egretta garzetta* | little egret | C | | 1 | 1 |
| Ardeidae | *Egretta novaehollandiae* | white-faced heron | C | | 1 | 1 |
| Ardeidae | *Ixobrychus flavicollis* | black bittern | C | | 1 | 1 |
| Ardeidae | *Ixobrychus minutus* | little bittern | C | | 1 | 1 |
| Ardeidae | *Nycticorax caledonicus* | nankeen night heron | C | | 1 | 1 |
| Threskiornithidae | *Platalea flavipes* | yellow-billed spoonbill | C | | 1 | 1 |
| Threskiornithidae | *Platalea regia* | royal spoonbill | C | | 1 | 1 |
| Threskiornithidae | *Plegadis falcinellus* | glossy ibis | C | | 1 | 1 |
| Threskiornithidae | *Threskiornis molucca* | Australian white ibis | C | | 1 | 1 |
| Threskiornithidae | *Threskiornis spinicollis* | straw-necked ibis | C | | 1 | 1 |
| Ciconiidae | *Ephippiorhynchus asiaticus* | black-necked stork | R | | 1 | 1 |
| Gruidae | *Grus rubicunda* | brolga | C | M | 1 | 1 |
| Rallidae | *Amaurornis olivaceus* | bush-hen | C | | 1 | 1 |
| Rallidae | *Fulica atra* | Eurasian coot | C | | 1 | 1 |
| Rallidae | *Gallinula tenebrosa* | dusky moorhen | C | | 1 | 1 |
| Rallidae | *Gallinula ventralis* | black-tailed native-hen | C | | 1 | |
| Rallidae | *Gallirallus philippensis* | buff-banded rail | C | | 1 | 1 |
| Rallidae | *Porphyrio porphyrio* | purple swamphen | C | | 1 | 1 |
| Rallidae | *Porzana fluminea* | Australian spotted crake | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Rallidae | *Porzana pusilla* | Baillon's crake | C | | 1 | 1 |
| Rallidae | *Porzana tabuensis* | spotless crake | C | | 1 | |
| Rallidae | *Rallus pectoralis* | Lewin's rail | R | | 1 | 1 |
| Scolopacidae | *Gallinago hardwickii* | Latham's snipe | C | M | 1 | 1 |
| Rostratulidae | *Rostratula australis* | australian painted snipe | V | V,M | 1 | 1 |
| Jacanidae | *Irediparra gallinacea* | comb-crested jacana | C | | 1 | 1 |
| Recurvirostridae | *Cladorhynchus leucocephalus* | banded stilt | C | M | 1 | |
| Recurvirostridae | *Himantopus himantopus* | black-winged stilt | C | M | 1 | 1 |
| Recurvirostridae | *Recurvirostra novaehollandiae* | red-necked avocet | C | M | 1 | 1 |
| Charadriidae | *Elseyornis melanops* | black-fronted dotterel | C | M | 1 | 1 |
| Charadriidae | *Erythrogonys cinctus* | red-kneed dotterel | C | M | 1 | 1 |
| Charadriidae | *Vanellus miles* | masked lapwing | C | | 1 | 1 |
| Laridae | *Chlidonias hybridus* | whiskered tern | C | | 1 | 1 |
| Laridae | *Chlidonias leucopterus* | white-winged black tern | C | M | 1 | 1 |
| **Species Richness** | | | | | **66** | **57** |

**Table D-3 Mammals**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Ornithorhynchidae | *Ornithorhynchus anatinus* | platypus | C | | 1 | |
| Tachyglossidae | *Tachyglossus aculeatus* | short-beaked echidna | C | | 1 | 1 |
| Dasyuridae | *Antechinus flavipes* | yellow-footed antechinus | C | | 1 | 1 |
| Dasyuridae | *Antechinus subtropicus* | | C | | 1 | |
| Dasyuridae | *Dasyurus hallucatus* | northern quoll | C | | 1 | |
| Dasyuridae | *Dasyurus maculatus* | spotted-tailed quoll (southern subspecies) | V | E | 1 | |
| Dasyuridae | *Phascogale tapoatafa* | brush-tailed phascogale | C | | 1 | 1 |
| Dasyuridae | *Planigale maculata* | common planigale | C | | 1 | 1 |
| Dasyuridae | *Sminthopsis murina* | common dunnart | C | | 1 | 1 |
| Peramelidae | *Isoodon macrourus* | northern brown bandicoot | C | | 1 | 1 |
| Peramelidae | *Perameles nasuta* | long-nosed bandicoot | C | | 1 | 1 |
| Phascolarctidae | *Phascolarctos cinereus* | koala (SEQ bioregion) | V | | 1 | 1 |
| Vombatidae | *Vombatus ursinus* | common wombat | R | | 1 | |
| Burramyidae | *Cercartetus nanus* | eastern pygmy-possum | C | | 1 | |
| Petauridae | *Petaurus australis* | yellow-bellied glider | C | | 1 | |
| Petauridae | *Petaurus breviceps* | sugar glider | C | | 1 | 1 |
| Petauridae | *Petaurus norfolcensis* | squirrel glider | C | | 1 | 1 |
| Pseudocheiridae | *Petauroides volans* | greater glider | C | | 1 | |
| Pseudocheiridae | *Pseudocheirus peregrinus* | common ringtail possum | C | | 1 | 1 |
| Acrobatidae | *Acrobates pygmaeus* | feathertail glider | C | | 1 | 1 |
| Phalangeridae | *Trichosurus caninus* | short-eared possum | C | | 1 | |
| Phalangeridae | *Trichosurus vulpecula* | common brushtail possum | C | | 1 | 1 |
| Potoroidae | *Aepyprymnus rufescens* | rufous bettong | C | | 1 | |
| Potoroidae | *Potorous tridactylus* | long-nosed potoroo | V | V | 1 | |
| Macropodidae | *Macropus agilis* | agile wallaby | C | | 1 | 1 |
| Macropodidae | *Macropus dorsalis* | black-striped wallaby | C | | 1 | |
| Macropodidae | *Macropus giganteus* | eastern grey kangaroo | C | | 1 | 1 |
| Macropodidae | *Macropus parryi* | whiptail wallaby | C | | 1 | |
| Macropodidae | *Macropus robustus* | common wallaroo | C | | 1 | |
| Macropodidae | *Macropus rufogriseus* | red-necked wallaby | C | | 1 | 1 |
| Macropodidae | *Petrogale herberti* | Herbert's rock-wallaby | C | | 1 | |
| Macropodidae | *Petrogale penicillata* | brush-tailed rock-wallaby | V | V | 1 | |
| Macropodidae | *Thylogale stigmatica* | red-legged pademelon | C | | 1 | |
| Macropodidae | *Thylogale thetis* | red-necked pademelon | C | | 1 | |
| Macropodidae | *Wallabia bicolor* | swamp wallaby | C | | 1 | 1 |
| Pteropodidae | *Nyctimene robinsoni* | eastern tube-nosed bat | C | | 1 | |
| Pteropodidae | *Pteropus alecto* | black flying-fox | C | | 1 | 1 |
| Pteropodidae | *Pteropus poliocephalus* | grey-headed flying-fox | C | V | 1 | 1 |
| Pteropodidae | *Pteropus scapulatus* | little red flying-fox | C | | 1 | 1 |
| Pteropodidae | *Syconycteris australis* | eastern blossom bat | C | | 1 | 1 |
| Megadermatidae | *Macroderma gigas* | ghost bat | V | | 1 | |
| Rhinolophidae | *Rhinolophus megaphyllus* | eastern horseshoe-bat | C | | 1 | |
| Rhinolophidae | *Rhinolophus philippinensis* | greater large-eared horseshoe bat | E | E | 1 | |
| Hipposideridae | *Hipposideros semoni* | Semon`s leaf-nosed bat | E | E | 1 | |
| Emballonuridae | *Saccolaimus flaviventris* | yellow-bellied sheathtail bat | C | | 1 | 1 |
| Emballonuridae | *Taphozous georgianus* | common sheathtail bat | C | | 1 | |
| Molossidae | *Mormopterus beccarii* | Beccari's freetail bat | C | | 1 | 1 |
| Molossidae | *Mormopterus norfolkensis* | east coast freetail bat | C | | 1 | 1 |
| Molossidae | *Mormopterus planiceps* | southern freetail bat | C | | 1 | |
| Molossidae | *Mormopterus sp. 2* | eastern freetail bat | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Molossidae | *Nyctinomus australis* | white-striped freetail bat | C | | 1 | 1 |
| Vespertilionidae | *Chalinolobus dwyeri* | large-eared pied bat | R | V | 1 | |
| Vespertilionidae | *Chalinolobus gouldii* | Gould's wattled bat | C | | 1 | 1 |
| Vespertilionidae | *Chalinolobus morio* | chocolate wattled bat | C | | 1 | 1 |
| Vespertilionidae | *Chalinolobus nigrogriseus* | hoary wattled bat | C | | 1 | 1 |
| Vespertilionidae | *Chalinolobus picatus* | little pied bat | R | | 1 | |
| Vespertilionidae | *Falsistrellus tasmaniensis* | eastern false pipistrelle | C | | 1 | |
| Vespertilionidae | *Kerivoula papuensis* | golden-tipped bat | R | | 1 | |
| Vespertilionidae | *Miniopterus australis* | little bent-wing bat | C | | 1 | 1 |
| Vespertilionidae | *Miniopterus schreibersii* | eastern bent-wing bat | C | CD | 1 | 1 |
| Vespertilionidae | *Myotis macropus* | large-footed myotis | C | | 1 | 1 |
| Vespertilionidae | *Nyctophilus bifax* | northern long-eared bat | C | | 1 | 1 |
| Vespertilionidae | *Nyctophilus geoffroyi* | lesser long-eared bat | C | | 1 | |
| Vespertilionidae | *Nyctophilus gouldi* | Gould's long-eared bat | C | | 1 | 1 |
| Vespertilionidae | *Nyctophilus timoriensis* | eastern long-eared bat | V | V | 1 | |
| Vespertilionidae | *Pipistrellus adamsi* | Cape York pipistrelle | C | | 1 | |
| Vespertilionidae | *Scoteanax rueppellii* | greater broad-nosed bat | C | | 1 | 1 |
| Vespertilionidae | *Scotorepens balstoni* | inland broad-nosed bat | C | | 1 | |
| Vespertilionidae | *Scotorepens greyii* | little broad-nosed bat | C | | 1 | |
| Vespertilionidae | *Scotorepens orion* | south-eastern broad-nosed bat | C | | 1 | 1 |
| Vespertilionidae | *Scotorepens sanborni* | northern broad-nosed bat | C | | 1 | |
| Vespertilionidae | *Scotorepens sp. (Parnaby)* | central-eastern broad-nosed bat | C | | 1 | 1 |
| Vespertilionidae | *Vespadelus darlingtoni* | large forest bat | C | | 1 | |
| Vespertilionidae | *Vespadelus pumilus* | eastern forest bat | C | | 1 | |
| Vespertilionidae | *Vespadelus regulus* | souther forest bat | C | | 1 | |
| Vespertilionidae | *Vespadelus troughtoni* | eastern cave bat | C | | 1 | 1 |
| Vespertilionidae | *Vespadelus vulturnus* | little forest bat | C | | 1 | |
| Muridae | *Hydromys chrysogaster* | water rat | C | | 1 | 1 |
| Muridae | *Melomys burtoni* | grassland melomys | C | | 1 | 1 |
| Muridae | *Melomys cervinipes* | fawn-footed melomys | C | | 1 | 1 |
| Muridae | *Pseudomys delicatulus* | delicate mouse | C | | 1 | 1 |
| Muridae | *Pseudomys gracilicaudatus* | eastern chestnut mouse | C | | 1 | |
| Muridae | *Pseudomys novaehollandiae* | New Holland mouse | C | | 1 | |
| Muridae | *Pseudomys oralis* | Hastings River mouse | V | E | 1 | |
| Muridae | *Pseudomys patrius* | eastern pebble-mound mouse | C | | 1 | |
| Muridae | *Rattus fuscipes* | bush rat | C | | 1 | 1 |
| Muridae | *Rattus lutreolus* | swamp rat | C | | 1 | 1 |
| Muridae | *Rattus sordidus* | canefield rat | C | | 1 | |
| Muridae | *Rattus tunneyi* | pale field-rat | C | | 1 | |
| Muridae | *Xeromys myoides* | false water-rat | V | V | 1 | 1 |
| Canidae | *Canis lupus dingo* | dingo | | | 1 | |
| **Species Richness** | | | | | **91** | **45** |

**Table D-4 Reptiles**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Chelidae | *Chelodina expansa* | broad-shelled river turtle | C | | 1 | |
| Chelidae | *Chelodina longicollis* | eastern snake-necked turtle | C | | 1 | 1 |
| Chelidae | *Elseya dentata* | northern snapping turtle | C | | 1 | |
| Chelidae | *Elseya latisternum* | saw-shelled turtle | C | | 1 | 1 |
| Chelidae | *Elusor macrurus* | Mary River turtle | E | E | 1 | |
| Chelidae | *Emydura macquarii krefftii* | Krefft's river turtle | C | | 1 | |
| Chelidae | *Emydura macquarii macquarii* | Murray turtle | C | | 1 | |
| Chelidae | *Emydura macquarii nigra* | Fraser Island short-neck turtle | C | | 1 | |
| Chelidae | *Emydura macquarii signata* | Brisbane short-necked turtle | C | | 1 | 1 |
| Gekkonidae | *Diplodactylus steindachneri* | Steindachner's gecko | C | | 1 | |
| Gekkonidae | *Diplodactylus vittatus* | wood gecko | C | | 1 | 1 |
| Gekkonidae | *Gehyra australis* | northern dtella | C | | 1 | |
| Gekkonidae | *Gehyra dubia* | | C | | 1 | 1 |
| Gekkonidae | *Gehyra variegata* | tree dtella | C | | 1 | |
| Gekkonidae | *Heteronotia binoei* | Bynoe's gecko | C | | 1 | 1 |
| Gekkonidae | *Nephrurus milii* | | C | | 1 | |
| Gekkonidae | *Oedura lesueurii* | Lesueur's velvet gecko | C | | 1 | |
| Gekkonidae | *Oedura monilis* | | C | | 1 | |
| Gekkonidae | *Oedura ocellata* | | C | | 1 | |
| Gekkonidae | *Oedura rhombifer* | zig-zag gecko | C | | 1 | |
| Gekkonidae | *Oedura robusta* | robust velvet gecko | C | | 1 | 1 |
| Gekkonidae | *Oedura tryoni* | southern spotted velvet gecko | C | | 1 | |
| Gekkonidae | *Phyllurus caudiannulatus* | ringed thin-tailed gecko | R | | 1 | |
| Gekkonidae | *Saltuarius cornutus* | northern leaf-tailed gecko | C | | 1 | |
| Gekkonidae | *Saltuarius salebrosus* | rough-throated leaf-tailed gecko | C | | 1 | |
| Gekkonidae | *Strophurus elderi* | jewelled gecko | C | | 1 | |
| Gekkonidae | *Strophurus taenicauda* | golden-tailed gecko | R | | 1 | |
| Gekkonidae | *Strophurus williamsi* | soft-spined gecko | C | | 1 | |
| Gekkonidae | *Underwoodisaurus milii* | | | | 1 | |
| Pygopodidae | *Delma inornata* | | C | | 1 | |
| Pygopodidae | *Delma plebeia* | common delma | C | | 1 | |
| Pygopodidae | *Delma tincta* | | C | | 1 | |
| Pygopodidae | *Delma torquata* | collared delma | V | V | 1 | |
| Pygopodidae | *Lialis burtonis* | Burton's legless lizard | C | | 1 | 1 |
| Pygopodidae | *Paradelma orientalis* | brigalow scaly-foot | V | V | 1 | |
| Pygopodidae | *Pygopus lepidopodus* | common scaly-foot | C | | 1 | 1 |
| Pygopodidae | *Pygopus schraderi* | | C | | 1 | |
| Agamidae | *Amphibolurus muricatus* | jacky lizard | C | | 1 | |
| Agamidae | *Amphibolurus nobbi* | | C | | 1 | |
| Agamidae | *Chlamydosaurus kingii* | frilled lizard | C | | 1 | 1 |
| Agamidae | *Diporiphora australis* | | C | | 1 | 1 |
| Agamidae | *Diporiphora bilineata* | two-lined dragon | C | | 1 | |
| Agamidae | *Hypsilurus spinipes* | southern angle-headed dragon | C | | 1 | |
| Agamidae | *Physignathus lesueurii* | eastern water dragon | C | | 1 | 1 |
| Agamidae | *Pogona barbata* | bearded dragon | C | | 1 | 1 |
| Varanidae | *Varanus gouldii* | sand monitor | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Varanidae | *Varanus tristis* | black-tailed monitor | C | | 1 | |
| Varanidae | *Varanus varius* | lace monitor | C | | 1 | 1 |
| Scincidae | *Anomalopus leuckartii* | | C | | 1 | |
| Scincidae | *Anomalopus verreauxii* | | C | | 1 | 1 |
| Scincidae | *Calyptotis lepidorostrum* | | C | | 1 | |
| Scincidae | *Calyptotis scutirostrum* | | C | | 1 | 1 |
| Scincidae | *Calyptotis temporalis* | | C | | 1 | |
| Scincidae | *Carlia amax* | | C | | 1 | |
| Scincidae | *Carlia foliorum* | | C | | 1 | 1 |
| Scincidae | *Carlia munda* | | C | | 1 | |
| Scincidae | *Carlia pectoralis* | | C | | 1 | |
| Scincidae | *Carlia schmeltzii* | | C | | 1 | |
| Scincidae | *Carlia tetradactyla* | | C | | 1 | |
| Scincidae | *Carlia vivax* | | C | | 1 | 1 |
| Scincidae | *Cautula zia* | | R | | 1 | |
| Scincidae | *Coeranoscincus reticulatus* | three-toed snake-tooth skink | R | V | 1 | |
| Scincidae | *Coggeria naufragus* | satinay sand skink | C | | 1 | |
| Scincidae | *Cryptoblepharus plagiocephalus* | | C | | 1 | |
| Scincidae | *Cryptoblepharus virgatus* | | C | | 1 | 1 |
| Scincidae | *Ctenotus arcanus* | | C | | 1 | 1 |
| Scincidae | *Ctenotus eurydice* | | C | | 1 | |
| Scincidae | *Ctenotus robustus* | | C | | 1 | 1 |
| Scincidae | *Ctenotus taeniolatus* | copper-tailed skink | C | | 1 | 1 |
| Scincidae | *Cyclodomorphus gerrardii* | pink-tongued lizard | C | | 1 | 1 |
| Scincidae | *Egernia cunninghami* | Cunningham's skink | C | | 1 | |
| Scincidae | *Egernia frerei* | major skink | C | | 1 | 1 |
| Scincidae | *Egernia major* | land mullet | C | | 1 | 1 |
| Scincidae | *Egernia mcpheei* | | C | | 1 | |
| Scincidae | *Egernia modesta* | | C | | 1 | |
| Scincidae | *Egernia rugosa* | yakka skink | V | V | 1 | |
| Scincidae | *Egernia striolata* | tree skink | C | | 1 | 1 |
| Scincidae | *Egernia whitii* | White's skink | C | | 1 | |
| Scincidae | *Eremiascincus fasciolatus* | narrow-banded sand swimmer | C | | 1 | |
| Scincidae | *Eremiascincus richardsonii* | broad-banded sand swimmer | C | | 1 | |
| Scincidae | *Eroticoscincus graciloides* | | R | | 1 | |
| Scincidae | *Eulamprus brachysoma* | | C | | 1 | |
| Scincidae | *Eulamprus martini* | | C | | 1 | 1 |
| Scincidae | *Eulamprus murrayi* | | C | | 1 | |
| Scincidae | *Eulamprus quoyii* | eastern water skink | C | | 1 | |
| Scincidae | *Eulamprus tenuis* | | C | | 1 | 1 |
| Scincidae | *Eulamprus tryoni* | | C | | 1 | |
| Scincidae | *Hemisphaeriodon gerrardii* | | | | 1 | |
| Scincidae | *Lampropholis adonis* | | C | | 1 | |
| Scincidae | *Lampropholis amicula* | | C | | 1 | 1 |
| Scincidae | *Lampropholis colossus* | | R | | 1 | |
| Scincidae | *Lampropholis couperi* | | C | | 1 | |
| Scincidae | *Lampropholis delicata* | | C | | 1 | 1 |
| Scincidae | *Lampropholis guichenoti* | | C | | 1 | 1 |
| Scincidae | *Lerista fragilis* | | C | | 1 | |
| Scincidae | *Lerista punctatovittata* | | C | | 1 | |
| Scincidae | *Menetia greyii* | | C | | 1 | |
| Scincidae | *Menetia timlowi* | | C | | 1 | |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Scincidae | *Morethia boulengeri* | | C | | 1 | |
| Scincidae | *Morethia taeniopleura* | fire-tailed skink | C | | 1 | 1 |
| Scincidae | *Nangura spinosa* | Nangur skink | R | | 1 | |
| Scincidae | *Ophioscincus cooloolensis* | | R | | 1 | |
| Scincidae | *Ophioscincus ophioscincus* | | C | | 1 | |
| Scincidae | *Ophioscincus truncatus* | | R | | 1 | 1 |
| Scincidae | *Saiphos equalis* | | C | | 1 | 1 |
| Scincidae | *Saproscincus rosei* | | R | | 1 | |
| Scincidae | *Saproscincus spectabilis* | | R | | 1 | |
| Scincidae | *Tiliqua scincoides* | eastern blue-tongued lizard | C | | 1 | 1 |
| Typhlopidae | *Ramphotyphlops affinis* | | C | | 1 | |
| Typhlopidae | *Ramphotyphlops ligatus* | | C | | 1 | 1 |
| Typhlopidae | *Ramphotyphlops nigrescens* | | C | | 1 | |
| Typhlopidae | *Ramphotyphlops proximus* | | C | | 1 | 1 |
| Typhlopidae | *Ramphotyphlops silvia* | | R | | 1 | |
| Typhlopidae | *Ramphotyphlops unguirostris* | | C | | 1 | |
| Typhlopidae | *Ramphotyphlops wiedii* | | C | | 1 | 1 |
| Boidae | *Antaresia maculosus* | | C | | 1 | |
| Boidae | *Aspidites melanocephalus* | black-headed python | C | | 1 | |
| Boidae | *Morelia spilota* | carpet python | C | | 1 | 1 |
| Colubridae | *Boiga irregularis* | brown tree snake | C | | 1 | 1 |
| Colubridae | *Dendrelaphis punctulata* | common tree snake | C | | 1 | 1 |
| Colubridae | *Tropidonophis mairii* | freshwater snake | C | | 1 | 1 |
| Elapidae | *Acanthophis antarcticus* | common death adder | R | | 1 | 1 |
| Elapidae | *Brachyurophis australis* | coral snake | C | | 1 | |
| Elapidae | *Cacophis harriettae* | white-crowned snake | C | | 1 | 1 |
| Elapidae | *Cacophis krefftii* | dwarf crowned snake | C | | 1 | 1 |
| Elapidae | *Cacophis squamulosus* | golden crowned snake | C | | 1 | |
| Elapidae | *Cryptophis boschmai* | Carpentaria whip snake | C | | 1 | |
| Elapidae | *Cryptophis nigrescens* | eastern small-eyed snake | C | | 1 | 1 |
| Elapidae | *Cryptophis nigrostriatus* | black-striped snake | C | | 1 | |
| Elapidae | *Demansia psammophis* | yellow-faced whip snake | C | | 1 | 1 |
| Elapidae | *Demansia torquata* | collared whip snake | C | | 1 | |
| Elapidae | *Demansia vestigiata* | black whip snake | C | | 1 | |
| Elapidae | *Denisonia devisi* | De Vis' Banded Snake | C | | 1 | |
| Elapidae | *Furina diadema* | red-naped snake | C | | 1 | |
| Elapidae | *Furina dunmalli* | Dunmall's snake | V | V | 1 | |
| Elapidae | *Furina ornata* | orange-naped snake | C | | 1 | |
| Elapidae | *Hemiaspis damelii* | grey snake | E | | 1 | |
| Elapidae | *Hemiaspis signata* | black-bellied swamp snake | C | | 1 | 1 |
| Elapidae | *Hoplocephalus bitorquatus* | pale-headed snake | C | | 1 | |
| Elapidae | *Hoplocephalus stephensii* | Stephens' banded snake | R | | 1 | |
| Elapidae | *Notechis scutatus* | eastern tiger snake | C | | 1 | |
| Elapidae | *Oxyuranus scutellatus* | taipan | C | | 1 | |
| Elapidae | *Pseudechis australis* | king brown snake | C | | 1 | |
| Elapidae | *Pseudechis guttatus* | spotted black snake | C | | 1 | |
| Elapidae | *Pseudechis porphyriacus* | red-bellied black snake | C | | 1 | 1 |
| Elapidae | *Pseudonaja nuchalis* | western brown snake | C | | 1 | |
| Elapidae | *Pseudonaja textilis* | eastern brown snake | C | | 1 | 1 |
| Elapidae | *Simoselaps warro* | robust burrowing | R | | 1 | |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| | | snake | | | | |
| Elapidae | *Suta suta* | Myall Snake | C | | 1 | |
| Elapidae | *Tropidechis carinatus* | rough-scaled snake | C | | 1 | |
| Elapidae | *Vermicella annulata* | bandy-bandy | C | | 1 | 1 |
| **Species Richness** | | | | | **151** | **52** |

**Table D-5 Frogs**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Myobatrachidae | *Adelotus brevis* | tusked frog | V | | 1 | 1 |
| Myobatrachidae | *Assa darlingtoni* | pouched frog | R | | 1 | |
| Myobatrachidae | *Crinia deserticola* | chirping froglet | C | | 1 | |
| Myobatrachidae | *Crinia parinsignifera* | beeping froglet | C | | 1 | 1 |
| Myobatrachidae | *Crinia signifera* | clicking froglet | C | | 1 | 1 |
| Myobatrachidae | *Crinia tinnula* | wallum froglet | V | | 1 | 1 |
| Myobatrachidae | *Lechriodus fletcheri* | black soled frog | R | | 1 | |
| Myobatrachidae | *Limnodynastes dumerilii* | grey bellied pobblebonk | C | | 1 | |
| Myobatrachidae | *Limnodynastes fletcheri* | barking frog | C | | 1 | |
| Myobatrachidae | *Limnodynastes peronii* | striped marshfrog | C | | 1 | 1 |
| Myobatrachidae | *Limnodynastes salmini* | salmon striped frog | C | | 1 | |
| Myobatrachidae | *Limnodynastes tasmaniensis* | spotted grassfrog | C | | 1 | 1 |
| Myobatrachidae | *Limnodynastes terraereginae* | scarlet sided pobblebonk | C | | 1 | |
| Myobatrachidae | *Mixophyes fasciolatus* | great barred frog | C | | 1 | |
| Myobatrachidae | *Mixophyes fleayi* | Fleay's barred frog | E | E | 1 | |
| Myobatrachidae | *Mixophyes iteratus* | giant barred frog | E | E | 1 | |
| Myobatrachidae | *Opisthodon ornatus* | ornate burrowing frog | C | | 1 | 1 |
| Myobatrachidae | *Philoria kundagungun* | mountain frog | R | | 1 | |
| Myobatrachidae | *Philoria loveridgeri* | Loveridege's Frog | R | | 1 | |
| Myobatrachidae | *Pseudophryne coriacea* | red backed broodfrog | C | | 1 | 1 |
| Myobatrachidae | *Pseudophryne major* | great brown broodfrog | C | | 1 | 1 |
| Myobatrachidae | *Pseudophryne raveni* | copper backed broodfrog | C | | 1 | 1 |
| Myobatrachidae | *Taudactylus pleione* | Kroombit tinkerfrog | E | V | 1 | |
| Myobatrachidae | *Uperoleia fusca* | dusky gungan | C | | 1 | 1 |
| Myobatrachidae | *Uperoleia laevigata* | eastern gungan | C | | 1 | 1 |
| Myobatrachidae | *Uperoleia rugosa* | chubby gungan | C | | 1 | 1 |
| Hylidae | *Cyclorana alboguttata* | greenstripe frog | C | | 1 | |
| Hylidae | *Cyclorana brevipes* | superb collared frog | C | | 1 | |
| Hylidae | *Cyclorana novaehollandiae* | eastern snapping frog | C | | 1 | |
| Hylidae | *Litoria bicolor* | northern sedgefrog | C | | 1 | |
| Hylidae | *Litoria brevipalmata* | green thighed frog | R | | 1 | |
| Hylidae | *Litoria caerulea* | common green treefrog | C | | 1 | 1 |
| Hylidae | *Litoria chloris* | orange eyed treefrog | C | | 1 | |
| Hylidae | *Litoria cooloolensis* | Cooloola sedgefrog | R | | 1 | 1 |
| Hylidae | *Litoria dentata* | bleating treefrog | C | | 1 | 1 |
| Hylidae | *Litoria fallax* | eastern sedgefrog | C | | 1 | 1 |
| Hylidae | *Litoria freycineti* | wallum rocketfrog | V | | 1 | 1 |
| Hylidae | *Litoria gracilenta* | graceful treefrog | C | | 1 | 1 |
| Hylidae | *Litoria inermis* | bumpy rocketfrog | C | | 1 | |
| Hylidae | *Litoria latopalmata* | broad palmed rocketfrog | C | | 1 | 1 |
| Hylidae | *Litoria nasuta* | striped rocketfrog | C | | 1 | 1 |
| Hylidae | *Litoria olongburensis* | wallum sedgefrog | V | V | 1 | 1 |
| Hylidae | *Litoria pearsoniana* | cascade treefrog | E | | 1 | |
| Hylidae | *Litoria peronii* | emerald spotted treefrog | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Hylidae | *Litoria rothii* | northern laughing treefrog | C | | 1 | |
| Hylidae | *Litoria rubella* | ruddy treefrog | C | | 1 | 1 |
| Hylidae | *Litoria tyleri* | southern laughing treefrog | C | | 1 | 1 |
| Hylidae | *Litoria verreauxii* | whistling treefrog | C | | 1 | |
| Hylidae | *Litoria wilcoxii* | stony creek frog | C | | 1 | 1 |
| **Species Richness** | | | | | **49** | **26** |

**Table D-6 Birds**

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Casuariidae | *Dromaius novaehollandiae* | emu | C | | 1 | 1 |
| Megapodiidae | *Alectura lathami* | Australian brush-turkey | C | | 1 | 1 |
| Phasianidae | *Coturnix chinensis* | king quail | C | | 1 | 1 |
| Phasianidae | *Coturnix pectoralis* | stubble quail | C | | 1 | 1 |
| Phasianidae | *Coturnix ypsilophora* | brown quail | C | | 1 | 1 |
| Anseranatidae | *Anseranas semipalmata* | magpie goose | C | | 1 | 1 |
| Anatidae | *Anas castanea* | chestnut teal | C | | 1 | 1 |
| Anatidae | *Anas gracilis* | grey teal | C | | 1 | 1 |
| Anatidae | *Anas rhynchotis* | Australasian shoveler | C | | 1 | |
| Anatidae | *Anas superciliosa* | Pacific black duck | C | | 1 | 1 |
| Anatidae | *Aythya australis* | hardhead | C | | 1 | 1 |
| Anatidae | *Biziura lobata* | musk duck | C | | 1 | 1 |
| Anatidae | *Chenonetta jubata* | Australian wood duck | C | | 1 | 1 |
| Anatidae | *Cygnus atratus* | black swan | C | | 1 | 1 |
| Anatidae | *Dendrocygna arcuata* | wandering whistling-duck | C | | 1 | 1 |
| Anatidae | *Dendrocygna eytoni* | plumed whistling-duck | C | | 1 | 1 |
| Anatidae | *Malacorhynchus membranaceus* | pink-eared duck | C | | 1 | |
| Anatidae | *Nettapus coromandelianus* | cotton pygmy-goose | R | | 1 | 1 |
| Anatidae | *Nettapus pulchellus* | green pygmy-goose | C | | 1 | |
| Anatidae | *Oxyura australis* | blue-billed duck | C | | 1 | 1 |
| Anatidae | *Stictonetta naevosa* | freckled duck | R | | 1 | 1 |
| Anatidae | *Tadorna radjah* | radjah shelduck | R | | 1 | |
| Anatidae | *Tadorna tadornoides* | Australian shelduck | C | | 1 | |
| Podicipedidae | *Podiceps cristatus* | great crested grebe | C | | 1 | 1 |
| Podicipedidae | *Poliocephalus poliocephalus* | hoary-headed grebe | C | | 1 | 1 |
| Podicipedidae | *Tachybaptus novaehollandiae* | Australasian grebe | C | | 1 | 1 |
| Sulidae | *Morus serrator* | Australasian gannet | C | | 1 | 1 |
| Sulidae | *Sula dactylatra* | masked booby | C | | 1 | 1 |
| Sulidae | *Sula leucogaster* | brown booby | C | | 1 | 1 |
| Anhingidae | *Anhinga melanogaster* | darter | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax carbo* | great cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax melanoleucos* | little pied cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax sulcirostris* | little black cormorant | C | | 1 | 1 |
| Phalacrocoracidae | *Phalacrocorax varius* | pied cormorant | C | | 1 | 1 |
| Pelecanidae | *Pelecanus conspicillatus* | Australian pelican | C | | 1 | 1 |
| Fregatidae | *Fregata ariel* | lesser frigatebird | C | | 1 | 1 |
| Fregatidae | *Fregata minor* | great frigatebird | C | | 1 | 1 |
| Ardeidae | *Ardea alba* | great egret | C | | 1 | 1 |
| Ardeidae | *Ardea ibis* | cattle egret | C | | 1 | 1 |
| Ardeidae | *Ardea intermedia* | intermediate egret | C | | 1 | 1 |
| Ardeidae | *Ardea pacifica* | white-necked heron | C | | 1 | 1 |
| Ardeidae | *Ardea sumatrana* | great-billed heron | C | | 1 | |
| Ardeidae | *Botaurus poiciloptilus* | Australasian bittern | C | | 1 | 1 |
| Ardeidae | *Butorides striatus* | striated heron | C | | 1 | 1 |
| Ardeidae | *Egretta garzetta* | little egret | C | | 1 | 1 |
| Ardeidae | *Egretta novaehollandiae* | white-faced heron | C | | 1 | 1 |
| Ardeidae | *Egretta sacra* | eastern reef egret | C | | 1 | 1 |
| Ardeidae | *Ixobrychus flavicollis* | black bittern | C | | 1 | 1 |
| Ardeidae | *Ixobrychus minutus* | little bittern | C | | 1 | 1 |
| Ardeidae | *Nycticorax caledonicus* | nankeen night heron | C | | 1 | 1 |
| Threskiornithidae | *Platalea flavipes* | yellow-billed spoonbill | C | | 1 | 1 |
| Threskiornithidae | *Platalea regia* | royal spoonbill | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Threskiornithidae | *Plegadis falcinellus* | glossy ibis | C | | 1 | 1 |
| Threskiornithidae | *Threskiornis molucca* | Australian white ibis | C | | 1 | 1 |
| Threskiornithidae | *Threskiornis spinicollis* | straw-necked ibis | C | | 1 | 1 |
| Ciconiidae | *Ephippiorhynchus asiaticus* | black-necked stork | R | | 1 | 1 |
| Accipitridae | *Accipiter cirrhocephalus* | collared sparrowhawk | C | | 1 | 1 |
| Accipitridae | *Accipiter fasciatus* | brown goshawk | C | | 1 | 1 |
| Accipitridae | *Accipiter novaehollandiae* | grey goshawk | R | | 1 | 1 |
| Accipitridae | *Aquila audax* | wedge-tailed eagle | C | | 1 | 1 |
| Accipitridae | *Aviceda subcristata* | Pacific baza | C | | 1 | 1 |
| Accipitridae | *Circus approximans* | swamp harrier | C | | 1 | 1 |
| Accipitridae | *Circus assimilis* | spotted harrier | C | | 1 | 1 |
| Accipitridae | *Elanus axillaris* | black-shouldered kite | C | | 1 | 1 |
| Accipitridae | *Elanus scriptus* | letter-winged kite | C | | 1 | |
| Accipitridae | *Erythrotriorchis radiatus* | red goshawk | E | V | 1 | |
| Accipitridae | *Haliaeetus leucogaster* | white-bellied sea-eagle | C | | 1 | 1 |
| Accipitridae | *Haliastur indus* | brahminy kite | C | | 1 | 1 |
| Accipitridae | *Haliastur sphenurus* | whistling kite | C | | 1 | 1 |
| Accipitridae | *Hamirostra melanosternon* | black-breasted buzzard | C | | 1 | |
| Accipitridae | *Hieraaetus morphnoides* | little eagle | C | | 1 | 1 |
| Accipitridae | *Lophoictinia isura* | square-tailed kite | R | | 1 | 1 |
| Accipitridae | *Milvus migrans* | black kite | C | | 1 | |
| Accipitridae | *Pandion haliaetus* | osprey | C | | 1 | 1 |
| Falconidae | *Falco berigora* | brown falcon | C | | 1 | 1 |
| Falconidae | *Falco cenchroides* | nankeen kestrel | C | | 1 | 1 |
| Falconidae | *Falco hypoleucos* | grey falcon | R | | 1 | |
| Falconidae | *Falco longipennis* | Australian hobby | C | | 1 | 1 |
| Falconidae | *Falco peregrinus* | peregrine falcon | C | | 1 | 1 |
| Falconidae | *Falco subniger* | black falcon | C | | 1 | |
| Gruidae | *Grus rubicunda* | brolga | C | | 1 | 1 |
| Rallidae | *Amaurornis olivaceus* | bush-hen | C | | 1 | 1 |
| Rallidae | *Fulica atra* | Eurasian coot | C | | 1 | 1 |
| Rallidae | *Gallinula tenebrosa* | dusky moorhen | C | | 1 | 1 |
| Rallidae | *Gallinula ventralis* | black-tailed native-hen | C | | 1 | |
| Rallidae | *Gallirallus philippensis* | buff-banded rail | C | | 1 | 1 |
| Rallidae | *Porphyrio porphyrio* | purple swamphen | C | | 1 | 1 |
| Rallidae | *Porzana fluminea* | Australian spotted crake | C | | 1 | 1 |
| Rallidae | *Porzana pusilla* | Baillon's crake | C | | 1 | 1 |
| Rallidae | *Porzana tabuensis* | spotless crake | C | | 1 | |
| Rallidae | *Rallus pectoralis* | Lewin's rail | R | | 1 | 1 |
| Otididae | *Ardeotis australis* | Australian bustard | C | | 1 | |
| Turnicidae | *Turnix maculosa* | red-backed button-quail | C | | 1 | 1 |
| Turnicidae | *Turnix melanogaster* | black-breasted button-quail | V | V | 1 | 1 |
| Turnicidae | *Turnix pyrrhothorax* | red-chested button-quail | C | | 1 | 1 |
| Turnicidae | *Turnix varia* | painted button-quail | C | | 1 | 1 |
| Turnicidae | *Turnix velox* | little button-quail | C | | 1 | 1 |
| Scolopacidae | *Actitis hypoleucos* | common sandpiper | C | | 1 | 1 |
| Scolopacidae | *Arenaria interpres* | ruddy turnstone | C | | 1 | 1 |
| Scolopacidae | *Calidris acuminata* | sharp-tailed sandpiper | C | | 1 | 1 |
| Scolopacidae | *Calidris alba* | sanderling | C | | 1 | 1 |
| Scolopacidae | *Calidris canutus* | red knot | C | | 1 | 1 |
| Scolopacidae | *Calidris ferruginea* | curlew sandpiper | C | | 1 | 1 |
| Scolopacidae | *Calidris melanotos* | pectoral sandpiper | C | | 1 | 1 |
| Scolopacidae | *Calidris ruficollis* | red-necked stint | C | | 1 | 1 |
| Scolopacidae | *Calidris subminuta* | long-toed stint | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Scolopacidae | *Calidris tenuirostris* | great knot | C | | 1 | 1 |
| Scolopacidae | *Gallinago hardwickii* | Latham's snipe | C | | 1 | 1 |
| Scolopacidae | *Heteroscelus brevipes* | grey-tailed tattler | C | | 1 | 1 |
| Scolopacidae | *Heteroscelus incanus* | wandering tattler | C | | 1 | 1 |
| Scolopacidae | *Limicola falcinellus* | broad-billed sandpiper | C | | 1 | 1 |
| Scolopacidae | *Limnodromus semipalmatus* | Asian dowitcher | C | | 1 | 1 |
| Scolopacidae | *Limosa lapponica* | bar-tailed godwit | C | | 1 | 1 |
| Scolopacidae | *Limosa limosa* | black-tailed godwit | C | | 1 | 1 |
| Scolopacidae | *Numenius madagascariensis* | eastern curlew | R | | 1 | 1 |
| Scolopacidae | *Numenius minutus* | little curlew | C | | 1 | 1 |
| Scolopacidae | *Numenius phaeopus* | whimbrel | C | | 1 | 1 |
| Scolopacidae | *Phalaropus lobatus* | red-necked phalarope | C | | 1 | 1 |
| Scolopacidae | *Philomachus pugnax* | ruff | C | | 1 | 1 |
| Scolopacidae | *Tringa flavipes* | lesser yellowlegs | C | | 1 | 1 |
| Scolopacidae | *Tringa glareola* | wood sandpiper | C | | 1 | 1 |
| Scolopacidae | *Tringa nebularia* | common greenshank | C | | 1 | 1 |
| Scolopacidae | *Tringa stagnatilis* | marsh sandpiper | C | | 1 | 1 |
| Scolopacidae | *Xenus cinereus* | terek sandpiper | C | | 1 | 1 |
| Rostratulidae | *Rostratula benghalensis* | painted snipe | V | V | 1 | 1 |
| Jacanidae | *Irediparra gallinacea* | comb-crested jacana | C | | 1 | 1 |
| Burhinidae | *Burhinus grallarius* | bush stone-curlew | C | | 1 | 1 |
| Burhinidae | *Esacus neglectus* | beach stone-curlew | V | | 1 | 1 |
| Haematopodidae | *Haematopus fuliginosus* | sooty oystercatcher | R | | 1 | 1 |
| Haematopodidae | *Haematopus longirostris* | pied oystercatcher | C | | 1 | 1 |
| Recurvirostridae | *Cladorhynchus leucocephalus* | banded stilt | C | | 1 | |
| Recurvirostridae | *Himantopus himantopus* | black-winged stilt | C | | 1 | 1 |
| Recurvirostridae | *Recurvirostra novaehollandiae* | red-necked avocet | C | | 1 | 1 |
| Charadriidae | *Charadrius bicinctus* | double-banded plover | C | | 1 | 1 |
| Charadriidae | *Charadrius leschenaultii* | greater sand plover | C | | 1 | 1 |
| Charadriidae | *Charadrius mongolus* | lesser sand plover | C | | 1 | 1 |
| Charadriidae | *Charadrius ruficapillus* | red-capped plover | C | | 1 | 1 |
| Charadriidae | *Charadrius veredus* | oriental plover | C | | 1 | |
| Charadriidae | *Elseyornis melanops* | black-fronted dotterel | C | | 1 | 1 |
| Charadriidae | *Erythrogonys cinctus* | red-kneed dotterel | C | | 1 | 1 |
| Charadriidae | *Pluvialis fulva* | Pacific golden plover | C | | 1 | 1 |
| Charadriidae | *Pluvialis squatarola* | grey plover | C | | 1 | 1 |
| Charadriidae | *Thinornis rubricollis* | hooded plover | C | | 1 | |
| Charadriidae | *Vanellus miles* | masked lapwing | C | | 1 | 1 |
| Charadriidae | *Vanellus tricolor* | banded lapwing | C | | 1 | 1 |
| Glareolidae | *Glareola maldivarum* | oriental pratincole | C | | 1 | |
| Glareolidae | *Stiltia isabella* | Australian pratincole | C | | 1 | 1 |
| Laridae | *Chlidonias hybridus* | whiskered tern | C | | 1 | 1 |
| Laridae | *Chlidonias leucopterus* | white-winged black tern | C | | 1 | 1 |
| Laridae | *Larus novaehollandiae* | silver gull | C | | 1 | 1 |
| Laridae | *Stercorarius parasiticus* | Arctic jaeger | C | | 1 | 1 |
| Laridae | *Stercorarius pomarinus* | pomarine jaeger | C | | 1 | |
| Laridae | *Sterna albifrons* | little tern | E | | 1 | 1 |
| Laridae | *Sterna bengalensis* | lesser crested tern | C | | 1 | 1 |
| Laridae | *Sterna bergii* | crested tern | C | | 1 | 1 |
| Laridae | *Sterna caspia* | Caspian tern | C | | 1 | 1 |
| Laridae | *Sterna hirundo* | common tern | C | | 1 | 1 |
| Laridae | *Sterna nilotica* | gull-billed tern | C | | 1 | 1 |
| Columbidae | *Chalcophaps indica* | emerald dove | C | | 1 | 1 |
| Columbidae | *Columba leucomela* | white-headed pigeon | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Columbidae | *Columba livia* | rock dove | | | | |
| Columbidae | *Geopelia cuneata* | diamond dove | C | | 1 | |
| Columbidae | *Geopelia humeralis* | bar-shouldered dove | C | | 1 | 1 |
| Columbidae | *Geopelia striata* | peaceful dove | C | | 1 | 1 |
| Columbidae | *Geophaps scripta scripta* | squatter pigeon | V | V | 1 | |
| Columbidae | *Leucosarcia melanoleuca* | wonga pigeon | C | | 1 | 1 |
| Columbidae | *Lopholaimus antarcticus* | topknot pigeon | C | | 1 | 1 |
| Columbidae | *Macropygia amboinensis* | brown cuckoo-dove | C | | 1 | 1 |
| Columbidae | *Ocyphaps lophotes* | crested pigeon | C | | 1 | 1 |
| Columbidae | *Phaps chalcoptera* | common bronzewing | C | | 1 | 1 |
| Columbidae | *Phaps elegans* | brush bronzewing | C | | 1 | |
| Columbidae | *Ptilinopus magnificus* | wompoo fruit-dove | C | | 1 | 1 |
| Columbidae | *Ptilinopus regina* | rose-crowned fruit-dove | C | | 1 | 1 |
| Columbidae | *Ptilinopus superbus* | superb fruit-dove | C | | 1 | 1 |
| Columbidae | *Streptopelia chinensis* | spotted turtle-dove | | | | |
| Cacatuidae | *Cacatua galerita* | sulphur-crested cockatoo | C | | 1 | 1 |
| Cacatuidae | *Cacatua leadbeateri* | Major Mitchell's cockatoo | V | | 1 | |
| Cacatuidae | *Cacatua roseicapilla* | galah | C | | 1 | 1 |
| Cacatuidae | *Cacatua sanguinea* | little corella | C | | 1 | 1 |
| Cacatuidae | *Calyptorhynchus banksii* | red-tailed black-cockatoo | C | | 1 | 1 |
| Cacatuidae | *Calyptorhynchus funereus* | yellow-tailed black-cockatoo | C | | 1 | 1 |
| Cacatuidae | *Calyptorhynchus lathami* | glossy black-cockatoo | V | | 1 | 1 |
| Cacatuidae | *Nymphicus hollandicus* | cockatiel | C | | 1 | |
| Psittacidae | *Alisterus scapularis* | Australian king-parrot | C | | 1 | 1 |
| Psittacidae | *Aprosmictus erythropterus* | red-winged parrot | C | | 1 | |
| Psittacidae | *Barnardius zonarius* | Australian ringneck | C | | 1 | |
| Psittacidae | *Barnardius zonarius barnardi* | mallee ringneck | C | | 1 | |
| Psittacidae | *Cacatua tenuirostris* | long-billed corella | C | | 1 | |
| Psittacidae | *Cyclopsitta diophthalma coxeni* | Coxen's fig-parrot | E | E | 1 | |
| Psittacidae | *Glossopsitta concinna* | musk lorikeet | C | | 1 | 1 |
| Psittacidae | *Glossopsitta porphyrocephala* | purple-crowned lorikeet | C | | 1 | |
| Psittacidae | *Glossopsitta pusilla* | little lorikeet | C | | 1 | 1 |
| Psittacidae | *Lathamus discolor* | swift parrot | E | E | 1 | |
| Psittacidae | *Melopsittacus undulatus* | budgerigar | C | | 1 | |
| Psittacidae | *Neophema pulchella* | turquoise parrot | R | | 1 | |
| Psittacidae | *Neophema splendida* | scarlet-chested parrot | C | | 1 | |
| Psittacidae | *Northiella haematogaster* | blue bonnet | C | | 1 | |
| Psittacidae | *Pezoporus wallicus wallicus* | ground parrot | V | | 1 | |
| Psittacidae | *Platycercus adscitus* | pale-headed rosella | C | | 1 | 1 |
| Psittacidae | *Platycercus elegans* | crimson rosella | C | | 1 | 1 |
| Psittacidae | *Platycercus eximius* | eastern rosella | C | | 1 | |
| Psittacidae | *Psephotus haematonotus* | red-rumped parrot | C | | 1 | 1 |
| Psittacidae | *Psitteuteles versicolor* | varied lorikeet | C | | 1 | |
| Psittacidae | *Trichoglossus chlorolepidotus* | scaly-breasted lorikeet | C | | 1 | 1 |
| Psittacidae | *Trichoglossus haematodus* | rainbow lorikeet | C | | 1 | 1 |
| Cuculidae | *Cacomantis flabelliformis* | fan-tailed cuckoo | C | | 1 | 1 |
| Cuculidae | *Cacomantis variolosus* | brush cuckoo | C | | 1 | 1 |
| Cuculidae | *Chrysococcyx basalis* | Horsfield's bronze-cuckoo | C | | 1 | 1 |
| Cuculidae | *Chrysococcyx lucidus* | shining bronze-cuckoo | C | | 1 | 1 |
| Cuculidae | *Chrysococcyx minutillus* | little bronze-cuckoo | C | | 1 | 1 |
| Cuculidae | *Chrysococcyx osculans* | black-eared cuckoo | C | | 1 | 1 |
| Cuculidae | *Chrysococcyx russatus* | Gould's bronze-cuckoo | C | | 1 | 1 |
| Cuculidae | *Cuculus pallidus* | pallid cuckoo | C | | 1 | 1 |

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|---|---|---|---|---|---|---|
| Cuculidae | *Cuculus saturatus* | oriental cuckoo | C | | 1 | 1 |
| Cuculidae | *Eudynamys scolopacea* | common koel | C | | 1 | 1 |
| Cuculidae | *Scythrops novaehollandiae* | channel-billed cuckoo | C | | 1 | 1 |
| Centropodidae | *Centropus phasianinus* | pheasant coucal | C | | 1 | 1 |
| Strigidae | *Ninox connivens* | barking owl | C | | 1 | 1 |
| Strigidae | *Ninox novaeseelandiae* | southern boobook | C | | 1 | 1 |
| Strigidae | *Ninox rufa queenslandica* | rufous owl (sth. subsp.) | V | | 1 | |
| Strigidae | *Ninox strenua* | powerful owl | V | | 1 | 1 |
| Tytonidae | *Tyto alba* | barn owl | C | | 1 | 1 |
| Tytonidae | *Tyto capensis* | grass owl | C | | 1 | 1 |
| Tytonidae | *Tyto novaehollandiae* | masked owl | C | | 1 | |
| Tytonidae | *Tyto tenebricosa* | sooty owl | R | | 1 | |
| Podargidae | *Podargus ocellatus plumiferus* | plumed frogmouth | V | | 1 | |
| Podargidae | *Podargus strigoides* | tawny frogmouth | C | | 1 | 1 |
| Caprimulgidae | *Caprimulgus macrurus* | large-tailed nightjar | C | | 1 | |
| Caprimulgidae | *Eurostopodus argus* | spotted nightjar | C | | 1 | |
| Caprimulgidae | *Eurostopodus mystacalis* | white-throated nightjar | C | | 1 | 1 |
| Aegothelidae | *Aegotheles cristatus* | Australian owlet-nightjar | C | | 1 | 1 |
| Apodidae | *Apus affinis* | house swift | C | | 1 | |
| Apodidae | *Apus pacificus* | fork-tailed swift | C | | 1 | 1 |
| Apodidae | *Collocalia esculenta* | glossy swiftlet | C | | 1 | |
| Apodidae | *Collocalia spodiopygius* | white-rumped swiftlet | R | | 1 | |
| Apodidae | *Collocalia vanikorensis* | uniform swiftlet | C | | 1 | |
| Apodidae | *Hirundapus caudacutus* | white-throated needletail | C | | 1 | 1 |
| Alcedinidae | *Alcedo azurea* | azure kingfisher | C | | 1 | 1 |
| Halcyonidae | *Dacelo leachii* | blue-winged kookaburra | C | | 1 | |
| Halcyonidae | *Dacelo novaeguineae* | laughing kookaburra | C | | 1 | 1 |
| Halcyonidae | *Todiramphus chloris* | collared kingfisher | C | | 1 | 1 |
| Halcyonidae | *Todiramphus macleayii* | forest kingfisher | C | | 1 | 1 |
| Halcyonidae | *Todiramphus pyrrhopygia* | red-backed kingfisher | C | | 1 | |
| Halcyonidae | *Todiramphus sanctus* | sacred kingfisher | C | | 1 | 1 |
| Meropidae | *Merops ornatus* | rainbow bee-eater | C | | 1 | 1 |
| Coraciidae | *Eurystomus orientalis* | dollarbird | C | | 1 | 1 |
| Pittidae | *Pitta versicolor* | noisy pitta | C | | 1 | 1 |
| Menuridae | *Menura alberti* | Albert's lyrebird | R | | 1 | |
| Menuridae | *Menura novaehollandiae* | superb lyrebird | R | | 1 | |
| Atrichornithidae | *Atrichornis rufescens* | rufous scrub-bird | V | | 1 | |
| Climacteridae | *Climacteris affinis* | white-browed treecreeper | C | | 1 | |
| Climacteridae | *Climacteris erythrops* | red-browed treecreeper | R | | 1 | |
| Climacteridae | *Climacteris picumnus* | brown treecreeper | C | | 1 | |
| Climacteridae | *Cormobates leucophaeus* | white-throated treecreeper | C | | 1 | 1 |
| Maluridae | *Malurus cyaneus* | superb fairy-wren | C | | 1 | 1 |
| Maluridae | *Malurus lamberti* | variegated fairy-wren | C | | 1 | 1 |
| Maluridae | *Malurus melanocephalus* | red-backed fairy-wren | C | | 1 | 1 |
| Maluridae | *Stipiturus malachurus* | southern emu-wren | V | | 1 | |
| Pardalotidae | *Acanthiza apicalis* | inland thornbill | C | | 1 | |
| Pardalotidae | *Acanthiza chrysorrhoa* | yellow-rumped thornbill | C | | 1 | 1 |
| Pardalotidae | *Acanthiza lineata* | striated thornbill | C | | 1 | 1 |
| Pardalotidae | *Acanthiza nana* | yellow thornbill | C | | 1 | 1 |
| Pardalotidae | *Acanthiza pusilla* | brown thornbill | C | | 1 | 1 |
| Pardalotidae | *Acanthiza reguloides* | buff-rumped thornbill | C | | 1 | 1 |
| Pardalotidae | *Chthonicola sagittata* | speckled warbler | C | | 1 | 1 |
| Pardalotidae | *Dasyornis brachypterus* | eastern bristlebird | E | E | 1 | |
| Pardalotidae | *Gerygone fusca* | western gerygone | C | | 1 | |

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|---|---|---|---|---|---|---|
| Pardalotidae | *Gerygone levigaster* | mangrove gerygone | C | | 1 | 1 |
| Pardalotidae | *Gerygone mouki* | brown gerygone | C | | 1 | 1 |
| Pardalotidae | *Gerygone olivacea* | white-throated gerygone | C | | 1 | 1 |
| Pardalotidae | *Gerygone palpebrosa* | fairy gerygone | C | | 1 | |
| Pardalotidae | *Hylacola pyrrhopygia* | chestnut-rumped heathwren | C | | 1 | |
| Pardalotidae | *Pardalotus punctatus* | spotted pardalote | C | | 1 | 1 |
| Pardalotidae | *Pardalotus rubricatus* | red-browed pardalote | C | | 1 | |
| Pardalotidae | *Pardalotus striatus* | striated pardalote | C | | 1 | 1 |
| Pardalotidae | *Sericornis citreogularis* | yellow-throated scrubwren | C | | 1 | 1 |
| Pardalotidae | *Sericornis frontalis* | white-browed scrubwren | C | | 1 | 1 |
| Pardalotidae | *Sericornis magnirostris* | large-billed scrubwren | C | | 1 | 1 |
| Pardalotidae | *Smicrornis brevirostris* | weebill | C | | 1 | 1 |
| Meliphagidae | *Acanthagenys rufogularis* | spiny-cheeked honeyeater | C | | 1 | 1 |
| Meliphagidae | *Acanthorhynchus tenuirostris* | eastern spinebill | C | | 1 | 1 |
| Meliphagidae | *Anthochaera carunculata* | red wattlebird | C | | 1 | 1 |
| Meliphagidae | *Anthochaera chrysoptera* | little wattlebird | C | | 1 | 1 |
| Meliphagidae | *Certhionyx niger* | black honeyeater | C | | 1 | |
| Meliphagidae | *Conopophila rufogularis* | rufous-throated honeyeater | C | | 1 | |
| Meliphagidae | *Entomyzon cyanotis* | blue-faced honeyeater | C | | 1 | 1 |
| Meliphagidae | *Epthianura albifrons* | white-fronted chat | C | | 1 | |
| Meliphagidae | *Grantiella picta* | painted honeyeater | R | | 1 | |
| Meliphagidae | *Lichenostomus chrysops* | yellow-faced honeyeater | C | | 1 | 1 |
| Meliphagidae | *Lichenostomus fasciogularis* | mangrove honeyeater | C | | 1 | 1 |
| Meliphagidae | *Lichenostomus fuscus* | fuscous honeyeater | C | | 1 | 1 |
| Meliphagidae | *Lichenostomus leucotis* | white-eared honeyeater | C | | 1 | |
| Meliphagidae | *Lichenostomus melanops* | yellow-tufted honeyeater | C | | 1 | |
| Meliphagidae | *Lichenostomus penicillatus* | white-plumed honeyeater | C | | 1 | |
| Meliphagidae | *Lichenostomus versicolor* | varied honeyeater | C | | 1 | |
| Meliphagidae | *Lichenostomus virescens* | singing honeyeater | C | | 1 | |
| Meliphagidae | *Lichmera indistincta* | brown honeyeater | C | | 1 | 1 |
| Meliphagidae | *Manorina flavigula* | yellow-throated miner | C | | 1 | |
| Meliphagidae | *Manorina melanocephala* | noisy miner | C | | 1 | 1 |
| Meliphagidae | *Manorina melanophrys* | bell miner | C | | 1 | |
| Meliphagidae | *Meliphaga lewinii* | Lewin's honeyeater | C | | 1 | 1 |
| Meliphagidae | *Melithreptus albogularis* | white-throated honeyeater | C | | 1 | 1 |
| Meliphagidae | *Melithreptus brevirostris* | brown-headed honeyeater | C | | 1 | |
| Meliphagidae | *Melithreptus gularis* | black-chinned honeyeater | R | | 1 | 1 |
| Meliphagidae | *Melithreptus lunatus* | white-naped honeyeater | C | | 1 | 1 |
| Meliphagidae | *Myzomela obscura* | dusky honeyeater | C | | 1 | |
| Meliphagidae | *Myzomela sanguinolenta* | scarlet honeyeater | C | | 1 | 1 |
| Meliphagidae | *Philemon buceroides* | helmeted friarbird | C | | 1 | |
| Meliphagidae | *Philemon citreogularis* | little friarbird | C | | 1 | 1 |
| Meliphagidae | *Philemon corniculatus* | noisy friarbird | C | | 1 | 1 |
| Meliphagidae | *Phylidonyris albifrons* | white-fronted honeyeater | C | | 1 | |
| Meliphagidae | *Phylidonyris nigra* | white-cheeked honeyeater | C | | 1 | 1 |
| Meliphagidae | *Phylidonyris novaehollandiae* | New Holland honeyeater | C | | 1 | 1 |
| Meliphagidae | *Plectorhyncha lanceolata* | striped honeyeater | C | | 1 | 1 |
| Meliphagidae | *Ramsayornis fasciatus* | bar-breasted honeyeater | C | | 1 | |
| Meliphagidae | *Xanthomyza phrygia* | regent honeyeater | E | E | 1 | |
| Petroicidae | *Eopsaltria australis* | eastern yellow robin | C | | 1 | 1 |
| Petroicidae | *Melanodryas cucullata* | hooded robin | C | | 1 | |
| Petroicidae | *Microeca fascinans* | jacky winter | C | | 1 | 1 |
| Petroicidae | *Petroica goodenovii* | red-capped robin | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Petroicidae | *Petroica multicolor* | scarlet robin | C | | 1 | |
| Petroicidae | *Petroica phoenicea* | flame robin | C | | 1 | 1 |
| Petroicidae | *Petroica rosea* | rose robin | C | | 1 | 1 |
| Petroicidae | *Tregellasia capito* | pale-yellow robin | C | | 1 | |
| Orthonychidae | *Orthonyx temminckii* | logrunner | C | | 1 | |
| Pomatostomidae | *Pomatostomus halli* | Hall's babbler | C | | 1 | |
| Pomatostomidae | *Pomatostomus superciliosus* | white-browed babbler | C | | 1 | |
| Pomatostomidae | *Pomatostomus temporalis* | grey-crowned babbler | C | | 1 | |
| Cinclosomatidae | *Cinclosoma punctatum* | spotted quail-thrush | C | | 1 | 1 |
| Cinclosomatidae | *Psophodes olivaceus* | eastern whipbird | C | | 1 | 1 |
| Neosittidae | *Daphoenositta chrysoptera* | varied sittella | C | | 1 | 1 |
| Pachycephalidae | *Colluricincla harmonica* | grey shrike-thrush | C | | 1 | 1 |
| Pachycephalidae | *Colluricincla megarhyncha* | little shrike-thrush | C | | 1 | 1 |
| Pachycephalidae | *Falcunculus frontatus* | crested shrike-tit | C | | 1 | |
| Pachycephalidae | *Oreoica gutturalis* | crested bellbird | C | | 1 | |
| Pachycephalidae | *Pachycephala olivacea* | olive whistler | R | | 1 | |
| Pachycephalidae | *Pachycephala pectoralis* | golden whistler | C | | 1 | 1 |
| Pachycephalidae | *Pachycephala rufiventris* | rufous whistler | C | | 1 | 1 |
| Dicruridae | *Dicrurus bracteatus* | spangled drongo | C | | 1 | 1 |
| Dicruridae | *Grallina cyanoleuca* | magpie-lark | C | | 1 | 1 |
| Dicruridae | *Monarcha leucotis* | white-eared monarch | C | | 1 | 1 |
| Dicruridae | *Monarcha melanopsis* | black-faced monarch | C | | 1 | 1 |
| Dicruridae | *Monarcha trivirgatus* | spectacled monarch | C | | 1 | 1 |
| Dicruridae | *Myiagra alecto* | shining flycatcher | C | | 1 | 1 |
| Dicruridae | *Myiagra cyanoleuca* | satin flycatcher | C | | 1 | 1 |
| Dicruridae | *Myiagra inquieta* | restless flycatcher | C | | 1 | 1 |
| Dicruridae | *Myiagra rubecula* | leaden flycatcher | C | | 1 | 1 |
| Dicruridae | *Rhipidura fuliginosa* | grey fantail | C | | 1 | 1 |
| Dicruridae | *Rhipidura leucophrys* | willie wagtail | C | | 1 | 1 |
| Dicruridae | *Rhipidura rufifrons* | rufous fantail | C | | 1 | 1 |
| Campephagidae | *Coracina lineata* | barred cuckoo-shrike | C | | 1 | |
| Campephagidae | *Coracina maxima* | ground cuckoo-shrike | C | | 1 | |
| Campephagidae | *Coracina novaehollandiae* | black-faced cuckoo-shrike | C | | 1 | 1 |
| Campephagidae | *Coracina papuensis* | white-bellied cuckoo-shrike | C | | 1 | 1 |
| Campephagidae | *Coracina tenuirostris* | cicadabird | C | | 1 | 1 |
| Campephagidae | *Lalage leucomela* | varied triller | C | | 1 | 1 |
| Campephagidae | *Lalage sueurii* | white-winged triller | C | | 1 | 1 |
| Oriolidae | *Oriolus sagittatus* | olive-backed oriole | C | | 1 | 1 |
| Oriolidae | *Sphecotheres viridis* | figbird | C | | 1 | 1 |
| Artamidae | *Artamus cinereus* | black-faced woodswallow | C | | 1 | |
| Artamidae | *Artamus cyanopterus* | dusky woodswallow | C | | 1 | 1 |
| Artamidae | *Artamus leucorynchus* | white-breasted woodswallow | C | | 1 | 1 |
| Artamidae | *Artamus minor* | little woodswallow | C | | 1 | 1 |
| Artamidae | *Artamus personatus* | masked woodswallow | C | | 1 | 1 |
| Artamidae | *Artamus superciliosus* | white-browed woodswallow | C | | 1 | |
| Artamidae | *Cracticus nigrogularis* | pied butcherbird | C | | 1 | 1 |
| Artamidae | *Cracticus torquatus* | grey butcherbird | C | | 1 | 1 |
| Artamidae | *Gymnorhina tibicen* | Australian magpie | C | | 1 | 1 |
| Artamidae | *Strepera graculina* | pied currawong | C | | 1 | 1 |
| Paradisaeidae | *Ptiloris paradiseus* | paradise riflebird | C | | 1 | |
| Corvidae | *Corvus bennetti* | little crow | C | | 1 | |
| Corvidae | *Corvus coronoides* | Australian raven | C | | 1 | 1 |
| Corvidae | *Corvus orru* | Torresian crow | C | | 1 | 1 |

| Family | Scientific Name | Common Name | NCA | EPBCA | SEQ | MB |
|---|---|---|---|---|---|---|
| Corcoracidae | *Corcorax melanorhamphos* | white-winged chough | C | | 1 | |
| Corcoracidae | *Struthidea cinerea* | apostlebird | C | | 1 | |
| Ptilonorhynchidae | *Ailuroedus crassirostris* | green catbird | C | | 1 | |
| Ptilonorhynchidae | *Ailuroedus melanotis* | spotted catbird | C | | 1 | |
| Ptilonorhynchidae | *Chlamydera maculata* | spotted bowerbird | C | | 1 | |
| Ptilonorhynchidae | *Ptilonorhynchus violaceus* | satin bowerbird | C | | 1 | 1 |
| Ptilonorhynchidae | *Sericulus chrysocephalus* | regent bowerbird | C | | 1 | |
| Alaudidae | *Mirafra javanica* | singing bushlark | C | | 1 | 1 |
| Motacillidae | *Anthus novaeseelandiae* | Richard's pipit | C | | 1 | 1 |
| Passeridae | *Lonchura castaneothorax* | chestnut-breasted mannikin | C | | 1 | 1 |
| Passeridae | *Neochmia modesta* | plum-headed finch | C | | 1 | |
| Passeridae | *Neochmia temporalis* | red-browed finch | C | | 1 | 1 |
| Passeridae | *Stagonopleura guttata* | diamond firetail | C | | 1 | |
| Passeridae | *Taeniopygia bichenovii* | double-barred finch | C | | 1 | 1 |
| Passeridae | *Taeniopygia guttata* | zebra finch | C | | 1 | |
| Nectariniidae | *Nectarinia jugularis* | yellow-bellied sunbird | C | | 1 | |
| Dicaeidae | *Dicaeum hirundinaceum* | mistletoebird | C | | 1 | 1 |
| Hirundinidae | *Cheramoeca leucosternus* | white-backed swallow | C | | 1 | 1 |
| Hirundinidae | *Hirundo ariel* | fairy martin | C | | 1 | 1 |
| Hirundinidae | *Hirundo neoxena* | welcome swallow | C | | 1 | 1 |
| Hirundinidae | *Hirundo nigricans* | tree martin | C | | 1 | 1 |
| Hirundinidae | *Hirundo rustica* | barn swallow | C | | 1 | |
| Sylviidae | *Acrocephalus stentoreus* | clamorous reed-warbler | C | | 1 | 1 |
| Sylviidae | *Cincloramphus cruralis* | brown songlark | C | | 1 | |
| Sylviidae | *Cincloramphus mathewsi* | rufous songlark | C | | 1 | |
| Sylviidae | *Cisticola exilis* | golden-headed cisticola | C | | 1 | 1 |
| Sylviidae | *Cisticola juncidis laveryi* | zitting cisticola | C | | 1 | |
| Sylviidae | *Megalurus gramineus* | little grassbird | C | | 1 | 1 |
| Sylviidae | *Megalurus timoriensis* | tawny grassbird | C | | 1 | 1 |
| Zosteropidae | *Zosterops lateralis* | silvereye | C | | 1 | 1 |
| Muscicapidae | *Zoothera heinei* | russet-tailed thrush | C | | 1 | |
| Muscicapidae | *Zoothera lunulata* | Bassian thrush | C | | 1 | |
| **Species Richness** | | | | | **403** | **290** |

# APPENDIX E: CURRICULAR VITAE OF AUTHORS

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Catchment and examines the risks and adaptation options for responding to expected increases in saltwater intrusion and flooding as a result of sea level rise and increased intensity of cyclones.

**Moreton Bay Ecological Character Description (2008 – on-going).** Project Manager for a major study of the wetlands of Moreton Bay including an ECD report, a report on the assessment and effectiveness of management actions, a report on management goals and environmental indicators and a review and refinement of the Moreton Bay Ramsar boundary and Ramsar Information Sheet. Extensive liaison and consultation with the scientists of the Moreton Bay Partnership Scientific Expert Panel to develop a Whole-of-Bay Conceptual Model.

**Cooktown Long Term Dredging and Dredge Spoil Management Strategy (2007 – on-going).** Project Manager for preparation of a long term strategy for Queensland Transport. Led a team of coastal engineers and scientists to assess the impacts from dredging and material placement from maintenance dredging of the Endeavour River.

**Northshore Hamilton Land Use Master Plan (2008).** Led and project managed inputs in the fields of ecology and coastal planning for the project being undertaken for the Urban Land Development Authority. Project undertaken in partnership with lead consultant Hassel for the proposed community in Hamilton, Queensland.

**Policy Review for Artificial Waterways - Queensland EPA (2008).** Project Manager and leader of a team of water quality scientists and ecologists to prepare a policy analysis and options paper for the Queensland EPA on the issue of artificial lake and waterway development in Queensland. Policy advice used in formulation of policy positions under the Queensland State Coastal Management Plan.

**SUN LNG Plant EIS, Gladstone Qld (2007-2008).** Project Manager for BMT WBM input into the EIS in the fields of ecology, water quality, coastal planning and coastal management. Project undertaken in partnership with lead EIS consultant RLMS for the proposed LNG Plant in Gladstone, Queensland.

**Currawinya Lakes Ecological Character Description (2007 – 2008).** Project Manager and Lead Author in the preparation of the ECD for the Currawinya Lakes Ramsar Site in Western Queensland. Managed a small team of ecologists and hydrologists in preparation of the resource assessment, Ramsar Information Sheet, and revised mapping boundaries.

**Marine Extraction Material Allocation Process (2007).** Represented several firms through the preparation of application and assessment reports for allocations of sand resources from Moreton Bay.

**New Parallel Runway Project EIS (2005 – 2007).** Co-ordinator for all consultant contracts related to land and marine impact issues associated with the Environmental Impact Statement (EIS) process. Project managed the dredge management strategy for the project involving a multi-disciplinary team of consultants and experts as well as the wetland mitigation and offset strategy for the project, approved by the Australian Government.

**Development of Water Quality Objectives under the EPP Water (2004 – 2005)**. Leader of the project management team that delivered environmental values and water quality objectives for Southeast Queensland, Mary River and Douglas Shire under Schedule 1 of the Environmental Protection Policy (EPP) Water. Delivery of a consultation and engagement programme with key stakeholders and project management Government approval process.

**Operational policy reform – Queensland Parks and Wildlife Service (2002).** Project manager for review and development of a range of operational policies related to the management of the Queensland protected area and State Forest estate. Established systems for internal review, evaluation and quality assurance for policy development between the Service's central and regional offices.

**Development and Implementation of Queensland coastal legislation reform (2000-2003).** Project manager for major reform to the State's coastal planning and assessment legislation. Project manager for implementation of the amendment process including negotiation with key Government and non-Government stakeholders, training and information delivery, development of new systems and procedures and preparation of operational policy and guidelines.

**Development of the Queensland Coastal Policy (State Coastal Management Plan) (2000-2002).** Lead role within the project team that developed the 2001 State Coastal Plan and first generation regional coastal management plans under the Queensland Coastal Protection and Management Act 1995. Development of key policies related to coastal development, natural resources, cultural resources and coastal processes and management.

**Publications and Presentations**

Fisk, GW. (2008) 'National Coastal Policy – Issues for Consideration'. Presented at the National Coast to Coast Conference 2008. Darwin Northern Territory.

Fisk, GW. (2004) 'Integrated Coastal Zone Management – the Queensland Experience". Presented at the Coastal Zone Asia Pacific Conference 2004. Brisbane, Queensland.

Contributing author on Queensland State of the Environment Reports (1999) and (2003).

Fisk, GW. (2002) 'Regulation of development on Queensland's coast under the Coastal Protection and Management Act'. Presented at the Coast to Coast 2002 Conference. Tweed Heads, New South Wales.

"Perceptions of the Performance of State Coastal Zone Management Programs in the United States. II. State and Regional Analysis" Robert W. Knecht, Biliana Cicin-Sain, Co-authors. *Coastal Management* Volume 25, No. 3, 1997: pp. 325 - 343.

"Growth in Capacity for Integrated Coastal Management Since UNCED: An International Perspective" Professors Biliana Cicin-Sain and Robert Knecht, Co-Authors, *Ocean and Coastal Management* Volume 26, 1996.

"Perceptions of the Performance of State Coastal Zone Management Programs in the United States" Professors Robert Knecht and Biliana Cicin-Sain, Co-authors. *Coastal Management* Volume 24, No. 2, 1996: pp. 141-164.

"Policy Issues in the Development of Marine Biotechnology: A Global Perspective" Co-author with Cicin-Sain, Knecht, and Bouman *Ocean Yearbook 12*, 1996.

Book Reviews on the Wollongong Papers on Maritime Policy Numbers 1 and 2 in Ocean and Coastal Management Volume 24, 1996.

"Impacts of Expansion at Port Everglades: A Case Study of Environmental Mitigation", in Urban Growth and Sustainable Habitats: Case Studies of Policy

Conflicts in South Florida's Coastal Environment. D. Suman, M. Shivlani, M. Villanueva eds. 1995: pp. 9-30.

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## Project Experience

### *Port and Dredging Related Assessments*

**Toondah Harbour Ecotoxicological Assessments (2006).** Project manager for a project assessing potential ecotoxicological impacts associated with the disposal of dredge spoil disposal within a marine park.

**Dalrymple Bay Coal Terminal Expansion Study (2005-2006).** Principal ecologist for a MCU application examining impacts of port expansion on marine water quality, ecological communities and fisheries values.

**Brisbane Airport Expansion EIS (2005-2006).** Principal ecologist for a major EIS examining the impacts of sand extraction in northern Moreton Bay, and reclamation of estuarine and terrestrial habitat near the existing airport.

**Toondah Harbour Sediment Quality Assessments (2005).** Scientist for a project assessing the physio-chemical proporties of sediments to be removed from a boat harbour.

**Abbot Point Expansion EIS (2005-2006).** Principal ecologist for a major EIS examining impacts of dredging of berth pockets, and on-land works within the existing port facility.

**Port of Brisbane Seawall Alliance (2004).** Senior scientist for environmental assessments for the construction of the Port of Brisbane expansion project.

**Anoxic Sediment Management in Lake Macquarie - Review of Environmental Factors (2004).** Principal ecologist for a REF examining impacts of anoxic sediment removal at three sites within Lake Macquarie, Newcastle.

**Swan Bay Dredging Review of Environmental Factors (2004).** Principal ecologist for a REF examining impacts of dredging and rock wall construction at Swan Bay and Swansea Channel, Lake Macquarie.

**Port of Dhamra Initial Risk Identification (2004).** Project manager for a study examining the potential risks and impacts of a major port project in a highly sensitive environment on the Orissa Coast, India. Particular focus of the study was on impact of port activities on the largest sea turtle rookery in the world.

**Sand Extraction Study Phase 2 – Marine Benthos (2003-2004).** Project manager for a research project examining the effects of dredging on marine fauna communities in Moreton Bay.

**Port of Hay Point Spoil Ground Assessments (2004).** Project manager on an investigation of environmental attributes and constraints to spoil dumping at the Port of Hay Point.

**Port of Bing Bong Dredge Feasibility Assessments (2003).** Marine biologist on a project examining the costs and benefits of dredge management options at the Port of Bing Bong, Northern Territory.

**Port of Weipa Impact Review (2003).** Project Manager of a study examining the potential impacts of sediment movement on biological communities at the Port of Weipa.

**Port of Mackay Sampling and Analysis Plan (2002).** Project Manager for the development of a SAP for the monitoring of dredge spoil.

**Harrington Waters Impact Assessment Study – Supplementary Report (2002).** Aquatic ecologist responsible for additional reporting for a Supplementary IAS report for a dredging proposal at Harrington, central NSW.

**Port of Bundaberg Dredge Material Placement Monitoring (1997-2002).** Benthic ecologist for field investigations monitoring impacts of dredging and material placement on seagrass and soft sediment macroinvertebrate communities. Responsible for the field work, identification of macroinvertebrate samples and reporting.

**Hay Point Services – Trestle Contaminants Investigation (2002).** Scientist examining the effects of abrasive grit on metal concentrations in sediments and biota.

**Port of Hay Dredge Monitoring (2001-2003).** Project Manager for monitoring impacts of dredged material placement on soft sediment macroinvertebrate communities and sediments. Responsible for the monitoring design and reporting.

**Bundaberg Port Deepening EIS (2000-2001).** Marine ecologist examining the estuarine benthic macroinvertebrates from dredged material placement areas at Weipa, North Queensland.

**Port of Mackay Long Term Dredge Spoil Management Strategy (2000-2001).** Project Manager for the development of a Long Term Dredge Spoil Management Strategy.

**Weipa Dredge Monitoring (1999-2000).** Aquatic ecologist examining the estuarine benthic macroinvertebrates from dredged material placement areas at Weipa, North Queensland.

**Assessment of Impacts Associated With Potential Ocean Disposal of Dredged Material (2000).** Project Manager co-ordinating elutriate tests and reporting of potential water quality impacts associated with dredged material at the Port of Mackay.

**Port of Brisbane Reclamation Impact Assessment Study (1999-2000).** Marine ecologist examining the characteristics of macrobenthic communities at and adjacent to proposed reclamation works at Fisherman Islands, Brisbane.

**Port of Bundaberg Long Term Dredge Spoil Management Strategy (1999).** Marne Ecologist for the development of a Long Term Dredge Spoil Management Strategy.

**Assessment of the Impacts of Dredging and Material Placement at Coffs Harbour (1999).** Aquatic ecologist examining the potential impacts of dredging and material placement at Muttonbird Island, Coffs Harbour.

**Karumba Dredge Monitoring (1998-1999).** Benthic ecologist for field investigations monitoring impacts of dredging and material placement on soft sediment macroinvertebrate communities. Responsible for the monitoring design, field work, identification of macroinvertebrate samples and reporting.

**Impacts of Superbund Construction on the Ecology of Fisherman Islands (1998).** Ecologist examining the potential impacts of port related works on the mangrove and seagrass communities, fisheries and sediment distributions at Fisherman Islands, Brisbane.

**Boathaven Bay Marina Development Impact Assessment Study (1998).** Benthic ecologist for field investigations of potential impacts of a proposed marina development in Boathaven Bay, Airlie Beach, as part of an environmental impact assessment. Responsible for survey design, field investigations of coral, soft sediment macroinvertebrate communities and fish, identification of macroinvertebrate samples and reporting.

**Mourilyan Harbour Bed-Levelling Impact Assessment (1998).** Benthic ecologist for field investigations of potential impacts of bed-levelling activities within Mourilyan Harbour. Involved survey design, identification of macroinvertebrate samples and reporting.

**Port of Weipa Dredge Material Disposal Area Options (1997-1998).** Benthic ecologist undertaking identification of soft sediment macroinvertebrate samples for a project examining potential dredge material placement areas.

**Removal of Tony's Bar Impact Assessment Study (1997).** Benthic ecologist for field investigations of potential impacts of bar removal in the Tweed River as part of an environmental impact assessment. Responsible for survey design, field investigations of hard-bottom and soft sediment macroinvertebrate communities, identification of macroinvertebrate samples and reporting.

### *Estuary Environment Impact Assessments and Monitoring (Non-dredging)*

**Laguna Whitsundays Resort Environmental Assessments and Approvals (2005-2006).** Senior scientist for a planning study examining the construction of a golf course and its potential impacts of marine communities and habitats.

**Noosa North Shore Assessment of 4WD impacts on beach fauna (2005-2006).** Project manager for a beach macroinvertebrate monitoring project.

**Ninds Creek STP monitoring (2004-2005).** Senior scientist for a sewage discharge-monitoring project in North Queensland. Study components included assessments of water quality, sediment quality and sewage mapping using $\delta^{15}N$ isotope analysis, and provision of recommendations on discharge criteria.

**Coomera River Environmental Assessment (2004-2005).** Senior scientist examining variations in estuarine macroinvertebrates in the Coomera River, and possible linkages to habitat degradation.

**Cruise Terminal Assessments for Gold Coast Broadwater (2003).** Senior scientist for a risk assessment examining the feasibility of developing a cruise ship terminal in Gold Coast Broadwater.

**Management Advice for Sewage Spill into a Ramsar listed Wetland (2003).** Project manager for an investigation into the impact of a sewage spill into a sensitive estuarine environment.

**Sunaqua Sea Cage EIS (2002-2003).** Ecologist for a proposed aquaculture development in eastern Moreton Bay. Responsible for reporting on macroinvertebrate impacts, focussing on nutrient enrichment impacts.

**Swansea Channel Management Options Assessment (2002).** Senior ecologist for aquatic vegetation mapping and conservation value assessment at Swansea Channel, Lake Macquarie.

**Hexham Swamp Macroinvertebrate Monitoring Technical Advisor (2002).** Provision of technical advice to Hunter Catchment Management Trust for the selection of tenders for a biological monitoring program examining impacts of floodgate removal on a brackish/freshwater wetland environment.

**Upstart Bay Aquaculture Facility – Statistical Advisor (2001).** Provision of statistical assessments and advice for a water quality monitoring program for waste water discharges into Upstart Bay, north Queensland.

**Maryborough Co-generation Thermal Modelling (2000).** Senior ecologist for assessments of the impacts of thermal discharges from a sugar refinery on aquatic communities. Responsible for survey design and reporting.

**Byron Bay Sewage Treatment Plant Environment Assessments (1999-2000).** Senior ecologist for environmental 'health' assessments of three estuaries in the northern rivers region, and environmental impacts of two outfalls.

**Rocky Point Prawn Farm - Impact Assessment Study (1999).** Ecologist examining the existing environment (biota, habitats, environmental zonings), potential impacts and environmental management of impacts for the upgrade and expansion of the Rocky Point Prawn farm, with a particular focus on waste water discharge impacts into Moreton Bay Marine Park.

**Eenie Creek Impact Assessment Study (1999).** Aquatic ecologist examining the existing environment and potential impacts of a retail development at Eenie Creek, Noosa.

**Historical Trends in Gold Coast Water Quality (1997-1999).** Ecologist examining historical changes in mangrove and seagrasses within Gold Coast City waterways, and the potential influence of water quality degradation on these changes.

**Karuah River Water Quality and Oyster Health Monitoring (1998).** Biologist in a baseline data collation study of the water quality and environmental health aspects of oysters in Port Stephens, prior to the construction of a bridge across the Karuah River.

**Caboolture River Sewage Monitoring (1997).** Benthic ecologist for field investigations to design a survey design to monitor impacts of sewage discharge on soft sediment macroinvertebrate communities.

**Environmental Impact Statement - 509 Tingal Road, Wynnum (1998).** Aquatic biologist examining the existing (marine biological) environment, potential impacts and mitigation strategies associated with a proposed urban development near mangrove communities in Brisbane.

**Ukerebagh Passage Tidal Flap Gates EIS (1997).** Aquatic biologist examining the aspects of the existing (marine biological) environment, potential impacts and mitigation strategies for the installation of tidal flap gates at Ukerebagh Passage, Tweed River.

**Brisbane Airport Rail-link - Ecological Assessment (1997-1998).** Aquatic biologist examining the existing (marine biological) environment and potential impacts along a number of train line routes.

**Response to Australian Heritage Commission Proposed Listing of Balaclava Island and the Narrows Area (1997).** Aquatic biologist examining the biological criteria used to proposed AHC listing of the Narrows area.

### *Estuary Management Studies*

**Woronora River Estuary Processes Study (2005)** Principal ecologist examining ecological patterns and processes relevant to the management of Woronora River estuary, Sydney. Included estuarine vegetation mapping and macroinvertebrate surveys.

**Richmond River Estuary Processes Study (2005)** Principal ecologist examining patterns and processes relevant to the management of Richmond River estuary, northern NSW.

**Nambucca River Estuary Management Plan and Study (2005)** Aquatic ecologist responsible for the development of management strategies for the Nambucca River estuary, northern NSW.

**Wooli Wooli River Estuary Processes Study (2004-2005)** Principal ecologist examining patterns and processes relevant to the management of Wooli Wooli River estuary, northern NSW.

**Botany Bay Conceptual Environmental Understanding Study (2003).** Marine ecologist on a study examining the interactions between hydraulics, water quality and ecological/fisheries patterns and processes at Botany Bay.

**Gold Coast Harbour Environmental Monitoring (2003-2004).** Project manager for a monitoring program examining the benthic macroinvertebrate and seagrass communities of the Broadwater, Gold Coast.

**Gold Coast Harbour Environmental Baseline Data Collation Study (2002).** Marine biologist for a data compilation study examining the natural, social and economic environment of the Gold Coast Harbour precinct.

**Burrill Lake Estuary Processes Study (2001).** Project manager and marine ecologist undertaking the estuary processes study.

**Maroochy River Mouth Remediation Environmental Assessments (2001).** Marine ecologist examining the environmental attributes of the Maroochy River mouth, and possible impacts associated with dredging and sediment relocation to remediate erosion problems in the study area.

**Gold Coast Harbour Environmental Baseline Study (2001).** Marine ecologist for the development of an environmental baseline for future planning and management of Gold Coast Harbour.

**Pittwater Estuary Processes Study and Management Plan (2001).** Marine Ecologist examining the processes influencing the ecological communities of Pittwater, Sydney.

**Burrill Lake Causeway Assessments (2000-2001).** Marine ecologist examining the impacts of the causeway on the ecology of Burrill Lake, NSW south coast.

**Gunnamatta Bay Estuary Processes Study and Management Plan (2000-2001).** Marine Ecologist examining the processes influencing the ecological communities of Gunnamatta Bay, Port Hacking.

**Evans River Estuary Plan (2000).** Ecologist for the development of a management plan for the Evans River estuary.

**Gymea Bay Estuary Processes Study and Management Plan (2000-2001).** Marine Ecologist examining the processes influencing the ecol0gical communities of Gymea Bay, Port Hacking.

**Fennell and Edmunds Bays Remediation Strategies (2000).** Aquatic ecologist for assessments of estuarine communities and habitats in and adjacent to Fennell and Edmunds Bays, Lake Macquarie. Responsible for survey design, statistical analyses and reporting.

**Narrabeen Lagoon Estuary Processes Study (2000).** Aquatic ecologist examining the estuarine benthic macroinvertebrates and fish communities in Narrabeen Lagoon, Sydney.

**Wonboyn Estuary - Estuary Processes Study, and Estuary Management Study and Plan (2000).** Ecologist examining the extent and types of ecological communities in the Wonboyn estuary, and the effects of estuary processes on the ecology of the area.

**Nambucca Estuary - Estuary Processes Study (1999-2000).** Ecologist examining the extent and types of ecological communities in the Nambucca estuary, and the effects of estuary processes on the ecology of the area. The results of the project provide input into the Nambucca Estuary Management Plan.

**Batemans Bay/Clyde River Estuary - Estuary Processes Study (1999).** Project Manager, responsible for undertaking assessments of the extent and types of ecological communities in the Batemans Bay/Clyde River estuary, the status of information on the health and condition of estuarine environments, and the effects of physical and biological processes on the ecology of the area. The results of the project provide input into the Batemans Bay/Clyde River Estuary Management Plan.

**Historical Trends in Water Quality of Gold Coast Waterways (1997-2000).** Aquatic ecologist examining changes in marine vegetation communities within Gold Coast waterways, and possible linkages to water quality.

**Aquatic and Riparian Environmental Assessment of Gold Coast Waterways (1997-2000).** Aquatic ecologist examining the condition and conservation values of aquatic communities within Gold Coast waterways.

### *State of Environment Assessments*

**State of the Catchment Report - Lake Samsonvale Catchment (2001).** Environmental scientist examining pressures and condition of land and water resources in the Lake Samsonvale catchment.

**State of the Environment Report - Caboolture Shire (2000).** Project Manager for the 1999-2000 SoE report. Involved the identification of key indicators, and reporting on the condition, pressures and responses related to key themes.

**State of the Rivers and Estuaries Report - NSW South Coast (1999).** Project Manager for the 'Estuaries' chapter of the SoRE report.

**State of the Rivers and Estuaries Report - NSW South Coast (1999).** Project Manager responsible for the compilation and editing of the overall SoRE report written by DLWC.

### *Freshwater Ecology - Non-mining Assessments*

**Robina Lakes Fisheries Assessments (2005-2006).** Project Manager for an investigation (legal case) of fisheries values of a proposed development in the Gold Coast hinterland.

**The Edge Noosa – Aquatic Ecology and Fisheries Assessments (2005-2006).** Project manager for a study examining the fish assemblages and platypus of a golf course development on Kin Kin Creek near Noosa. Targeted field surveys focussed on threatened fish species, namely Oxleyan Pygmy Perch and Honey Blue-eye, and platypus.

**Caboolture-Landsborough Rail Upgrade (2005-2006).** Senior aquatic ecologist for a planning study examining potential impacts of rail infrastructure of aquatic ecosystems and their values. Targeted field surveys focussed on threatened fish species, namely Oxleyan Pygmy Perch and Honey Blue-eye.

**Bruce Highway Upgrade – Caboolture Morayfield (2006).** Senior aquatic ecologist for a planning study examining potential impacts of road infrastructure options on aquatic ecosystems and their values.

**Bruce Highway Upgrade – Cooroy to Curragh (2005).** Senior aquatic ecologist for a planning study examining potential impacts of road infrastructure options on aquatic ecosystems and their values.

**Burnett River Dam Baseline Monitoring Study (2003).** Project manager for a multidisciplinary study examining the water quality, macrophytes, macroinvertebrates, fish and platypus assemblages of a future dam development on the Burnett River near Gayndah.

**Eidsvold Weir Fish Monitoring Study (2003).** Project manager for a multidisciplinary study examining the water quality, fish and platypus assemblages of a future weir development on the Burnett River near Eidsvold.

**Pinjara Hills Ecological Assessments (2002).** Expert witness in a court case assessing the potential impacts of a proposed development on a stream at Kenmore.

**Noosa Hill Freshwater Habitat Management Plan (2002).** Project Manager a Plan to develop and maintain a freshwater habitat feature in a new development.

**Eprapah Creek Macroinvertebrate Monitoring (2001).** Project Manager for monitoring surveys of the freshwater and estuarine reaches of Eprapah Creek, for input into a Management Plan for the catchment and waterway. Responsible for fieldwork and reporting.

**Tingalpa Creek Macroinvertebrate Monitoring (2001).** Project Manager for monitoring surveys of the freshwater and estuarine reaches of Tingalpa Creek, for input into a Stormwater Management Plan for the catchment and waterway. Responsible for fieldwork and reporting.

**Environmental Assessments for Scrubby Creek Stormwater Management Plan (2000).** Project Manager for an assessment of environment conditions and pressures on ecosystems in the upper Scrubby Creek catchment. Responsible for project management, reporting and development of management strategies.

**Kooloonbung Wetland Monitoring (1999).** Aquatic ecologist for monitoring the impacts of a dump site of Kooloonbung Wetland, located near Port Macquarie. Responsible for fieldwork, identification of freshwater macroinvertebrate and fish samples and reporting.

**Aquatic and Riparian Fauna Surveys of Brisbane Koala Bushlands (1998).** Aquatic biologist undertaking field surveys of the fish and other aquatic fauna of creek systems within Brisbane Koala Bushlands (Brisbane City Council).

**Caboolture Atlas of Natural Assets - Fauna Species of Conservation Significance (1998).** Aquatic ecologist for a review of fish fauna of conservation significance within the Caboolture Shire. Responsible for defining, reporting and mapping aquatic fauna species of conservation value.

**Burnett River Catchment Aquatic and Terrestrial Flora/Fauna Data Review (1998).** Aquatic biologist responsible for reviewing information on the aquatic fauna of the Burnett River system, and in evaluating and defining a methodology to identify areas of high conservation value within the catchment.

**Central Burnett River: Hydrological and Fisheries Issues Associated with Dam & Weir Construction (1998).** Aquatic biologist examining the fisheries of the Central Burnett River area, general aspects of their life-cycle, potential impacts of dam/weir construction and available mitigation strategies.

**Kedron Brook Water Quality Assessments (1998-1999).** Aquatic ecologist for investigations of the 'environmental health' of Kedron Brook. Responsible for field work, identification of freshwater macroinvertebrate samples and reporting.

**Coomera Woods Retail Development EIS (1997).** Aquatic biologist undertaking field surveys of the fish communities of creek systems within a proposed retail development on the Gold Coast, as part of an environmental impact assessment.

**Fish Surveys of Gold Coast City Waterways (1999).** Aquatic biologist undertaking field surveys and reporting of the fish and other aquatic fauna of 35 sites at creek systems within Gold Coast City Council.

**Gowrie Creek Sewage Monitoring Design (1997).** Benthic ecologist for field investigations to design a monitoring program examining the impacts of sewage discharge on macroinvertebrate communities in a highly polluted stream.

**Woodford Sewage Monitoring Design (1997).** Benthic ecologist for field investigations in a study to design a monitoring program of sewage discharge impacts on soft sediment macroinvertebrate communities.

### *Reef Ecology*

**Inventory and Assessment of Intertidal Rocky Shores of South-East Queensland (1998-1999)**. Project Manager and author of a study which defined and mapped all intertidal rocky shores within south-east Queensland. The project identified rocky shores of outstanding conservation value, with information adopted in the south-east Queensland Coastal Management Plan.

**Influence of Benthic Community Structure on Reef Fishes on Moreton Island Reefs (1995-present)**. Scientist on a research project (with S.A. Banks, QPWS) examining the characteristics of the benthic communities at the coastal reefs off Moreton Island, and their relationship with reef fish community structure.

**Influence of Habitat Availability on the Population Ecology of Anemonefishes (1993-1996)**. Ph.D. research program examining the population ecology of anemonefishes. This research has resulted in several refereed publications (four published, two in preparation), conference presentations and a thesis (see publication list below).

**Benthic Community Structure of Northern NSW Coastal Reefs (1994-1998)**. Marine ecologist/author on a research project examining the characteristics of the coastal reef communities of the Tweed Coast, Byron Bay and South West Rocks (N.NSW). Results published in Harriott *et al.* (1999).

**Benthic Community Ecology on Eastern Australian Sub-Tropical Rocky Reefs (1993-1996)**. Field assistant on a range of research projects undertaken by V. Harriott, P. Harrison and S. Banks (SCU) examining the benthic communities of Flinders Reef, Gneering Shoals, Solitary Islands and South West Rocks.

**Macroalgae of Moreton Bay Database (1997)**. Aquatic biologist undertaking investigations on the distribution of macroalgae in Moreton Bay, and its potential use as a indicator of water quality.

### *General Environmental Assessments*

**Commonwealth Threat Abatement Plan for Marine Debris (2004-ongoing)** Scientist for the development of a national plan for mitigating impacts of marine debris on listed marine species.

**State of the Catchment Report - Lake Samsonvale Catchment (2001).** Environmental scientist examining pressures and condition of land and water resources in the Lake Samsonvale catchment.

**State of the Environment Report - Caboolture Shire (2000).** Project Manager for the 1999-2000 SoE report. Involved the identification of key indicators, and reporting on the condition, pressures and responses related to key themes.

**State of the Rivers and Estuaries Report - NSW South Coast (1999).** Project Manager for the 'Estuaries' chapter of the SoRE report.

**State of the Rivers and Estuaries Report - NSW South Coast (1999).** Project Manager responsible for the compilation and editing of the overall SoRE report written by DLWC.

### *Freshwater Ecology – Mining*

**Moranbah North Mine – Assessment of Aquatic Ecosystems within a Subsidence Area (2006).** Project manager for an investigation of the ecosystem health and management of a subsided river bed environment on the Isaac River, central Queensland.

**Yarraman Lakes Water Quality Monitoring (2005-2006).** Senior scientist examining potential impacts of mine discharges on water quality on North Stradbroke Island.

**Gregory-Crinum Mine Environmental Investigations (2004-2005).** Project manager for an investigation of the ecosystem health and management of waterbodies at Gregory Crinum Mine.

**Kounpee Trench Recharge Risk Assessment (2004-2005).** Project manager of a risk assessment examining the potential impacts of artificial recharge of a disturbed lake on North Stradbroke Island.

**Kogan Power Station Baseline Water Quality Monitoring Program (2004-2005)**. Project manager for the development pf a sampling and analysis plan to develop a baseline water quality database for the Kogan Creek power station, Chinchilla.

**Lenton Mine EMOS (2004)** Development of the Water Quality component for the proposed Lenton Mine Environmental Management Overview Strategy.

**Olive Downs Mine EMOS (2004)** Development of the Water Quality component for the proposed Olive Downs Mine Environmental Management Overview Strategy.

**Sanoma Mine EIS (2004)** Senior author for the Water Quality investigations for the Sanoma Mine EIS.

**North Curragh Aquatic Ecosystem Baseline Surveys (2004)** Project manager for baseline aquatic ecosystem surveys for the proposed North Curragh Mine.

**Vermont Mine EIS (2004)** Senior author for the Aquatic Ecology investigations for the Vermont Mine EIS.

**Strathmore Creek Aquatic Ecosystem Health Assessment (2003).** Aquatic ecologist examining the potential impacts of groundwater seepage from a mine on aquatic ecosystems.

**Collinsville Coal Environmental Evaluation (2002).** Project manager for a study determining the impacts of coal mining on a stream at Collinsville Mine.

**Moorvale Coal Project - Aquatic Biology Monitoring Sampling and Analysis Plan (2002).** Project manager for the development of a SAP for monitoring impacts of a new coal development.

**Assessment of the Impacts of Coal Mining and other Land Uses on the Ecosystem Health of the Fitzroy River (2002-ongoing).** Project Manager for an ACARP-funded research project examining the ecosystem health of the Fitzroy River system using fish and macroinvertebrates indicators.

**Moorvale Coal Project EIS (2001).** Aquatic ecologist examining the potential impacts on stream communities of a proposed mining development near Coppabella, Bowen Basin.

**Significant Species Management Plan Monitoring Reports – Oxleyan Pygmy Perch (2001-ongoing).** Project Manager for monitoring investigations associated with the Oxleyan Pygmy Perch Management Plan at North Stradbroke Island.

**Moranbah North Mine Aquatic Fauna Assessments (2001).** Project Manager for baseline monitoring of aquatic fauna communities adjacent to Moranbah North Mine, Bowen Basin. Responsible for sampling of freshwater macroinvertebrate and fish and reporting.

**Goonyella Riverside Mine Aquatic Fauna Assessments (2001).** Project Manager for baseline monitoring of aquatic fauna communities adjacent to Goonyella Riverside Mine, Bowen Basin. Responsible for sampling of freshwater macroinvertebrate and fish and reporting.

**Herring-Enterprise Aquatic Fauna and Water Quality Assessments (2001-2002).** Project Manager for baseline monitoring of aquatic fauna in wetlands and lagoons in the Herring-Enterprise Mine lease, North Stradbroke Island. Surveys were directed towards describing spatial and temporal variations in benthic macroinvertebrate, nekton, plankton and fish communities. Responsible for field work, identification of freshwater macroinvertebrate and fish samples and reporting.

**Development of Water Quality Triggers – Little Canalpin Creek (2000).** Project Manager for the development of trigger levels developed for the purpose of water quality monitoring at Little Canalpin Creek, North Stradbroke Island.

**Analysis of the Ionic Composition of Waters from North Stradbroke Island Freshwater Waterbodies (2000).** Undertook detailed statistical analysis of long-term water quality data sets to determine any differences in the ionic composition of waterbodies on North Stradbroke Island.

**Ibis Lagoon Flooding Incident (2000).** Project manager and aquatic ecologist for a study examining the potential and known impacts of raised water levels, associated with sand mining operations, on the water quality and ecology of Ibis lagoon, North Stradbroke Island.

**Significant Species Management Plan – Oxleyan Pygmy Perch (2000).** Project Manager for the development of a management plan to mitigate possible impacts of sand mining operations on a local population of Oxleyan Pygmy Perch at North Stradbroke Island.

**Ibis Mine Aquatic Fauna Surveys (1999-2000).** Project Manager for baseline monitoring of aquatic fauna in wetlands and lagoons in the Ibis Mine lease, North Stradbroke Island. Surveys were directed towards describing spatial and temporal variations in benthic macroinvertebrate, nekton, plankton and fish communities. Responsible for field work, identification of freshwater macroinvertebrate and fish samples and reporting.

**Goulbourn River Impact Assessments (1997).** Aquatic ecologist for investigations of the fish, macroinvertebrate and aquatic flora of Goulburn River, as part of impact assessment studies of mine expansion at Ulan (NSW). Responsible for survey design, field work, identification of freshwater macroinvertebrate and fish samples and reporting.

**Aquatic and Water Quality Surveys of the Yarraman Mine Site, North Stradbroke Island (1997).** Aquatic biologist for field investigations of the water quality and fish, macroinvertebrate and aquatic flora communities of the freshwater lakes of North Stradbroke Island, southern Queensland.

**Aquatic and Terrestrial Fauna Surveys of the Theodore Coal Projects Sites (1996).** Aquatic biologist for field investigations of the fish and other aquatic fauna communities of the Dawson River, central Queensland.

## Refereed Publications

Cullen E. L., Morgan, C. D., Richardson, D.L. and Tiedt, B. (2003). Integrated Approach to Assessing Mine-Related Impacts on the Sustainable Management of Water Resources Case Study – Three Mile Creek, Collinsville (Northern Bowen Basin, Queensland). *Water In Mining Conference, 13-15th October 2003*, Brisbane.

Richardson, D.L. (1999). Correlates of environmental variables with patterns in the distribution and abundance of two anemonefishes (Pomacentridae: *Amphiprion*) on an eastern Australian sub-tropical reef system. *Environmental Biology of Fishes*. **55**: 255-263.

Harriott, V.J., Banks, S.A., Mau, R.L., Richardson, D.L., and Roberts, L.G. (1999). The ecological and conservation significance of the subtidal rocky reef coral communities in northern N.S.W., Australia. *Marine and Freshwater Research.* **50**: 299-306.

Richardson, D.L. (1998). Descriptions of the juvenile colour patterns of three anemonefish species (Pomacentridae: *Amphiprion*) from New South Wales and Lord Howe-Norfolk Island region. *Proceedings of the Linnean Society of N.S.W.* **120**: 81-86.

Richardson, D.L., Harriott, V.J. and Harrison, P.L. (1997) Distribution and abundance of giant sea-anemones (Actiniaria) in sub-tropical eastern Australian waters. *Marine and Freshwater Research*, **48**: 59-66.

Richardson, D.L., Harrison, P.L. and Harriott, V.J. (1997) Timing of spawning and fecundity of a tropical and sub-tropical anemonefish (Pomacentridae: *Amphiprion*) at a high latitude reef on the east coast of Australia. *Marine Ecology Progress Series*, **156**: 175-181.

### Theses & Non-Refereed Publications and Presentations

Richardson, D.L. (1999). Environmental Values of Waterways: A Broad-Scale Waterway Habitat Classification Method used in the Burnett Catchment. *Proceedings of the Workshop on the Conservation Status and Sustainability of Waterways*. 7th December 1998, Water Resource Environmental Planning, Brisbane.

Richardson, D. L. (1996) Aspects of the Ecology of Anemonefishes (Pomacentridae: *Amphiprion*) and Giant Anemones (Actiniaria) within Sub-tropical Eastern Australian Waters. Ph.D. thesis, Centre for Coastal Management, Southern Cross University Lismore. 250 pp.

Richardson, D. L. (1995) Biogeography of host sea-anemones and anemonefishes in the eastern Australian sub-tropics. *Australian Coral Reef Society Annual Conference*, 15-16th July 1995, Lismore NSW (*Awarded Best Poster*).

Richardson, D. L. (1995) Factors influencing the distribution and abundance of anemonefishes at North Solitary Island, northern NSW. *Australian Coral Reef Society Annual Conference*, 15-16th July 1995, Lismore NSW.

Richardson, D. L. (1991) Some Aspects of Food and Feeding in the Sydney Rock Oyster *Saccostrea commercialis* (Iredale & Roughley) in Port Stephens, N.S.W. Honours Thesis, Centre for Coastal Management, University of New England 117 pp.

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Threatened Species Habitat Assessment – Howard's Tree Farm, Wooyung (2001)
Conservation Management Plan for Glossy Black-Cockatoos-Progress Hill, Noosa (2001)
Rare & Threatened Flora & Fauna Assessment–Gregory to Blackwater Dragline Relocation Route (2000)
Grass Owl Surveys & Assessment of Coastal Habitats of the Harrington District, New South Wales (1999).
Conservation Management of Microbat Roosts and Maternity Sites at Moura Mine (1999). -
Wallum Froglet Survey and Habitat Assessment of Crowdy Bay National Park and Harrington (1999) -
Harrington Waters Estate - Wallum Froglet Habitat Assessment (1999)
Shorebird High Tide Roost Assessment - Sovereign Islands (1999)
Rare and Threatened Vertebrate Fauna Surveys of Moura Mine (1999)
An Appraisal of Little Tern occurrence at Woogoompah Island - Opportunities and Recommendations (1998)

**Natural Resource Inventories & Conservation Planning Studies**

Ecological Character Description of the Currawinya Lakes National Park Ramsar Site (2008 - )
Threatened Species and Biodiversity Action Plan – BMA Saraji (2006).
Threatened Species and Biodiversity Action Plan – BMA Peak Downs (2006).
Review of Habitat Values for Biodiversity & Species of Conservation Significance – BMA Poitrel Leases (2006).
An Audit & Regional Overview of Biodiversity Values for BMA Coal Operations within Central Queensland (2006).
Review of Habitat Values for Biodiversity & Species of Conservation Significance – BMA Terang Leases (2005).
Review of Habitat Values for Biodiversity & Species of Conservation Significance – BMA Blackwater Mine (2005).
Review of Habitat Values for Biodiversity & Species of Conservation Significance – BMA Saraji Mine (2005).
Review of Habitat Values for Biodiversity & Species of Conservation Significance – Gregory Crinum Mine (2005).
Review of Habitat Values for Biodiversity &Species of Conservation Significance – Peak Downs Mine (2005).
Review of Habitat Values for Biodiversity a Species of Conservation Significance – South Walker Mine (2005).
Review of Habitat Values for Biodiversity a Species of Conservation Significance – Goonyella Riverside & Broadmeadows Mines (2005)
Review of Habitat Values for Biodiversity and Species of Conservation Significance – Hay Point Facility (2005)
Biodiversity and Threatened Species Action Plan – BMA Norwich Park Mine (2005)
Coomera River Catchment Environmental Inventory – Avifauna (2003-2004)
Mapping of Ecological Habitats and Inventory for Botany Bay - Planning NSW (2003)
Caboolture Common Classification System Application – Stage 2 (2002)
Moreton Bay Sand Extraction Study (2001)
An Investigation of EPBC and NCA Act implications of the Proposed Coomera Town Centre LAP (2002)
Caboolture Shire Environmental Planning Study – Nature Conservation Studies (2001)
Lake Samsonvale ICMS – State of the Catchment Report (2001)
Tamborine Mountain Escarpment Flora and Fauna Study (2000)
An Assessment of Fauna Habitat Values of the Port of Brisbane Corporation Land Portfolio (2000)
North East Wetlands Fauna Survey (1999)
Ecological Background Studies for Tallows, Belongil and Jerusalem Creeks (1999)
Brisbane Entertainment Centre Precinct Fauna and Flora Assessment (1999)
Burnett River Catchment Fauna and Flora Overview (1998)
Habitat Inventory of Rocky Reefs of South-east Queensland (1999)
Aquatic and Riparian Environmental Assessments - Gold Coast (1998)

**Impact Assessment Statements, Review of Environmental Factors, Environment Management Plans**

Vertebrate Fauna Habitat Values – Sunshine Motorway Upgrade – Mooloolah River to Eenie Creek (2008 - )
Gladstone Area Water Board Fitzroy Gladstone Pipeline EIS – Terrestrial Fauna (2008)
EPBC Referral - Terrestrial Fauna - 84 Eagleby Road, Eagleby. Eagleby (2007).
Terrestrial Vertebrate Fauna Issues - Pacific Paradise Bypass and Maroochydore Road Upgrade (2007 - ).
REF and EPBC Referral - Ipswich Motorway Northern Options - Terrestrial Fauna (2007).
United Collieries Warkworth Longwall Panels 10 & 11 Expansion EIS - Flora and Fauna, (2007)
Ipswich Motorway Northern Option Feasibility Study - Vertebrate Fauna Issues Report (2007).
Caloundra South CAMCOSS Re-alignment EIS & EPBC Referral - Terrestrial Fauna (2007).
Design Issues related to Terrestrial Vertebrate Fauna - Glasshouse Mountains Road Upgrade (2007)
GAWB Rockhampton to Gladstone Pipeline REF and EPBC Referral - Terrestrial Fauna (2007).
Brisbane Airport Parallel Runway EIS – Terrestrial Vertebrate Fauna (2005-06).
REF and EPBC Referral - Brisbane Airport Parallel Runway Project - Terrestrial Fauna (2007).
Flora & Fauna Baseline Surveys for the BMA Isaac River IAS (2006)
Wonbindi Coal Project Flora and Fauna EMP (2006)
Fauna, Flora and Vegetation Assessment for South Walker Mine SAA4 IAS (2006)
Dawson North Expansion EIS and EPBC Referral – Vertebrate Fauna and Ecology Sections (2005).
An Investigation of Flora, Fauna and Biodiversity Values associated with Brigalow Remnants along the Proposed Heyford Back Access Road – BMA Peak Downs Mine (2005).
Ecological Assessments – Ipswich Motorway Northern Options (2005)
Wildlife Management Issues associated with Fresh Air Rises and Intakes-Cannington Mine (2004)
Bruce Highway (Cooroy to Curra) Strategic Planning Study Stage 2 - Ecological Issues and Constraints (2004)
Moura North EMOS – Flora and Fauna (2003-04)
Theodore Coal Project (Stage 2) EIS – Nature Conservation (2003-04).

Vermont Coal Project IAS and EIS – Nature Conservation (2003)
Mt. Birnie to Boulia Telstra Cable Alignment – Ecological Assessments (2003)
Theodore Mine EPBC Act Assessments (2003)
Caboolture to Landsborough Rail Duplication (2002-2003)
Fauna and Flora Management Plan-Manning River Dredging for the Harrington Waters Estate (2002)
Jacaranda Pit IAS – Terrestrial Vertebrate Fauna Assessments - Saraji Mine (2002)
Fauna and Fauna Habitat Assessment – Ramp 4 Underground Project, Goonyella Riverside Mine (2002)
Coledale Beach Hazards Study-Ecology Section (2002)
Bruce Highway Upgrade (Uhlmann to Buchanans Road)-Flora and Fauna Pre-construction REF (2002)
Moreton Bay Sand Extraction-Ecology Section (2002)
Moorvale Coal Project IAS (2001)
Review of Flora and Fauna EIS Issues – Pacific Beach Development, Tugun (2001)
Environmental Assessments of Four Mile Beach, Port Douglas (2001)
Fauna and Flora Habitat Assessment for the Peak Downs Highway Diversion at Coppabella (2000)
Port of Brisbane Expansion IAS (2000)
Caboolture to Maroochydore Corridor Study - IAS and Land Use Transport Strategy (1999)
Eenie Creek Flora and Fauna Impact Assessment (1999)
Terrestrial and Aquatic and Terrestrial Vertebrate Fauna Survey - Saraji Mine IAS (1999)
Hexham Swamp/Ironbark Creek EIS (1998)
Port of Airlie Marina IAS (1998)

**Extractive Industry**

Brigalow and SEVT RE and Regrowth Community Assessments - Anglo Dawson Mine (2008)
Rehabilitation Monitoring Program 2008 – Anglo Dawson Mine (2008)
Surveys of Biodiversity and Rare and Threatened Fauna and Flora – BMA Poitrel Mine (2007).
South Marshmead Biodiversity Inventory, Blackwater (2007).
Autumn Fauna Baseline Survey – United Collieries, Warkworth (2007)
Koala Surveys and Habitat Assessment for BMA Peak Downs (2006).
Summer Fauna Baseline Survey – United Collieries, Warkworth (2006).
2006 Fauna Survey of Post-Mining Landscapes of Peak Downs Mine (2006)
Summer Season Fauna Baseline Survey – BMA Goonyella Riverside & Broadmeadows Mines (2006).
2006 Vertebrate Fauna Survey of Selected Remnant Regional Ecosystems – BMA Saraji (2006).
Winter Season Fauna Baseline Inventory - BMA Saraji (2006).
Winter Season Fauna Survey - BMA Peak Downs (2006).
Flora and Fauna Baseline Survey and Biodiversity Action Plan – United Collieries, Warkworth (2005).
2005 Vegetation, Fauna and Soils Monitoring Program for Post-mining Rehabilitation – Moura Mine (2005).
Autumn Season Vertebrate Fauna Surveys of Remnant Habitats of Norwich Park Mine 2005
Vertebrate Fauna Surveys of Remnant Habitats associated with One Mile Dam & Surrounds – Saraji Mine (2005)
Peak Downs Mine Flora and Fauna Surveys – Summer 2005
Abbott Point Wetlands Flora and Fauna Surveys – Dry Season (2004)
Target Species Investigations and Replicate Baseline Surveys of Cannington Mine Leases–Summer 2004
Flora and Fauna Assessment of Oaky Creek Mine Proposed Lease Extension (2004)
Blackwater Mine –Regional Ecosystem and Fauna Habitat Assessment (2004)
Norwich Park Mine – Baseline Flora and Fauna Habitat Assessment (2004)
Review of Fauna Habitat Values of Mine Rehabilitation in the Ramp 6E/7 area, Moura Mine (2004)
Flora and Fauna Assessment of the Moranbah North Mine – Summer 2002 and 2004 (2004)
Flora and Fauna Assessment – Collinsville Coal Project (2003-04)
Moranbah North Mine Isaac River Subsidence – Review of Ecological Impacts (2003)
Phase Two Vertebrate Fauna Monitoring & Data Integration Report – Cannington Mine & Surrounds (2003)
Vertebrate Diversity & Target Species Surveys of Wetland & Riparian Habitats - Saraji Mine (2003)
Theodore Mine EPBC Act Assessments (2003)
Threatened Species and Wetland Surveys – Saraji Mine (2003)
Terrestrial Vertebrate Fauna Monitoring Program (Phase 2)–Moura Mine (2002)
Flora and Fauna Assessment of the Moranbah North Coal Lease (2002)
Dry Season Aquatic & Terrestrial Vertebrate Fauna Surveys – Cannington Mine (2002)
Jacaranda Pit IAS – Terrestrial Vertebrate Fauna Assessments - Saraji Mine (2002)
Vertebrate Biodiversity & Flora Assessments, Remnant Habitats-Goonyella Riverside underground project (2002)
Design and Field Trials for Bat Gates for Disused Mine Tunnels, Moura Mine (2001)
Moorvale Coal Project IAS – Terrestrial Ecology Section (2001)
Fauna Habitat Assessment of Disused Voids and Low Wall Landscapes of Blackwater Mine (2001)
Ravensworth Mine Baseline Terrestrial Fauna Assessment (2001)
Summer 2001 Aquatic and Terrestrial Fauna Surveys of South Blackwater Mine (2001)
Terrestrial Vertebrate Fauna Monitoring Program (Phase 1)–Moura Mine (2001)
Summer 2001 Vertebrate Fauna Survey and Data Integraton Report for Curragh Mine, Blackwater (2001)
Rare & Threatened Flora & Fauna Assessments – Oakey Creek to Blackwater Dragline Relocation Route (2000)
Wet and Dry Season Vertebrate Fauna Surveys of Blackwater Mine (2000)
Flora and Fauna Surveys – Southern Exploration Lease, Coppabella Mine (2000)

An Investigation of the Flora and Fauna Values for the Dragline Relocation Route between Goonyella Riverside and South Walker Mines (2000)
Wet Season Aquatic and Terrestrial Fauna Survey- Goonyella Riverside Mine (2000)
A Terrestrial and Aquatic Fauna Study of Curragh Mine (2000)
Summer Season Terrestrial Vertebrate Fauna Survey of the Moorvale EPC, Nebo District (2000)
Conservation Management of Microbat Roosts and Maternity Sites at Moura Mine (1999)
Rare and Threatened Vertebrate Fauna Surveys of Moura Mine (1999)
Assessment of Fauna Habitat Enhancement Initiatives at Peak Downs Mine (1999)
Terrestrial Flora and Fauna Assessment of Coppabella Mine Site (1999)
Wet Season Survey of Terrestrial and Aquatic Fauna of Saraji Mine (1999)
An Assessment of Terrestrial Fauna Habitat Values and Management Practices at Moura Mine (1999)
Terrestrial Flora and Fauna Assessment of Moorvale Mine Site (1999)
An Investigation of the Terrestrial Vertebrate Fauna Values of Holts Hill, Clagiraba (1999)
Wet Season Aquatic and Terrestrial Survey of Blackwater Mine (1999)
Port of Airlie Extractive Industry IAS (1998).

**Urban Development**

Terrestrial Fauna & Fauna Habitat Values Assessment-Tinnanbar EcoVillage Site (2007 - ).
Ecological Design Considerations for Bioremediation Wetlands – Neumann Developments Chevallum (2007).
Fauna & Fauna Habitat Values Assessment – 55 Alligator Creek Road, Townsville (2007 - ).
Fauna & Fauna Habitat Values Assessment – Lot 207 K124620 & part of Lot 1 on EP2169, Townsville (2007 - ).
Fauna and Fauna Habitat Values Assessment – Svensson Rd, Mt. Low (2007 - ).
Assessment of Fauna & Fauna Habitat Values - Turtle Cove, Captain Cook Highway, Wangetti (2007 - )
Biodiversity & Threatened Species Assessments – 1105-1030 Currumbin Creek Road, Currumbin Valley (2006).
Fauna and Fauna Habitat Values Assessment – Juniper Lands adjacent to the Mooloolah River (2005)
Survey of Vertebrate Fauna Diversity & Species of Conservation Significance – 293 Compton Rd, Kuraby (2005)
Fauna and Fauna Habitat Assessment Report for 19 First Ave, Woorim (2005)
Fauna Assessment Report for 438 Old Cleveland Road East, Birkdale (2005)
Review of Fauna and Fauna Habitat Values – Hoffmann land at Old Hollett Road, Noosaville (2005).
Fauna Habitat Values Assessment – 105 Mt Petrie Road, Belmont (2005).
Ecological Assessment Report – 30 & 38 Sheaffe Street, Bracken Ridge (2004)
Pre-clearing and Clearing Surveys – Kelvin Grove Campus, Queensland University of Technology (2004)
Ecological Assessment Report – 35 Arenga Street, Manly (2004)
Fauna Habitat Values Investigation - 720-744 New Cleveland Road, Gumdale (2004)
Fauna and Fauna Habitat Values Assessment – 2 Inala Avenue, Durack (2004)
Habitat Values Assessment – 784/808 Blunder Road & 32 Peacock Street, Durack (2004)
Habitat Values Assessment – 73 Landis Street, McDowall (2004)
Fauna and Fauna Habitat Values Assessment – 100 Brookside Street, Doolandella (2004)
Threatened Species and Biodiversity Assessment – Maree Street, Caloundra (2004)
Re-evaluation of Fauna Habitat Values - 102-122 Cloverdale Road, Doolandella (2004)
Fauna and Fauna Habitat Values Assessment, 972-1010 Blunder Road, Doolandella (2004)
Flora and Fauna Assessment Report - 678 Manly Road, Wakerley (2004)
Fauna and Fauna Habitat Values Assessment – 744 New Cleveland Road, Wakerley (2004)
Habitat Values Assessment – University of Queensland land at Salisbury Street, Redland Bay (2003)
Fauna and Fauna Habitat Values – Lacey & Telegraph Roads, Bracken Ridge (2003)
Revision of Aspects of Ecological Assessments of the Noosa Shire Business Centre (2002)
Fauna Assessment – Tilley and New Cleveland Roads, Wakerley (2002)
Fauna and Fauna Habitat Values - 35 Crossacres St, Doolandella (2002)
Coastal and Ecological Studies for the Armada Development-Bayview Street, Holywell (2002)
Royal Queensland Golf Club Brisbane City Plan Designated Wetland Assessment (2002)
Fauna and Flora Values Assessment – Noosa Springs Resort (2002)
Mt Cotton Winery Amphitheatre Site -Flora and Fauna Report (2002)
Fauna Assessment - Tilley and New Cleveland Roads, Wakerley (2002)
Fauna and Fauna Habitat Values - 256-260 Lacey Road & 107-113 Telegraph Road, Bald Hills (2002)
Wetland Reconstruction Design and Management Criteria for Fauna-Grindle Road, Rocklea (2002)
Fauna Habitat Values Investigation for 102-122 Cloverdale Road, Doolandella (2002)
Fauna & Wetland Values Assessment – Grindle Road, Rocklea (2002)
An Investigation of Potential Riparian Habitat & Fauna Movement Values – Springfield Lakes (2001)
Fauna Habitat Values Investigation for the Broad Lakes Development Site, Merrimac (2001)
Flora and Fauna EIS Studies - Ardgour Pastoral Co., Nerang-Broadbeach Road, Nerang (2001)
Rothwell Environmental Studies - Flora & Fauna Report (1999)
Terrestrial Fauna Assessment of 202A Lacey Road, Bald Hills (1999)
Proposed Sporting Clay Shooting Ground - Woongoolba - Flora and Fauna Assessment (1998)
Emerald Lakes Golf Course Redevelopment - Flora and Fauna Issues (1998)
470 Seventeen Mile Rocks Road - Flora and Fauna Assessment (1998)

**Expert Witness**

Extensive experience as an expert witness for appeals to the Planning and Environment Court and compensation claims before the Land Court. Participation in over 90 matters since 1998. A full listing can be provided on request.

### Third Party Review

Draft BHP Billiton Biodiversity Policy – Review of Fauna Issues (2007).
Review of Threatened Fauna Issues associated with Pelican Links, Caloundra - RFI response (2005).
Shorebird Management Plan-Manning River Dredging for the Harrington Waters Estate (2002)
Naturelink Cableway EIS Review (2000)
Threatened Species Assessment - Harrington Waters Estate, NSW (1999).

### Research

Australian Coal Association Research Program (2006-2008) – *Assessment of Seasonal Habitat Characteristics as Predictors of Habitat Suitability for the Threatened Ornamental Snake.*

ACARP (2005-2008) – *Artificial Structures to Enhance Vertebrate Fauna Habitat Values and Accelerate Fauna Colonisation within Mine Rehabilitation of the Bowen Basin, Central Queensland – Microbats.*

### Publications

Geering, A., Agnew, L., and Harding, S. (2007). *Shorebirds of Australia*. CSIRO Publishing, Collingwood.

Agnew, L.R., Veary, A.T. and Richardson, D.L. (2003). *Determination of Criteria for Mining Lease Relinquishment within central Queensland using Terrestrial Vertebrate Fauna as Indicators of Rehabilitation Success.* Project C10033. Australian Coal Association Research Program, Brisbane.

Debus, S.J.S., Agnew, L.R., and Schulz, M. 2001. Surveys for Eastern Grass Owl *Tyto Capensis* in Coastal New South Wales. Australian Bird Watcher 19(3), 55-60.

Agnew, L.R and Stewart, D. 1998. Birds of Moreton Bay. In; Ryan, M. (ed.). *Wild Guide to Moreton Bay-Wildlife and Habitats of a Beautiful Australian Coast - Noosa to the Tweed*, Queensland Museum. pp 319-353.

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**Tennyson Riverside Development Marine Plant Monitoring (2008 – ongoing).** Field survey and associated reporting for a monitoring programme to examine ecological responses of mangrove communities to disturbance activities.

**Whyte Island Ecological Survey and Impact Assessment (2008).** Field survey to map marine plant species and identify potential impacts and management issues associated with development of a sand-offloading facility.

**Goonyella Riverside Mine Aquatic and Riparian Ecosystem Monitoring (2008 – ongoing).** Flora component of an aquatic and riparian monitoring study to investigate ecological impacts following saline water discharge, including input into the preparation of a remediation plan.

**National Coastal Vulnerability Assessment, Kakadu, Northern Territory (2008 – ongoing).** Ecological input for a major study to assess vulnerability as a result of climate change in the South Alligator River, Kakadu National Park.

**Brisbane Desalination Plant Siting Study (2008).** Input into the environmental component, including identification of ecological values of potential desalination plant wastewater outfall sites and a review to assess expected tolerances of sensitive ecological receptors.

**Angle-stemmed Myrtle Survey (2008).** Targeted field survey for the Endangered flora species *Gossia gonoclada* within the Pacific Motorway Transit Project (Section B).

**OZ Minerals Pipeline Environmental Audit (2008).** An environmental audit of noxious plants and landform condition along an underground pipeline from OZ Minerals Century Mine to Karumba port.

**Refereed Publications**

Ward, M. and Johnson S.D. 2005. Pollen limitation and demographic structure in small fragmented populations of *Brunsvigia radulosa* (Amaryllidaceae). *Oikos* 108:253-262.

Ward, M., Dick C.W., Gribel, R., and Lowe, A.J. 2005. To self or not to self… A review of outcrossing and pollen-mediated gene flow in neotropical trees. *Heredity* 95:246-254.

Lowe, A.J., Boshier, D., Ward, M., Bacles, C.F.E. and Navarro, C. 2005. Genetic resource impacts of habitat loss and degradation; reconciling empirical evidence and predicted theory for neotropical trees. *Heredity* 95:255-273.

**Theses and Non-refereed Publications and Presentations**

Carlson, C.A., Bower, J.P. and Ward, M. 2003. An evaluation and analysis of nutritional data collected from Eucalyptus clone banks. Technical Report, Forestry Plant Propagation Working Group.

Ward, M. 2003. The effects of habitat fragmentation on the reproduction and population demographics of *Brunsvigia radulosa* (Amaryllidaceae). Honours Thesis, University of Natal, South Africa.

Ward, M. 2007. Is bigger always better? Reproductive Allee effects in invasive Asclepiads. Oral Presentation, 9th International Conference on the Ecology and Management of Alien Plant Invasions.

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government liaison, and awareness and training in environmental law for villagers from communities within Milne Bay.

**August 2002 – October 2005: WBM Oceanics Australia**
Senior Environmental Scientist (Environmental Law) with the environmental planning and ecology section, providing services in the areas of environmental law/policy, environmental management (planning and systems), and marine biology and ecology.

**December 2000 – January 2002: WBM Oceanics Australia**
Undergraduate Environmental Scientist with the marine ecology section, providing services in the areas of environmental law, marine biology and ecology.

**April 2000-Dec 2000: KBR (previously Kinhill Pty Ltd)**
Undergraduate Environmental Scientist in the environment and planning group responsible for carrying out data collection and assessment, report writing, collation of projects, and research of both legal and scientific information.

**April 1999 – March 2000: Hyder Environmental**
Undergraduate Environmental Scientist in the environment and planning group providing a wide range of services, including carrying out data collection and assessment, research and report writing.

## PROJECT EXPERIENCE

### Environmental Planning, Law and Policy

**Kakadu National Coastal Vulnerability Assessment (2008 – Ongoing)**
Project Manger for an assessment of climate change impacts on river system dynamics in the Kakadu National Park and implications for government planning, management and policy responses.

**Moreton Bay Ecological Character Description (2008 – Ongoing).** Team member providing advice on policy and legislation for input into a major study of the wetlands of Moreton Bay including an ECD report, and a report on the assessment and effectiveness of management actions. Lead author of a report on management goals and environmental indicators. The project also involved a review and refinement of the Moreton Bay Ramsar boundary and Ramsar Information Sheet. Extensive liaison and consultation with the scientists of the Moreton Bay Partnership Scientific Expert Panel to develop a Whole-of-Bay Conceptual Model.

**Currawinya Lakes Ecological Character Description (2007 – 2008).** Team member providing advice on cultural issues associated with the preparation of the ECD for the Currawinya Lakes Ramsar Site in Western Queensland. The project involved a team of ecologists and hydrologists in preparation of the resource assessment, Ramsar Information Sheet, and revised mapping boundaries.

**Cardwell Shoreline Erosion Management Plan (2007- 2008)**
Provision of advice on ecological and environmental planning and legislative aspects for the development of a Shoreline Erosion Management Plan (SEMP) for the area of beach adjacent to Cardwell township. The SEMP assessed beach protection options for the beach, detailing; the existing condition, likely future erosive processes, and priorities for works or strategies required to protect the shoreline giving regard to risk, cost/benefit and ecological and legislative constraints. It also considered the constraints of potential sand source areas

**Port of Abbot Point Vegetation Clearing Approvals (2007 – 2008)**
Project manager of review of botanical surveys from Port of Abbot Point Expansion EIS, and provision of advice regarding possible areas to be remapped (incorrect RE mapping) and areas to be cleared on strategic and non-strategic port land.

**Ramsar Snapshot (2007)**
Project manager of an initial review (Snapshot) of the health and management of Australia Ramsar estate for the Australian Government Department of the Environment and Water Resources. This involved analysis of the level of information on the current state of Ramsar sites (e.g. currency of each site's Ramsar Information Sheet, site maps and management plans), the financial investment in Australia's Ramsar estate, assessment of major threats and management issues facing the sites, and anticipated key pressures in the future.

**Coomera Marina Development (2007)**
Provision of advice regarding referral under the *EPBC Act* and declaration of the project as being of state significance under the *State Development and Public Works Organisation Act 1971* (Qld).

**Maroochydore Structure Plan Advice (2007)**
Project manager for a review of the hydrological, ecological and water quality aspects of the Maroochydore Structure Plan Advice, considered from the perspective of the clients (Lend Lease) and proposed future developments.

**Sunshine Plaza Master Plan Advice (2007)**
Project manager for provision of advice on the proposed amendment of the Sunshine Plaza Master Plan. Advice provided included potential studies that may be required prior to submission of development applications in accordance with the proposed amended Master Plan.

**Woorim Shoreline Erosion Management Plan (2006-2007)**
Provision of advice on ecological and environmental planning and legislative aspects for the development of a Shoreline Erosion Management Plan (SEMP) for Woorim Beach. The SEMP assessed beach protection options for the beach, detailing; the existing condition, likely future erosive processes, and priorities for works or strategies required to protect the shoreline giving regard to risk, cost/benefit and ecological and legislative constraints.

**Cairns Shoreline Erosion Management Plan (2005 - 2006)**
Provision of advice for the development of a shoreline erosion management plan to protect and enhance the coastal values within the Cairns Council area whilst protecting existing infrastructure. The plan took into account information from past studies in the area, the *Coastal Protection and Management Act 1995*, the State and Regional Coastal Management Plan, other relevant regulatory requirements, environmental (ecological, social, cultural, economic) values, and community attitudes and concerns.

**Cairns Shoreline Erosion Management Plan Terms of Reference (2005)**
Drafting of the terms of reference for the Cairns City Council's tender for the proposed Cairns Shoreline Erosion Management Plan. The drafting of the ToR required an understanding of the current erosion issues, potential management measures, community concerns, and applicable legislation and policy (State and Regional Coastal Management Plans).

**Maroochy Shoreline Erosion Management Plan (2004 – 2007)**
Development of a shoreline erosion management plan to protect and enhance the coastal values within the Maroochy Shire (study area - Mooloolaba to Mudjimba) whilst protecting existing infrastructure. The plan took into account information from past studies in the area, the *Coastal Protection and Management Act 1995*, the State and Regional Coastal Management Plan, other relevant regulatory requirements, environmental (ecological, social, cultural, economic) values, and community attitudes and concerns. Generic erosion protection options were assessed for suitability against policy and financial criteria, and the most appropriate management measure recommended for each beach unit.

**Gippsland Lakes RT-4 Project (2005)**
Compilation and assessment of relevant international, national, state, regional and local legislation and policy applicable to the use of natural or constructed wetlands adjacent to, and adjoining, the Gippsland Lakes, as a nutrient trap for improvement of water quality in the Gippsland Lakes (including the Gippsland Lakes Ramsar site). The review provided the client with an understanding of the complexity of the legislation applicable to the Gippsland Lakes wetlands.

**Dredge Management Plan Development for Sand Extraction (2004-2005)**
Development of a dredge management plan for sand extraction operations of two companies within Moreton Bay, to ensure operations comply with requirements under the *Coastal Protection and Management Act 1995* and the *State Coastal Management Plan.*

**Marine Debris Threat Abatement Plan (2004 – 2005)**
The development of a draft threat abatement plan under the requirements of the *EPBC Act,* for the designated key threatening process of *Injury and Fatality to Vertebrate Marine Life Caused by Ingestion of, or Entanglement in, Harmful Marine Debris.* The information gathering stage involved extensive stakeholder consultation (including national workshops) from industry, government, NGOs and volunteer groups throughout Australia.

**Maroochy Canal Approvals (2004)**
Application for Maroochy Shire Council's canal maintenance dredging development approval, including ERA19 and tidal works approval. Liaison was required with EPA (Coastal section in Brisbane), EPA Maroochydore, and the Maroochy Shire Council. The application was written to apply to all canals in the Maroochy Shire to ensure the Shire-wide maintenance program can continue unhindered in the future.

**Maroochy Retaining Wall Approval (2004)**
Application for development approval for a retaining wall adjacent to Cotton Tree Park, Cotton Tree, including tidal works approval.

**Aquafarms Pearl Aquaculture Facility *EPBC* Preliminary Information Advice (2004)**
Advice on preliminary information prepared by client under the requirements of the *EPBC Act* and the reconstruction of that material to satisfy DEH needs and requirements under the Act. Additional information requests from DEH fulfilled where required.

**Russell Island Marine Survey and Marine Parks Re-Zoning Comments (2004)**
Assessment of the marine environment adjacent to the client's property, and letter of comment prepared for submission to Marine Parks (QWPS) for the proposed rezoning of the area under the *Marine Parks (Moreton Bay) Zoning Plan 1997.*

**Environmental Offsets and Management Plans (2004)**
The project consisted of two parts: **1.**The drafting of guidelines to be posted as a public document on the Department of Environment and Heritage (DEH) website outlining the requirements for the development of environmental management plans required by conditions of approval under the *Environment Protection and Biodiversity Conservation Act 1999*. The guidelines are to be used by proponents, DEH officers and consultants. **2**. A comprehensive review of the use of offsets policy in Australia, at State and Commonwealth level. Consultation of government agencies was undertaken to ensure offset policies implemented in a non-formal manner were included in the review.

**Golf Links Development EPBC Act Referral Advice (2004)**
Advice provided on the need for referral of the project under the *EPBC Act.* Discussions with DEH regarding aspects of the project which were of particular concern, and scoping of studies to fill information gaps.

**Implementation of the Geelong Stormwater Management Plan (2003-2004)**
This project won the Water Quality section of the 2005 Victorian Coastal Awards for Excellence. It involved development of material to be used for community education with respect to stormwater management in residential, commercial and industrial programs run by the City of Greater Geelong, and performance of assessments of industrial businesses in Geelong for their management of stormwater onsite, and their potential impact to water quality in Corio Bay.

**Norwich Park Mine *EPBC* Referral (2003 –2004)**
Preparation of referral forms based on prior work undertaken by WBM terrestrial ecologists for referral of an extension of the Norwich Park Mine under the *EPBC Act 1999.*

**Duranbah Beach Dune Management Plan (2002-2004)**
Preparation of a plan of management for Duranbah Beach and dunes on the boundary of the Queensland New South Wales border. The project involved community and state agency consultation (NSW) to identify issues and management options, and to balance long-term intensive utilisation and conservation of the beach and dune system, to operate within an integrated planning framework.

**Coomera Dredging Approvals Advice (2003)**
Interpretation of legislation and regulations, and liaison with Queensland state agencies to determine the approvals required and processes to be followed for deepening of a channel in an area in, or in close proximity to, Marine Parks, Fish Habitat Areas and Ramsar sites.

**Wonboyn Estuary Management Study and Plan (2002 - 2003)**
Preparation of an Estuary Management Study outlining management objectives derived from results of a community and stakeholder survey, and the management options to satisfy these objectives. Following approval of the Study, the Estuary Management Plan was prepared. The Plan outlined management actions to be undertaken satisfy management options and objectives from the Management Study.

**Maroochy River Entrance Dredging and Beach Nourishment Approvals (2002)**
Interpretation of legislation, regulations and coastal policy, and liaison with Queensland state agencies to determine the approvals required and processes to be followed for a beach nourishment project, requiring groyne construction and dredging of sand in an area in, or in close proximity to Fish Habitat Areas.

## Environmental Management

**BMT WBM Environmental Management System (2007-Ongoing)**
Scoping and development of an environmental management system with the aim of becoming ISO 14001 compliant and accredited by mid-2008.

**Environmental Management Plan for Settlers Cove Jetty (2006 –2008)**
Development of an Environmental Management Plan for the jetty at Settlers Cove high density residential development at Noosa with the main issues being ecological management and restoration, marine plant protection and marine and on-site water quality management.

**Implementation of the Geelong Stormwater Management Plan (2003-2004)**
This project won the Water Quality section of the 2005 Victorian Coastal Awards for Excellence. It involved development of material to be used for community education with respect to stormwater management in residential, commercial and industrial programs run by the City of Greater Geelong, and performance of assessments of industrial businesses in Geelong for their management of stormwater onsite, and their potential impact to water quality in Corio Bay.

**Department of Main Roads, North-Coast Hinterland District (Gympie) (1999)**
Involved in the assessment of an environmental awareness training program developed for Main Roads at Gympie.

## Public Infrastructure

**Fitzroy to Gladstone EIS (2007 – Ongoing)**
Project Manager of the terrestrial and aquatic ecology components of an Environmental Impact Assessment of the Gladstone-Fitzroy Pipeline, proposed for the transfer of water from the Fitzroy River to storage at Aldoga to supply existing and potentially new industrial customers in the Gladstone area. The pipeline is the first pipeline located within the Stanwell to Gladstone Infrastructure Corridor (SGIC) and is proposed to be constructed within this corridor for the majority of its length.

**Secondment to SRWP Alliance for the North Stradbroke Island Borefield and Pipeline EIS (2007)**
Senior Environmental Scientist seconded to develop the EIS for the borefield and pipeline on North Stradbroke Island. Concurrent groundwater modelling assessments prepared by the Queensland government, together with inputs from the current study, indicated that groundwater draw-down represented a major risk to the environment. The project was suspended on this basis.

**North Stradbroke Island Borefield and Pipeline Initial Advice Statement and Terms of Reference (2007)**
Preparation of an Initial Advice Statement (IAS) pursuant to section 26(1)(a) of the Queensland *State Development and Public Works Organisation Act 1971* and the proposed borefield and pipeline on North Stradbroke Island subsequently declared a significant project for which an EIS was required. Preparation of a draft terms of reference followed, and the Environmental Impact Assessment commenced.

**North Stradbroke Island Borefield and Pipeline *EPBC* Referral (2007)**
Provision of advice to Redland Shire Council and the Coordinator-General's Department regarding the requirement under State legislation to construct and have operational a new borefield at North Stradbroke Island (NSI) to pump groundwater via a pipeline into the SEQ regional water grid by 31 December 2008. Referral of the proposed borefield and pipeline on North Stradbroke Island to the Australian Government Department of the Environment and Water Resources was required under the *Environment Protection and Biodiversity Conservation Act 1999* for the project's potential to impact on matters of national environmental significance (NES). As a controversial and political project, extensive preparation and liaison with Commonwealth, State and local level government was required.

**Main Roads Gateway Upgrade Project (2003)**
Project management of a project requiring the provision of a report on the impacts and mitigation measures of the Gateway Upgrade Project on a matter of national environmental significance (Ramsar site) under the *EPBC Act 1999.*

## Port and Related Dredging Assessments

**Port of Cooktown Maintenance Dredging (2007-Ongoing)**
Development of the ecological and legislative/planning aspects of a long term dredging strategy, including the investigation of alternative sites and the impacts at/near the current site, for the long-term maintenance dredging of the Port of Cooktown and shipping channels.

**Port of Abbot Point Vegetation Clearing Approvals (2007 – 2008)**
Project manager of review of botanical surveys from Port of Abbot Point Expansion EIS, and provision of advice regarding possible areas to be remapped (incorrect RE mapping) and areas to be cleared on strategic and non-strategic port land.

**Port of Botany Expansion Tender (2006-2007)**
Project Manager for the marine and terrestrial ecology and turbidity management components of a tender for the expansion of port facilities at the Port of Botany, Sydney, following a successful Expression of Interest. BMT WBM was part of the Leighton Contractors – Van Oord Joint Venture tender.

**Port of Abbot Point Expansion -Environmental Impact Assessment (2005 – 2006)**
Preparation of the Initial Advice Statement and Terms of Reference for the EIA. Following public consultation and review by Qld Government authorities, BMT WBM began consultancy services for the EIS. On approval of the ToR, information collation, field work for data collection and drafting of the EIS will commence.

**Bing Bong Maintenance Dredging Assessment (2003)**
Research and preparation of a report detailing presence/absence and density of previous seagrass communities within the barge channel and surrounding area in the Gulf or Carpentaria, and assessment of possible dredge spoil dumping sites and the likely impact of dumping on seagrass.

**Coomera Dredging Approvals Advice (2003)**
Interpretation of legislation and regulations, and liaison with Queensland state agencies to determine the approvals required and processes to be followed for deepening of a channel in an area in, or in close proximity to, Marine Parks, Fish Habitat Areas and Ramsar sites.

**Twofold Bay Naval Facility – Environmental Monitoring (2002 – 2003)**
Quarterly field assessments to determine impacts during the construction of the Twofold Bay Naval Facility on the sensitive communities within the bay. This involves assessment of seagrass, rocky reefs, intertidal areas and fish stocks, as well as inspection of the wharf pylons and areas nearby for introduced species.

**Turbidity Monitoring of Maintenance Dredging Karumba (2002)**
Analysis of results and compilation of report following turbidity monitoring during the 2002 maintenance dredging of the channel entrance to the Port of Karumba.

**Port Curtis Baseline Water Quality Sampling Program (2002)**
Compilation of results of ongoing water quality monitoring program.

**Mackay Port Long Term Dredge Spoil Management Strategy (2000-2001)**
Research and preparation of legal (relevant legislation) and environmental issues for the Mackay Port long term dredge spoil management strategy.

**Bundaberg Port Authority (2000)**
Research and preparation of legal aspects, such as licensing and relevant legislation, of an IAS for the extension of the Bundaberg Port involving capital dredging and sea dumping of dredge material.

## Private Development Assessments (including resource extraction assessments)

**Sunshine Plaza Redevelopment (2006 – Ongoing)**
Project manager for provision of advice on hydrology, aquatic ecology, water quality and stormwater management components of two development applications and information requests associated with the redevelopment of Sunshine Plaza (Stage 3) and Lot 38, respectively.

**Riverside Resource Allocation (2007)**
Project manager for the preparation of a resource allocation application and supporting material to extract sand from the Spitfire permit area (northern Moreton Bay) for the period 1 February 2008 to 31 January 2014.

**Maroochydore Structure Plan Advice (2007)**
Project manager for a review of the hydrological, ecological and water quality aspects of the Maroochydore Structure Plan Advice, considered from the perspective of the clients (Lend Lease) and proposed future developments.

**Coomera Marina Development (2007)**
Project management of coastal process and hydrological aspects of a proposed marina and boat building development of State significance. Provision of advice regarding referral under the *EPBC Act* and declaration of the project as being of state significance under the *State Development and Public Works Organisation Act 1971* (Qld).

**Environmental Management Plan for Settlers Cove Jetty (2006 – 2008)**
Development of an Environmental Management Plan for the jetty at Settlers Cove high density residential development at Noosa with the main issues being ecological management and restoration, marine plant protection and marine and on-site water quality management.

**Readymix Integrated Environmental Management System (2005)**
Development of an integrated environmental management system (IEMS), designed to integrate the requirements of Readymix's national Safety Health and Environment Management System (SHE) and the requirements of the licence (registration certificate) issued by the EPA (Qld) to conduct environmentally relevant activities (ERAs). The IEMS is compliant with the requirements for the contents of an IEMS pursuant to s313 *Environmental Protection Act 1994* (Qld).

**Coomera Dredging Approvals Advice (2003)**
Interpretation of legislation and regulations, and liaison with Queensland state agencies to determine the approvals required and processes to be followed for deepening of a channel in an area in, or in close proximity to, Marine Parks, Fish Habitat Areas and Ramsar sites.

**Golf Links Development EPBC Act Referral Advice (2004)**
Advice provided on the need for referral of the project under the *EPBC Act.* Discussions with DEH regarding aspects of the project which were of particular concern, and scoping of studies to fill information gaps.

**Norwich Park Mine *EPBC* Referral (2003 –2004)**
Preparation of referral forms based on prior work undertaken by WBM terrestrial ecologists for referral of an extension of the Norwich Park Mine under the *EPBC Act 1999.*

## Environmental / Ecological Studies, Monitoring and Reviews

**Noosa North Shore Vehicle Impact Study (2005 – 2006)**
Development of a survey program to determine the impact of long-term usage of 4WDs on sandy beaches, in particular on benthic macrofauna. Other aspects of the project include information collation regarding previous studies in the area, and consultation with the Noosa North Shore working group, local Universities and other environmental consultants.

**Gippsland Lakes RT-4 Project (2005)**
Compilation and assessment of relevant international, national, state, regional and local legislation and policy applicable to the use of natural or constructed wetlands adjacent to, and adjoining, the Gippsland Lakes, as a nutrient trap for improvement of water quality in the Gippsland Lakes (including the Gippsland Lakes Ramsar site). The review provided the client with an understanding of the complexity of the legislation applicable to the Gippsland Lakes wetlands.

**Ninds Creek STP Environmental Monitoring (2004 – 2005)**
Project management (part of project) of the environmental monitoring of Ninds Creek, including data collection and analysis of water quality (for reactive P, faecal coliforms, COD and BOD), sediment quality, and isotope analysis of the marine red algae, *Catenella nipae*, to identify the presence of sewage-derived nitrogen.

**Main Roads Gateway Upgrade Project (2003)**
Project management of a project requiring the provision of a report on the impacts and mitigation measures of the Gateway Upgrade Project on a matter of national environmental significance (Ramsar site) under the *EPBC Act 1999.*

**Gold Coast Harbour Marine Surveys (2003 –2004)**
Field surveys, data collation and preparation of a report detailing the 'health' of the Gold Coast Harbour in relation to seagrass and benthic macrofaunal communities. As project manager, the project also involves coordination and liaison with the Gold Coast City Council

**Botany Bay Habitat Inventory (2003)**
Collation of spatial data from numerous government agencies and community groups for inclusion in a habitat inventory, with the view to creating an integrated planning assessment framework for Botany Bay. The project required extensive consultation with various agencies and groups, and negotiating in relation to data/information required.

**Bing Bong Maintenance Dredging Assessment (2003)**
Research and preparation of a report detailing presence/absence and density of previous seagrass communities within the barge channel and surrounding area in the Gulf or Carpentaria, and assessment of possible dredge spoil dumping sites and the likely impact of dumping on seagrass.

**Twofold Bay Naval Facility – Environmental Monitoring (2002 – 2003)**
Quarterly field assessments to determine impacts during the construction of the Twofold Bay Naval Facility on the sensitive communities within the bay. This involves assessment of seagrass, rocky reefs, intertidal areas and fish stocks, as well as inspection of the wharf pylons and areas nearby for introduced species.

**Waste Management Facilities Literature Review and Generic Assessment (2002-2003)**
Research and preparation of a report detailing the actual and potential impacts that different types of waste management facilities may have on water quality and catchment health. On the basis of the information collated in the literature review, a generic assessment was made of catchment effects for each facility type.

**Mackay Port Long Term Dredge Spoil Management Strategy (2000-2001)**
Research and preparation of legal (relevant legislation) and environmental issues for the Mackay Port long term dredge spoil management strategy.

**Bundaberg Port Authority (2000)**
Research and preparation of legal aspects, such as licensing and relevant legislation, of an IAS for the extension of the Bundaberg Port involving capital dredging and sea dumping of dredge material.

**Urangan Boat Harbour (2000)**
Data collection of water velocity data in and around the Urangan Harbour for a study investigating possible dredging and dumping strategies, and follow-up research for community consultation.

**Department of Main Roads, Nerang District (1999)**
Preparation of system of responsibility for the Senior Environmental Officer in the Nerang District of the Department of Main Roads

**Caboolture Northern Bypass (Department of Main Roads) (1999)**
Assistance in the development of an EMP for the Caboolture Northern Bypass which crossed environmentally sensitive areas.

**Carole Park (1999)**
Assistance in the preparation of licensing applications for the Carole Park project which involves the development of an energy park for food and beverage manufacturing.

**Luggage Point Success Determination Monitoring Year 2 (2002)**
Water quality sampling to aid in determination of the success of a mangrove rehabilitation project.

**Turbidity Monitoring of Maintenance Dredging Karumba (2002**
Analysis of results and compilation of report following turbidity monitoring during the 2002 maintenance dredging of the channel entrance to the Port of Karumba.

**Port Curtis Baseline Water Quality Sampling Program (2002)**
Compilation of results of ongoing water quality monitoring program.

**Gunnamatta Bay Estuary Process Study (2001)**
Assistance with writing of report for the Gunnamatta Bay Process Study.

**Gymea Bay Estuary Process Study (2001)**
Assistance with writing of report for the Gymea Bay Process Study.

**Nathan Dam (2000)**
Assistance in macroinvertebrate and water quality data collection, and data analysis to establish baseline conditions for the proposed Nathan Dam near Taroom (Qld).

**CSR (2000)**
Water quality sampling and analysis as part of a long term monitoring program for CSR.

## PRESENTATIONS

*The Implementation of Sustainable Development Principles – Queensland and Australia,* University of Queensland, 2005

*Environmental Impact Assessment,* University of Queensland, 2005

*Is the Legal Framework Achieving Sustainable Development?* University of Queensland, 2005

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## Project Experience

### *Water Quality and Estuary Management*

**Maroochy Estuary Sustainable Loads Study (2003-2004)** – Project manager and modelling supervisor of a model based project to develop sustainable or target loads for the estuary.

**Sandgate Estuary Water Quality Modelling Study (2003)** – Project manager and modelling supervisor of a project that simulated water quality dynamics in Cabbage Tree Creek, a tributary of Moreton Bay, aimed at studying the effects of an existing 27ML/day wastewater outfall, and determining the quality improvements required to achieve defined water quality objectives for the estuary.

**Batemans Bay Effluent Transport Study (2003) –** Project Manager of a study investigating sewage effluent transport processes in the Batemans Bay area on the South Coast of New South Wales.

**Lake Illawarra Estuary Processes Study, Management Study and Management Plan (2001-2002)** – Project Manager of a study to develop an Estuary Processes Study, Management Study and Management Plan for the waterways and catchment of Lake Illawarra.

**Wonboyn Lake and River Estuary Processes Study, Management Study and Management Plan (2000-2001) –** Project Manager of an Estuary Processes Study, Management Study and Management Plan of the Wonboyn Lake and River on the Far South Coast of New South Wales.

**Maroochy Estuary Eutrophication Modelling (2001-2002)** – Project manager of a study to develop and calibrate MIKE11 EU models of the Maroochy Estuary, and to subsequently use these models to assess a range of future land use and wastewater discharge scenarios.

**Batemans Bay and Clyde River Estuary Processes Study (2000) –** Project Manager of an Estuary Processes Study of the Clyde River and Batemans Bay area in the South Coast of New South Wales.

**Nambucca River Estuary Processes Study (1999-2000) –** Project Manager of an Estuary Processes Study of the Nambucca River on the North Coast of New South Wales.

**Samut Prakarn Wastewater Outfall Water Quality Study (1999) -** Project Manager of a major water quality modelling study aimed at the determination of the water quality impacts on the Upper Gulf of Thailand of a large wastewater outfall (*ultimate capacity* $20m^3/s$) treating domestic and industrial waste from much of south-eastern Bangkok.

**Brisbane River and Moreton Bay Wastewater Management Study (1994 - 2006) -** A range of key roles in the study including the following:
- Study Team Member in Aquatic Ecosystem and Water Quality Management Scoping Studies
- Project Manager of Stage 1 Conceptual Model Study
- Project Manager of Stage 2 Hydrodynamics (HD) and Non Point Source Loading (PL2) tasks
- Member of the Scientific Advisory Group (SAG), Modelling Advisory Group (MAG), Stage 2 Round 2 Core Group (S2R2)
- Project manager of receiving water quality modelling conducted by DEH personnel
- Project Manager of Stage 3 Catchment Non Point Source Data Collection Scoping Study

- Project Manager of all Stage 4 Catchment and Receiving Water Quality Modelling Studies (total budget in excess of $500,000)

**Development of an Action Plan to Improve the Water Quality of the Central Basin of Thailand (1995-1997) -** Project Manager of the water quality modelling component of a major multi-national study aimed at the development of relevant action plans to manage and improve the water quality of some 700km of major rivers in the Central Basin of Thailand, including the Chao Phraya River flowing through Bangkok.

**Preliminary Conceptual Model Study, Task G4, Stage 1 of the Brisbane River and Moreton Bay Wastewater Management Study (1996)** - Project Manager of a study to investigate key water quality variables and ecological processes affecting water quality within the Brisbane River and Moreton Bay region. The main product of the study was a spreadsheet based conceptual model of water quality in the study area, calibrated in a general manner to ambient water quality levels.

**Trinity Inlet Advection-Dispersion and Water Quality Model Study (1996)** - Project Manager of a MIKE11 Advection-Dispersion and Water Quality model study of trinity Inlet. The study involved a Rhodamine WT dye release, other data collection, model calibration and various scenario assessments.

**Buran Darat Development, Sentosa Island - Singapore (1994-1995)** - Project Manager of a study that evaluated water quality, hydraulic, coastal engineering and construction aspects of a proposed waterway development. Provision of design and operational advice.

**Stour Estuary Water Quality Modelling (1993) -** Project Engineer of a study that developed, calibrated and validated a 1-D water quality model of the Stour Estuary in Kent. This model included the simulation of tidal flow, saline intrusion, nutrient, sediment and algal dynamics.

**Hawkesbury Nepean Blue Green Algal Modelling (1993)** - Project Engineer responsible for the development of algorithms to simulate the growth dynamics of blue-green algae, and the inclusion of these algorithms in the HR Wallingford 1-D Water Quality model, SALMON-Q. Testing of these algorithms for Sydney Water on the Hawkesbury-Nepean system

**Avon River Barrage Blue Green Algal Assessments (1993) -** Project Engineer responsible for assessment of the potential for blue-green algal blooms behind proposed Avon River Barrage.

**Benthic Respiration Study, Kent Stour Estuary (1993)** - Project Manager of a Benthic Respiration study of the Kent Stour Estuary.

**Combined Sewer Overflows Assessments - Proposed Tees Barrage (1993)** - Project Engineer responsible for water quality assessments of the effects of combined sewer overflows downstream of the proposed Tees Tidal Barrage on water quality.

**Water quality studies for proposed Maleny development (1991)** - Project Engineer responsible for water quality assessments associated with a proposed residential development at Maleny.

**Water quality modelling of the Clarence River, NSW (1990) -** Project Engineer responsible for a study aimed at the determination of acceptable discharge periods for a proposed aquaculture project on the Clarence River, NSW.

**Water quality modelling of the Tweed River (1990) -** Project Engineer involved in a study to evaluate the impacts of various entrance/dredging works on the hydraulics, water quality and ecology of the Tweed River, NSW.

**Banora Point STP Outfall Study, Tweed Heads (1989)** - Project Manager and modeller of a study aimed at evaluating the impacts of sewage effluent discharge strategies/qualities from the Banora Point STP on water quality in the Tweed River.

**Gladstone tradewaste outfall study (1989)** - Project Engineer on a multi disciplinary study investigating the potential water quality and environmental impacts of a proposed tradewaste outfall into Port Curtis.

**Water quality implications of urban area development at Narangba - Brisbane** - Project Engineer responsible for water quality impact assessments associated with a proposed urban development at Narangba in Brisbane.

**Urban lake water quality study -** Forest Lake, Brisbane - Project Engineer undertaking initial water quality management studies associated with the Forest Lake development.

***Stormwater Management, Water Sensitive Urban Design (WSUD) and Integrated Water Cycle Management (IWCM)***

**Pimpama Coomera Water Futures Rainwater Tank Optimisation Study (2004-2005)** - Project manager and modelling supervisor of a study that assessed the benefits of various rainwater tank configurations on stormwater and water supply elements of the proposed 150,000 person Pimpama Coomera Water Futures area in Gold Coast City.

**Yarrabilba WSUD and IWCM study (2004)** – Project manager and modelling supervisor of a study that assessed and scoped WSUD and IWCM elements of the proposed 50,000 person Yarrabilba master planned community in Beaudesert Shire.

**Pimpama Coomera Water Futures WSUD Study (2003-2004)** - Project manager and modelling supervisor of a study that assessed WSUD and lot scale IWCM elements of the proposed 150,000 person Pimpama Coomera Water Futures area in Gold Coast City.

**Victorian WSUD Technical Manual (2003-2004)** – Member of joint WBM/Ecological Engineering and Parsons Brinckerhoff team developing a WSUD Technical Manual for Melbourne Water.

**Brisbane WSUD Technical Manual (2004-2005)** – Member of joint WBM/Ecological Engineering and Bligh Tanner team developing a WSUD Technical Manual for Brisbane City Council.

**NSW Managing Urban Stormwater (2003-2004)** – Member of joint WBM/Ecological Engineering and Parsons Brinckerhoff team rewriting the NSW Managing Urban Stormwater (MUS) series of documents for the NSW DEC.

**Lensworth Lake Doonella (Noosa) Development** – Project manager of a team of engineers and ecologists developing a WSUD/IWCM strategy for the Lensworth Lake Doonella development at Noosa.

**Lower Hunter and Central Coast and Western Sydney WSUD Capacity Building Programs (2000-2003)** – Technical advisor on the subject of WSUD to both these capacity building programs.

**Australian Runoff Quality WSUD Chapter (2003-2006)** – Key member of team of authors tasked by Engineers Australia with preparing the WSUD chapter of Australian Runoff Quality.

**Road Runoff Characterisation Study (2002)** – Project Manager of a study team assessing the qualities of runoff from varying road surfaces in South East Queensland, and assessing the potential magnitudes of these loads in comparison to other sources of runoff in local urban areas.

**Varsity Lakes Stormwater Management (2002) –** Project manager of a study team assessing stormwater management requirements for the proposed Varsity lake development on the Gold Coast.

**Gold Coast Ecovillage WSUD and IWCM study (2000-2004) –** Manager of team of WBM staff assisting with the conceptualisation, development and design of WSUD/IWCM strategies for the proposed Gold Coast Ecovillage in the Currumbin Valley.

**Springfield Development Scoping and Detailed Design Investigations (1999-2002)** – Principal researcher for Delfin to develop suitable stormwater quality management strategies to guarantee appropriate water quality levels in a proposed series of freshwater lakes in the Springfield Development to the west of Brisbane. The project involved conceptual and actual design of a number of water quality management measures (wetlands, GPT's, lake destratification systems, etc), development of relevant Water Quality Management Plans for the entire system and preparation of relevant Environmental Planning studies.

**Stormwater Reuse Background Study (1998)** - Project Manager of a study investigating the potential for Stormwater Reuse as a component of the Queensland Wastewater Reuse Strategy. This project involved extensive literature searches, visits to relevant locations around Australia to inspect stormwater reuse projects, and discussions with national and international experts in the field.

**Artificial Wetlands for stormwater quality control design, Wollongong NSW (1995)** - Project Manager responsible for the layout configuration and detailed design documentation of two (*2*) large artificial wetlands proposed (*and recently constructed*) at Wollongong.

**Long Term Consultancy - Brisbane City Council (1993-1995)** - Provision of a long term consultancy service to Brisbane City Council, advising on stormwater quality issues, catchment management and the establishment of a stormwater quality monitoring and modelling program

***Catchment Management***

**Lake Samsonvale Integrated Catchment Management Strategy (2001-2002)** – Project Manager of a study aimed at developing a sustainable land use planning framework for the catchment of Lake Samsonvale, one of the principal water supply resources for the Greater Brisbane region. This framework will be used as the basis for land use planning in the catchment in the next 10-15 years. The strategy had as one of its key requirements a need to reduce nutrient and sediment loads from the catchment to achieve a net improvement with time in water quality levels in the dam.

**Task BSES - Broad Scale Evaluation of Sources (2001)** – Project Manager of a major study for the SEQRWQMS to ascertain the magnitudes and sources of pollutant loads entering Moreton Bay from its catchment, and also to quantify the measures that are available to manage these loads, and their relative efficacy and costs in achieving various scenarios of non point source load management/reduction.

**Gowrie Creek (Toowoomba) Catchment Management Study (1997-1998)** - Project Manager supervising a major catchment management study for Gowrie Creek in Toowoomba. The project involved extensive community and stakeholder liaison, technical and financial assessments, ecological and water quality investigations and recreational planing.

**Catchment Runoff Pollutant Load Estimation, Task PL2, Stage 2 of the Brisbane River and Moreton Bay Wastewater Management Study (1997-1998)** - Project Manager of a study to develop catchment pollutant export models of the Brisbane River and Moreton Bay Study area.

**Blue Gum Hills (Newcastle) Catchment Management Strategy (1996)** - Project Manager of a study aimed at determining an ecologically sustainable development solution for a large catchment in Newcastle intended for urban development.

**Bremer River Catchment Management Strategy (1995-1996)** - Project Manager of Stage 1 of the Bremer River Catchment Management Strategy. This study involved extensive stakeholder representative consultation and workshop facilitation to identify key issues requiring management within the catchment, and a range of possible solution strategies for these issues. The study set the scene for subsequent more detailed implementation assessments.

**Rose Bay Catchment Management Study (1991)** - Project Engineer responsible for mathematical modelling aspects of a catchment management study of an area in Rose Bay, Sydney

***Flood Management and Hydraulic Modelling***

**Banora Point/South Tweed Master Drainage Plan (1996)** - Project Manager of a flood and pollutant export assessment study aimed at developing viable master drainage and water quality control infrastructure for a large catchment, under development pressure, in Tweed Shire.

**Carseldine-Taigum Master Drainage Plan (1995-1996)** - Project Manager of a flood and pollutant export assessment study aimed at developing viable master drainage and water quality control infrastructure for a large catchment, under development pressure, in Brisbane City.

**Tidal hydraulic, hydrology and flooding assessments of Cudgen and Mooball Creeks, Clarence, Manning and Maroochy Rivers (1987-1991)** - A wide range of modelling related assessments of a number of rivers in Northern New South Wales for various local government and industry clients.

**Development of mathematical tidal model of the Gold Coast Broadwater (1989)** - Project Engineer and Modeller responsible for the development, calibration and validation of a 1D hydraulic model of the Gold Coast Broadwater.

**Evaluation of the impacts on flooding in the Manning River of various alternative Pacific Highway routes (1989-1991)** - Project Manager and Modeller responsible for assessing the effects on flooding of various Pacific Highway alignments and configurations, with the study ultimately encompassing the design of major minimum energy culvert structures under the highway at several key locations.

*Environmental Management*

**Thai Oil Spill Fingerprinting and Characterisation Study (2000)** – Project manager of a multidisciplinary project team tasked by the Thai Pollution Control Department to develop protocols and procedures to 'fingerprint' oils commonly handled in Thailand, and to characterise how these oils weather in local conditions if spills occur.

**Malaysian Wetland Sanctuary Hydraulic and Water Quality Studies (1997)** - Project Manager of a study investigating hydraulic and water quality aspects of a major, and degraded, natural wetland area near Kuala Lumpur, Malaysia, with expert input into Master Planning to remediate the areas as a Wetland Sanctuary.

**Logan Waterways Strategy Study (1993-1994)** - Project Manager of a study aimed at developing a strategy for the remediation and sustainable development of the waterways of Logan City. This study involved extensive Community and Council liaison and input.

**Environmental Appraisal of Lake Illawarra for NSW Public Works Department (1993-1994)** - Project Manager of a multi disciplinary study aimed at appraising the proposed $20 million works program of the Lake Illawarra Authority (*including entrance modifications, dredging, wetland construction, habitat improvements etc.*), and making appropriate recommendations for continuation or modification of the program.

**Investigation of dispersion and hydrodynamic processes - Halifax Bay, North Queensland (1992)** - Project Engineer responsible for field investigations and modelling studies associated with a proposal to import nickel ore to Halifax Bay in Townsville. This work also included extensive involvement in an Administrative Appeals Tribunal with respect to the project, including considerable time under examination as an expert witness.

**Alternative Dredging Strategy Study - Weipa (1990)** - Project Manager of a field and model based study evaluating the potential efficacy of alternative dredging strategies (*e.g. sidecasting, alternative spoil dumping sites, agitation dredging*) at the Port of Weipa. The study involved a two week field investigation, comprising prototype testing of the alternative strategies.

**Investigation of hydraulic, sediment transport and water quality implications of lower estuarine dredging, Tweed River (1990)** - Project Engineer responsible for a wide range of hydraulic, water quality and sediment transport modelling studies associated with various lower estuarine dredging proposals for the Tweed River.

**Participation in Weipa South Channel Siltation Study (1989)** - Project Engineer responsible for all field and modelling investigations associated with the Weipa South Channel Siltation Study.

**Evaluation of tidal hydrodynamic and siltation related impacts of a proposed marina at Fingal Head, Tweed River, NSW (1988)** - Project Engineer responsible for hydrodynamic and siltation assessments as part of an EIS being prepared for a proposed marina development in Tweed Shire

**Conference Papers and Presentations**

Milligan, C.J. and McAlister, A.B. (1988), 'Water Quality Management at Palm Meadows Golf Course by Limited Tidal Exchange', IAWPRC/AWWA Conference - Water Quality and Management for Recreation and Tourism, Brisbane.

McAlister, A.B. (1989), 'Development and Testing of a Lagrangian Water Quality Model', I.E. Aust. Hydrology and Water Resources Symposium, Christchurch, N.Z.

McAlister, A.B. (1989), 'Dye Dispersion Studies and Mathematical Modelling of a Tidal Canal in the Clarence River, New South Wales', M.Eng.Sc Thesis, University of Queensland.

McAlister, A.B. and Stokoe, P.C. (1990), 'An Evaluation of Alternative Dredging Operations for the Shipping Channel-Weipa', Third Australian Port and Harbour Engineering Conference, Melbourne.

McAlister, A.B. (1991), 'Management of Urban Water Quality', AWWA Dirty Waters Workshop, Brisbane.

McAlister, A.B. (1991), 'Urban Stormwater Pollution - A Description of the Problem, Analysis and Solution Techniques', IE Aust QLD Division Technical Papers.

McAlister, A.B. and Witt, C.L. (1993), 'Providing a Better Understanding of Flooding Behaviour with Detailed Numerical Models', 33rd Annual N.S.W. Flood Mitigation Conference.

McAlister, A.B. (1994), 'The Importance of Accurately Simulating Hydraulic Processes in Water Quality Modelling Studies', IE Aust Conference on Hydraulics in Civil Engineering, Brisbane.

McAlister, A.B. and Hutchinson, R. (1994), 'The Practical Applications of Advanced Numerical Modelling Techniques in the Development of a Functional and Cost-Effective Layout for the Buran Darat Development - Sentosa Island, Singapore', Ninth Congress of the Asia Pacific Division of IAHR, Singapore.

McAlister, A.B., Syme, W., Bycroft, B., and Mack, P. (1995), 'The Application of a Common Australian Stormwater Quality and Quantity Model in the Sub-Tropical Environment'. The Second International Symposium on Urban Stormwater Management, Melbourne.

Bycroft, B., Mack, P., and McAlister, A.B. (1995), 'Stormwater Quality Data Collection Program for Brisbane City Council'. The Second International Symposium on Urban Stormwater Management, Melbourne.

Hogarth, W., Walden, W.J., McAlister, A.B. (1995), 'A Review of current water quality modelling practices in Australia', 3rd Princess Chulabhorn Science Conference, Thailand.

McAlister, A.B. (1997), 'Water Sensitive Urban Design', Keynote Address, Stormwater and Soil Erosion '97, Brisbane.

McAlister, A.B., Walden, W.J., and Taylor, L. (1997), 'The Application of Mathematical Water Quality Models in Areas of Limited Data Availability'. Pollution Control '97, Bangkok, Thailand.

McAlister, A.B. (1998), 'Brisbane City Council Water Sensitive Urban Design Case Study', Hydrastorm '99, Adelaide.

McAlister, A.B. and Keane, P. (1998), 'Gowrie Creek Catchment Management and Stream Restoration Program', Hydrastorm '99, Adelaide.

Walden, W.J., McAlister, A.B. and Robbins, P. (1998), 'Pollutant Export Assessments in Tropical and Sub-tropical Environments', Hydrastorm '99, Adelaide.

McAlister, A.B. and Walden, W.J.(1998), ‘Water Quality Modelling in the Central Basin of Thailand’, Hydrastorm ‘99, Adelaide.

McAlister, A.B. and Keane, P. (1998), ‘Gowrie Creek Catchment Management Strategy’, IMEAQ Conference, Toowoomba. - **awarded Best Paper of Conference**

McAlister, A.B. (2000), ‘Water Sensitive Urban Design’, Water Sensitive Urban Design in the Australian Context Conference, Melbourne 2000

McAlister, A.B. and Cavanagh, D.C. (2002), ‘Past, present and Future Directions in Catchment and Stormwater Pollutant Modelling’, 4th Queensland Environmental Conference, I.E. Aust Environmental Engineering Society.

McAlister, A.B. (2005), ‘Integrated water cycle management considerations in a greenfield site: the way forward’, Hallmark Publications Masterplanned Urban Communities Conference, Sydney 2005 - **awarded Best Paper of Conference**

**Book Chapters and National Publications**

***Australian Runoff Quality*** (Engineers Australia 2006) – Principal author of Modelling Chapter and Co-author of Water Sensitive Urban Design chapter

***Healthy Waterways, Healthy Catchments: Making the Connection in South East Queensland, Australia,*** Co-Author of Chapter 8 ‘Integration’.

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# *REPRESENTATIVE PROJECTS*

## 2007: *PROJECTS*

Management of cultural heritage and native title aspects of the ZeroGen Project
- CLIENT: Stanwell

Management of the cultural heritage and native title aspects of the Gladstone Fitzroy water pipeline project
- CLIENT: Gladstone Area Water Board

Management of the cultural heritage aspects of the Emu Swamp Dam
CLIENT: Stanthorpe Shire Council and Sinclair Knight Merz

## 2006: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage assessment of the Eastern Busway Project
- CLIENT: Translink

Cultural heritage assessment of the Northern Busway Project
- CLIENT: Translink

Heritage assessment of the Townsville to Ballera and Cape York Peninsula to Gove Gas Pipelines
- CLIENT: API and Enesar

Heritage Aspects of the Beaudesert Whole of Shire Strategic Plan
- CLIENT: Beaudesert Shire Council and Buckley Vann Town Planning

## 2005: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage assessment of the Airport Link Tunnel
- CLIENT: Brisbane City Council and Connell Wagner/SKM Partnership

Management of Heritage Issues for the Brisbane Airport Parallel Runway Project
- CLIENT: Brisbane Airport Corporation and Arup Sustainability

Cultural Heritage Management Plan for the Stanwell QCE Project
- CLIENT; QLD Coke and Energy and URS

Cultural Heritage Management Plan for ML 1108, North Stradbroke Island
- CLIENT; UNIMIN

## 2004: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage assessment of the North South Bypass Tunnel
- CLIENT: Brisbane City Council and Connell Wagner/SKM Partnership

Advice on management of Cleveland bora ring and development of Cultural Heritage Management Plan
- CLIENT: Euro Natural Fine Foods and Department of State Development and Innovation

Advice on duty of care protocols for cultural heritage, and implementation into administration systems
- CLIENT: Toowoomba City Council

Cultural heritage assessment of the Hamilton Wharves redevelopment masterplan area
- CLIENT: Port of Brisbane Corporation

## *2004: EXCAVATION AND ANALYSIS*

Archaeological programme for mitigation strategy of Millennium Arts Project

- CLIENT: Arts Queensland

Archaeological investigation of sites near Teewah, Cooloolah Coast

- CLIENT: Energex

## 2003: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage analysis of Musgrave Park, South Brisbane

- CLIENT: Brisbane City Council and Arts Queensland

Cultural heritage analysis of the Millennium Arts Project Site, South Brisbane

- CLIENT: Arts Queensland

Cultural heritage analysis of Wises Farm, Maroochydore

- CLIENT: Hills Property Group

Cultural heritage analysis of land at Dudgeon Point, near Mackay

- CLIENT: Ports Queensland Corporation

## *2003: EXCAVATION AND ANALYSIS*

Excavation and analysis of recovered material from "Military Road" now the Kawana Way road corridor

- CLIENT: Department of Main Roads

Excavation and analysis of material from Buderim

- CLIENT: Stocklands

Excavation and analysis of material from Bribie Island (two sites)

- CLIENT: QM Properties

## 2002: *CULTURAL HERITAGE ASSESSMENTS*

**Advice to the Kogan Project (coal mine and power station) on cultural heritage procedures for 20 year life**

- **CLIENT: CS Energy**

Cultural heritage analysis of Toowong ferry terminal site

- CLIENT: Maunsell

Cultural heritage analysis of Musgrave Road, Red Hill

- CLIENT: Brisbane City Council

Cultural heritage analysis of land at Agnes Waters

- CLIENT: KBR

Photographic recording of the Brisbane Port Corporation development

- CLIENT: Brisbane Port Corporation

## *2002: EXCAVATION AND ANALYSIS*

Mitigation, excavation and analysis of cultural heritage material from the Acland Coal Project area, Acland

- CLIENT: New Hope Coal Pty. Ltd.

## *2001: CULTURAL HERITAGE ASSESSMENTS*

Toowoomba City Gowrie Creek cultural heritage analysis

- CLIENT: Toowoomba City Council

Cultural heritage analysis of "Chancellor Park", Mooloolah

- CLIENT: Developer

Cultural heritage analysis of Mackay City landfill

- CLIENT: Mackay City Council and Maunsell

Cultural heritage analysis of "Tong Park' at Warra

- CLIENT: Developer

## *2001: PLANNING STUDIES*

**Historical Interpretation of Glengallen Homestead**

- **CLIENT: Convergence**

**Training workshops on cultural heritage and workplace health and safety issues, Department of Main Roads**

- **CLIENT: Department of Main Roads**

## *2001: EXCAVATION AND ANALYSIS*

**Reburial at Bundaberg Port Authority lands, Bundaberg**

- **CLIENT: Gooreng Gooreng, Gurang and Taribelang People, Bundaberg Port Authority**

## 2000: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage analysis of exploration sites, near Longreach

- CLIENT: Galilee Energy; chosen by the Traditional Owners

Cultural heritage analysis of proposed ferry sites, Brisbane River

- CLIENT: Maunsell McIntyre for the Brisbane City Council

Cultural heritage analysis of the Gold Coast Convention Centre site

- CLIENT: Weathered Howe for Jupiters Casino

Cultural heritage analysis of the Roma Street redevelopment
- CLIENT: Bovis Australia for the Department of Public Works

Cultural heritage analysis, artefact collection, excavations and analysis of the Georgina River bridge crossing, Camooweal
- CLIENT: Department of Main Roads; chosen by the Injilandji People

## *2000: PLANNING STUDIES*

State of Environment of cultural heritage issues in Caboolture Shire
- CLIENT: WBM Oceanics

Cultural heritage issues in the IPA Planning Study for Southern Burnett Shires
- CLIENT: Gutteridge Haskins & Davey

## *2000: EXCAVATION AND ANALYSIS*

Analysis of the material from the Victoria Park excavation
- CLIENT: Brisbane City Council

Excavation and analysis of material from the Caboolture Northern Bypass
- CLIENT: Department of Main Roads

Excavation and analysis of material from Carole Park Energy Park
- CLIENT: Hyder Consulting for the Department of State Development

## 1999: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage analysis of the Boyne Valley for the Awoonga Dam raising project
- CLIENT: Gladstone Area Water Board; chosen by the Gooreng, Bailai and Gurang People

Archaeological assessment of the Millmerran Power mining lease, and adviser to the Gambuwal Reference Group
- CLIENT: Millmerran Power; chosen by the Gambuwal People

Cultural heritage assessment of the Southbank Bridge project
- Department of State Development

## 1999: *MANAGEMENT AND ADVISORY PROJECTS*

Adviser to Brisbane City Council regarding cultural heritage issues associated with their transport infrastructure developments

Preferred consultant for Transport Technology Section, Department of Main Roads

## 1999: *EXCAVATIONS*

Excavation of the Inner City Bypass corridor in Victoria Park

- CLIENT: Brisbane City Council

## 1998: *CULTURAL HERITAGE ASSESSMENTS*

Cultural heritage issues associated with the Kogan coal and power station project

- CLIENT: Southern Company; chosen by the Western Wakka and Iman People

Cultural heritage analysis and advice to the Acland coal and power station project

- CLIENT: Shell Australia

Cultural heritage analysis of the Infrastructure Corridor, Gladstone to Aldoga

- CLIENT: Department of Economic Development and Trade

Cultural Heritage Analysis of the Proposed Comalco Site, Aldoga, Gladstone.

- CLIENT: Dames & Moore Pty Ltd. for Comalco.

Cultural Heritage Analysis of a proposed Transmission Power line corridor between Ilfracombe and Longreach.

- CLIENT: Longreach Aboriginal Community and Capricornia Electricity Corp.

Cultural Heritage Issues associated with the Stuart Oil Project, Gladstone, Central Queensland.

- Sinclair Knight Mertz Pty Ltd. for SPP

## 1998: *MANAGEMENT AND ADVISORY PROJECTS*

Adviser on cultural heritage issues associated with the Gatton to Gympie Allgas pipeline corridor.

- CLIENT: Indigenous Steering Committee

Management of Cultural Heritage Issues Associated with the Proposed Power Transmission Line between Tarong and Calvale.

- CLIENT: Indigenous Steering Committee

Preferred consultant for Transport Technology Section, Department of Main Roads

## 1998: *EXCAVATIONS*

Excavation of specified areas near Little Rocky Creek axe grinding grooves

- CLIENT: Caloundra City Council

Excavation of specified areas of the proposed Southeast Transit corridor in South Brisbane

- CLIENT: Connell Wagner and Queensland Transport

## 1997: *CULTURAL HERITAGE ASSESSMENTS*

Cultural Heritage Assessment of the Wallangarra/Jennings Logistics Company Army Base, Queensland and New South Wales.

- CLIENT: Sinclair Knight Merz Pty. Ltd.

Cultural Heritage Assessment of a proposed Transmission Line between Tarong and Calvale. Stage One.

- CLIENT: Powerlink Qld.

Cultural Heritage Assessment of the Planned Bus Lanes Associated with the Southeast Freeway Between Southbank and the Logan Motorway.

- CLIENT: Connell Wagner for Main Roads Department.

## *1997: PLANNING STUDIES*

Assessment of Historical Heritage of the southern Moreton Bay Islands, Redland Shire.

- CLIENT: Gutteridge Haskins and Davey Pty Ltd. for Redland Shire Council

Integration of Indigenous Cultural Heritage into the Ipswich City Town Plan.

- CLIENT: Ipswich City Council

## 1997: *MANAGEMENT AND ADVISORY PROJECTS*

Management of Selected Cultural Heritage Issues Associated with the Proposed Gas Pipeline from Papua New Guinea to Gladstone.

- CLIENT: Chevron Pty Ltd.

Management of Cultural Heritage Issues Associated with the Proposed Power Transmission Line between Tarong and Calvale.

- CLIENT: Indigenous Steering Committee

Production in conjunction with Transport Technology Section, of a handbook on cultural heritage issues.

- CLIENT: Department of Main Roads.

## 1997: *EXCAVATIONS*

Cultural Heritage Analysis and Artefact Collection, Landsborough Highway, Longreach

- By invitation of indigenous community; for Department of Main Roads.

Excavation of an Historical Precinct, William Street, Brisbane.

- CLIENT: Primary Industries Department

Excavation of an Historical Goal Site, Police Barracks Precinct, Petrie Terrace, Brisbane.

- CLIENT: QM Properties

## 1996: *CULTURAL HERITAGE ASSESSMENTS*

Cultural Heritage Assessment of Proposed New and Ungraded Ferry Terminals, Brisbane River.

- CLIENT: Maunsell

Cultural Heritage Assessment of a Proposed Power Sub-Station, Springdale, Western Moreton.

- CLIENT: Powerlink

Cultural Heritage Assessment of the Proposed Amberley Turnoff Upgrade, Cunningham Highway, Western Moreton.

- CLIENT: Arup & Partners

Assessment of Aboriginal Archaeological Values Associated with the Tennyson Powerhouse Site.

- CLIENT: Connell Wagner

## 1996: *MANAGEMENT AND ADVISORY PROJECTS*

Management of Selected Historical Cultural Heritage Issues Associated with the Proposed Gas Pipeline from Papua New Guinea to Gladstone.

- CLIENT: Chevron Pty Ltd.

Management of Cultural Heritage Issues Associated with the Proposed Power Transmission Line between Tarong and Calvale.

- CLIENT: Indigenous Steering Committee

## *1996: PLANNING STUDIES*

Assessment of Cultural Values Associated with the Bayside Park Planning Study, Mount Cotton.

- CLIENT: Bayview Group.

Assessment of Heritage Values Associated with the Oxley Creek Catchment Study.

- CLIENT: Kinhill

## 1996: *EXCAVATIONS*

Excavation of a Midden Site, Peel Road, Beachmere.

- CLIENT: Pacific Sands Pty Ltd.

Analysis of Stone Artefacts Collected at Plainlands, Southeast Queensland.

- CLIENT: Sunwest

Excavation of Site of Convict Building, North Quay, Brisbane.

- CLIENT: Suncorp

## 1995: *CULTURAL HERITAGE ASSESSMENTS*

Cultural Heritage Assessment of the Proposed Expansion of the QCL Plant at Fisherman's Landing, Port Curtis.

- CLIENT: Connell Wagner

Cultural Heritage Assessment of a Potential Sand Extraction Site, Donnybrook.

- CLIENT: Kinhill

Cultural Heritage Assessment of the Upgrading Plans for the Warrego Highway Between Withcott and Minden.

- CLIENT: Department of Main Roads

Assessment of Cultural Heritage Values Associated with Department of Primary Industries' Land at Rocklea.

Assessment of the Cultural Heritage Values of the site of *Murrumba*, Petrie.

- CLIENT: GHD

## *1995: PLANNING STUDIES*

Assessment of Heritage Values in the Mango Hill/Griffin Planning Study Area.

- CLIENT: Private development

Caloundra City Council Cultural Landscape Assessment.

- CLIENT: Caloundra City

## 1995: *EXCAVATIONS*

Interpretations and Excavations on the Glengallen Homestead Precinct, Darling Downs (with E. Crosby).

Archaeological Excavation, Interpretation and Analysis of Cultural Material from Pine Ridge Environmental Park, Oxley Drive, Hollywell.

- CLIENT: Ngarangwal Land Council

Archaeological Assessment, Interpretation and Analysis of Artefacts from the Bribie Island Haul Road.

- CLIENT: Maunsell Pty Ltd.

## 1994: *CULTURAL HERITAGE ASSESSMENTS*

Cultural Heritage Assessment of Three North/South Transport Corridor Options in the Kawana Area, Caloundra City Council and Maroochy Shire Council.

- CLIENT: SKM

Heritage Assessments of Proposed Telecom Fibre Optic Routes, 1. Toogum to Burrum Heads and 2. Mt. Morgan-Rockhampton

- CLIENT: Telstra

## 1994: *EXCAVATIONS*

Archaeological excavations of midden material in the "Noosa Springs" Estate, Noosa.

*And numerous other projects...*

| | |
|---|---|
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# Information Sheet on Ramsar Wetlands (RIS)

*Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).*

This Ramsar Information Sheet has been converted to meet the 2009 – 2012 format, but the RIS content has not been updated in this conversion. The new format seeks some additional information which could not yet be included. This information will be added when future updates of this Ramsar Information Sheet are completed. Until then, notes on any changes in the ecological character of the Ramsar site may be obtained from the Ecological Character Description (if completed) and other relevant sources.

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**1. Name and address of the compiler of this form:**

Division of Environmental Planning
Environmental Protection Agency
PO Box 155
BRISBANE ALBERT STREET QLD 4002
Ph: (07) 3227 6938
Fax: (07)3227 7237

FOR OFFICE USE ONLY.

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|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

Designation date Site Reference Number

**2. Date this sheet was completed/updated:**
June 1999

**3. Country:**
Australia

**4. Name of the Ramsar site:**
The precise name of the designated site in one of the three official languages (English, French or Spanish) of the Convention. Alternative names, including in local language(s), should be given in parentheses after the precise name.

Moreton Bay Queensland

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**5. Designation of new Ramsar site or update of existing site:**
Moreton Bay was designated on 22 October 1993

**This RIS is for** (tick one box only)**:**
**a) Designation of a new Ramsar site** ❑; or
**b) Updated information on an existing Ramsar site** ❑

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**6. For RIS updates only, changes to the site since its designation or earlier update:**

**a) Site boundary and area**

**The Ramsar site boundary and site area are unchanged:** ❑

or
**If the site boundary has changed:**
i) the boundary has been delineated more accurately ❑; or
ii) the boundary has been extended ❑; or
iii) the boundary has been restricted** ❑

and/or

**If the site area has changed:**
i) the area has been measured more accurately ❑; or
ii) the area has been extended ❑; or
iii) the area has been reduced** ❑

** **Important note**: If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

**b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:**

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**7. Map of site:**
Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

**a) A map of the site, with clearly delineated boundaries, is included as:**
i**) a hard copy** (required for inclusion of site in the Ramsar List): ❑;

ii**) an electronic format** (e.g. a JPEG or ArcView image) ❑;

iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables ❑**.

**b) Describe briefly the type of boundary delineation applied:**
e.g. the boundary is the same as an existing protected area (nature reserve, national park, etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

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**8. Geographical coordinates** (latitude/longitude, in degrees and minutes):
Provide the coordinates of the approximate centre of the site and/or the limits of the site. If the site is composed of more than one separate area, provide coordinates for each of these areas.

Latitude: 27º 20' S; Longitude: 153º 10' E

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**9. General location:**
Include in which part of the country and which large administrative region(s) the site lies and the location of the nearest large town.

Immediately East and extending North-East and South-East of the City of Brisbane, the Capital of the State of Queensland.

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**10. Elevation:** (in metres: average and/or maximum & minimum)
Varying from sea level to 280 metres at Mt Tempest, Moreton Island.

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**11. Area:** (in hectares)
113 314 ha

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**12. General overview of the site:**
Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

Moreton Bay is a semi-enclosed basin bounded on its eastern side by two of the largest sand islands in the world. It is one of only three extensive intertidal areas of seagrass, mangroves and saltmarsh on the eastern coast of Australia that provide habitat for water birds.

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**13. Ramsar Criteria:**

Tick the box under each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11). All Criteria which apply should be ticked.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ❑ | ❑ | ❑ |

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**14. Justification for the application of each Criterion listed in 13 above:**

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

***Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.***

[Justification against former Criterion **1(b)** under the Pre-1999 Criteria]:

Moreton Bay is one of the largest estuarine bays in Australia which are enclosed by a barrier island of vegetated sand dunes.

[Justification against former Criterion **1(c)** under the Pre-1999 Criteria]:

Moreton Bay plays a substantial role in the natural functioning of a major coastal system through its protection from oceanic swells providing habitat for wetland development, receiving and channeling the flow of all rivers and creeks east of the Great Dividing Range from the McPherson Range in the south to the north of the D'Aguilar Range.

***Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.***

[Justification against former Criterion **2(a)** under the Pre-1999 Criteria]:

Moreton Bay supports appreciable numbers of the vulnerable green and hawksbill turtles, the endangered loggerhead turtle and is ranked among the top ten dugong habitats in Queensland.

***Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.***

[Justification against former Criterion **2(b)** under the Pre-1999 Criteria]:

Moreton Bay supports over 355 species of marine invertebrates, at least 43 species of shorebirds, 55 species of algae associated with mangroves, seven species of mangrove and seven species of seagrass.

[Justification against former Criterion **3(b)** under the Pre-1999 Criteria]:

At least 43 species of shorebirds use intertidal habitats in the Bay, including 30 migratory species listed by JAMBA and CAMBA.

***Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.***

Justification against former Criterion **2(c)** under the Pre-1999 Criteria]:

It is a significant feeding ground for green turtles and is a feeding and breeding ground for dugong. The Bay also has the most significant concentration of young and mature loggerhead turtles in Australia.

***Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.***
[Justification against former Criterion **3(a)** under the Pre-1999 Criteria]:
Moreton Bay supports more than 50,000 wintering and staging shorebirds during the non-breeding season.

***Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.***
[Justification against former Criterion **3(c)** under the Pre-1999 Criteria]:
The Bay is particularly significant for the population of wintering Eastern curlews (3,000 to 5,000) and the Grey-tailed tattler (more than 10,000), both substantially more than 1% of the known Flyway population.

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**15. Biogeography** (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):
Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

**a) biogeographic region:**

**b) biogeographic regionalisation scheme** (include reference citation):

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**16. Physical features of the site:**
Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

**(a) Geology and Geomorphology:** Moreton Bay is one of the largest estuarine bays in Australia which are enclosed by barrier island of vegetated sand dunes. Moreton Bay is about 80 km long, 35 km wide in the north, tapering to less than 5 km in the south. Only near Moreton Island does water depth exceed 40 m. Moreton Bay is situated close to the southernmost limit of reef-building corals. These occur around Peel, St Helena, and Green Islands, and from Wellington Point to Raby Bay (Hekel et al, 1978).

The mountains lying west of the coastal plains from south of Sydney to Fraser Island are formed chiefly by Mesozoic and Permian sedimentary rocks and granites. The eastern side of the range is and has been characterised by heavy rainfall and rapidly flowing rivers and creeks. A very large amount of detrital material is moved by these rivers to the sea, where strong longshore currents move the sediments, mainly quartz sand, northward. This process has continued all through the Quaternary to the present day (Benussi, 1975). Along the mainland shore, the Bay is bordered by extensive estuarine flats formed by coastal progradation during high sea levels of the Quaternary period of geologic time (approximately the last two million years)(Hekel et al 1978).

The coastline south of Fraser Island is characterised by sandy beaches alternating with rocky headlands. Because of these features, the movement of sand is not uniform but intermittent. The sand accumulates south of rocky headlands or river mouths, building up the beach and moving the shoreline eastward. Especially during seasonal summer storms, sand moves around obstacles towards the north (Benussi, 1975).

**(b) Origins:** Recent sediments are composed of two types:

**A.** Oceanic quartz sand giving rise to immense tidal deltas consisting of sand banks:

**B.** River sands and muds confined to the western side of the Bay. Unconsolidated Cainozoic sediments dominate, however rocks are exposed at Point Lookout, at Dunwich, and at the south-west of North Stradbroke Island near Canaipa Passage.

The stratigraphic and geomorphic succession of North Stradbroke Island (Laycock, 1975) is as follows:
- Mangrove muds (organic silt), freshwater swamps - in process of formation.
- Beach, beach ridges, and sand dunes, without vegetative cover - in process of formation.
- Cainozoic beach ridges, stabilised by vegetative cover post - Recent emergence.
- Sand dunes, stabilised by vegetative cover - post-Recent emergence.
- Freshwater swamps in coastal regions - post-Recent emergence.
- Sand dunes, stabilised by vegetative cover - pre-Recent emergence.
- Mesozoic Sandstone and conglomerate Rhyolite and rhyolitic tuff.
- Palaeozoic Greenstone.

Fringing coral reefs have formed around islands in the centre of the Bay. Notable coral reef areas include Peel Island, Goat Island, One Mile, the Rainbow Channel and a small reef off the south-west tip of Moreton Island.

Coastal headlands and most of the Bay islands of Moreton Bay are formed of Tertiary age basalts and freshwater shales, Mesozoic age sandstones, and Palaeozoic age metamorphic rocks with laterite soils developed at the surface.

In the Quaternary, the major influence on sedimentation was sizeable fluctuations (up to 150 m) in sea level. This resulted from changing volumes of the oceans when water was transferred between the ocean, and glaciers and ice sheets. Moreton Bay was filled and drained several times in response to these distant glacial cycles.

During low sea level phases the bed of the Bay was exposed. Sediments dried out, weathered, and soils developed. Rivers flowed across the emerged Bay to the ocean shore which, at times of extreme low sea level, coincided with the edge of the continental shelf. As the rivers crossed the Bay they incised river valleys and transported sediment to the ocean.

At times of rising sea level, the coastline moved westwards, the former river valleys were back filled with river gravels and subsequently estuarine mud and then with marine sand and mud.

Moreton and Stradbroke Islands are drowned sand dune island barriers anchored by rocky headlands. They formed by wave and wind action during several cycles of sea level change. The stages of dune development are marked by characteristic soil profiles (Hekel et al, 1978).

Four sedimentation zones are present in the Bay under present conditions:

- Nearshore zone of active sediment accumulation: This is the tidal flat environment where sand and muddy sand is deposited, and coral reef develops.

- Quiescent basin sedimentation: Depressions in the drowned former land surface have been filled by marine mud. The Brisbane, Pine, and Caboolture Rivers have been the main suppliers of sediment, which rarely exceeds 10 m in thickness in this zone.

- Zone of minimal deposition: Little sediment is supplied to this zone because of its distance from the source of sediment. In addition, any mud that does reach this zone tends to be kept in suspension by tidal currents thus preventing significant deposition. The older sediments remain exposed at the sea floor or are covered by only a thin layer of muddy sand.

- Tidal delta depositional zone: Much of the longshore drifting sand of the ocean beaches of Moreton and Stradbroke Islands is trapped in tidal deltas which have formed at the Southern, South Passage and Northern entrances to Moreton Bay.

**(c) Climate:** Being situated on a biogeographical boundary separating the tropical from the more temperate areas the climate of the bay is sub-tropical. Annual average rainfall is 113.5 cm. This occurs predominantly in summer during the months of October to April. Average annual temperatures for Brisbane are a maximum of 30°C and a minimum of 18°C. The site is subject to the effects of tropical cyclones which originate in the Coral Sea and may travel as far south as Moreton Bay before usually weakening into a low or rain depression as they cross the coast. Most of the rainfall from these lows usually falls in the catchment areas of the major rivers flowing into Moreton Bay and considerable silt, mud and sand is washed down into the bay when these rivers flood. From 1840 to 1893 there were eight major floods in the Brisbane River. The latest occurred in 1974 (Saunders, 1975).

**(d) Hydrology:** On the large sand islands of Moreton and North Stradbroke rainfall filters through the sand dunes to emerge in lakes and swamps and thence into Moreton Bay and the Pacific Ocean. On North Stradbroke Island some of this fresh water is extracted by the Local Authority for domestic use. Increased urbanisation of the central bay islands and the adjacent mainland may result in increased demands for water extraction from North Stradbroke Island. Increases in waste discharges and runoff into the bay may also occur. The bay receives most of the sewage and industrial effluent of the wider Caloundra-Brisbane-Gold Coast metropolitan areas as well as the storm water runoff containing sediment, fertilisers, pesticides and other pollutants from the urban and rural areas. These areas comprise the catchments of several large rivers and smaller creeks rising in the Lamington Plateau in the south, north along the Great Dividing Range to the D'Aguilar Range. These rivers are: Nerang, Pimpama, Coomera, Albert, Logan, Brisbane, Bremer, Pine, and Caboolture Rivers (Laycock, 1975).

The hydrodynamic nature of Moreton Bay is determined by interaction of the semi-diurnal tide, propagating mainly through the northern entrance, with the depth variations inside the bay. The tidal range inside the bay is about 20% greater than outside the bay. The patterns of the tide-height contours and the tidal currents in the bay are strongly influenced by the depth-topography of the bay. The tidal currents vary from 0.2 ms-' in the shallow western region to 1.0 $ms^{-1}$ in the deep channels to the north-east.

The salinity of Moreton Bay is higher on the eastern side because freshwater flows into the western side. Therefore the spatial and temporal distribution of salinity in the bay depends on the varying rainfall in the catchment of the rivers flowing into it. Higher temperatures in summer and lower temperatures in winter are recorded in the shallow western bay compared with the north-eastern area of the bay and near South Passage due to the moderating influence of the Pacific Ocean on the latter areas.

Surges due to cyclones off the Queensland coast occur in Moreton Bay while severe local storms can cause transient changes in the water level of the bay. (Harding, 1979).

**(e) Water quality:** Depending on water depths and circulation patterns, the Bay has a limited capacity to assimilate the large quantity of waste it receives. A draft environmental policy on water seeks to grade all Queensland waters into one of four water quality classes, Q1 to Q4. The intention is for all the waters of Moreton Bay, except near waste discharges, to ultimately meet at least Q2 standard, defined as the maintenance of a high water quality with the only discharges to be permitted being those which, at the worst, result in minor changes to the biological community.

**(f) Water depth fluctuations and permanence:** Moreton Bay has experienced several sea level oscillations over the past 500,000 years and tides are semi-diurnal with an amplitude of more than 2 metres.

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**17. Physical features of the catchment area:**

Describe the surface area, general geology and geomorphological features, general soil types, and climate (including climate type).

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**18. Hydrological values:**

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

The two principal rivers entering the bay are the Brisbane and Logan Rivers which have an average annual discharge of 1 215 000 Ml and 810 000 M1 respectively. These are joined by tributaries from the southern slopes of the Brisbane Range, from the Great Dividing Range and from the southern eastern and western slopes of the D'Aguilar Range. The Logan and Albert Rivers extend from the northern slopes of the McPherson Range across the lowlands in the southern part of the region. The rivers are tidal for most of their course across the lowlands.

Moreton Bay consists of a deeper eastern section subject to strong north-south tidal circulation and a shallower western section with much weaker east-west mixing. Consequently, fine particles settle in the less turbulent western areas of the Bay while the eastern Bay is characterised by sandy sediments associated with higher tidal velocities. This maintains an ecological gradient based on particle size ensuring high levels of biodiversity.

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**19. Wetland Types**

**a) presence:**

Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

**Marine/coastal:** **A** • **B** • **C** • **D** • **E** • **F** • **G** • **H** • **I** • **J** • K • Zk(a)

**Inland:** **L** • **M** • N • **O** • P • **Q** • R • Sp • Ss • **Tp** • **Ts** • U • Va • Vt • **W** • **Xf** • **Xp** • Y • Zg • Zk(b)

**Human-made:** 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • **9** • Zk(c)

**b) dominance:**

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

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**20. General ecological features:**

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

The Moreton Bay region is an important habitat for many species of birds and is one of only four recognised sites of significance to wintering migratory wading birds along the eastern Australian coast (Thompson and Kikkawa, 1988). Australia is a signatory to the Japan-Australia (JAMBA) and China-Australia (CAMBA) migratory bird agreements which require the habitats used by certain species listed in the agreements to be set aside as reserves. At least 34 listed species have been recorded from Moreton Bay including the eastern curlew; whipbird; bar-tailed godwit; grey-tailed tattler; ruddy turnstone; rednecked stint; sanderling; curlew; sandpiper and common sandpiper (Thompson and Kikkawa, 1988). At least 254 species of bird have been recorded from North Stradbroke Island including gould's petrel, the arctic tern and the long-tailed jaeger (Vernon and Martin. 1975).

Image analysis of all intertidal areas in Moreton Bay, including Pumicestone Passage estimated that a total of 23,000 ha of tidal flats are exposed at low water datum characterised by marked differences in substrate type and species of waders present (Thompson, 1990b). Four types of roosts and four habitats have been determined for waders in Moreton Bay (Thompson, 1991 **Appendix 1**) using particle size analysis. The main habitats were:

- muddy intertidal, often with seagrass;
- muddy intertidal with no seagrass, usually associated with sewage outlets;
- sandy; and
- coral.

High amounts of silt were found at very muddy sites associated with slow currents. High amounts of fine sand occurred at very sandy sites with fast currents. The amount of fine sand and very fine sand in the substrate reflected estuarine conditions at a site. High percentages of fine sand were recorded at oceanic influenced sites where fast currents and limited riverine sediment deposition led to large average particle sizes. Sites with very fine sand are associated with muddy riverine conditions due to slower currents and the contribution of fine particles from nearby rivers. A relationship was shown to exist between the location of those habitat sites with high species numbers and the location of roosts. Species of waders present differed significantly among the four habitats.

The ruddy turnstone was found to be a key indicator species of the coral habitat strewn with coral rubble giving the surface considerable topographic relief. The bar-tailed godwit characterised the other extreme distinguished by sandy sites with a lush covering of seagrass (Thompson,1990 a, 1991) (**Appendix 1**) .

A total of 19 plant formations occur on the tidal wetlands. Six of those formations are dominated by the mangrove *Avicennia marina.* Climatic conditions in Moreton Bay provide optimum temperatures of 18-24 degrees for the growth of *Avicennia marina* for six to seven months of the year. Behind the fringing mangroves, salt-marsh is usually zoned parallel to the shoreline and consists of three plant communities broadly classified as:

- shrublands, the dominant species being Sarcocornia spp. and Suaeda australis;
- sedge *(Juncus krausii)* and rush swamps ; and
- grasslands *(Sporobolus virginicus)* as well as bare salt pans.

Seven species of mangroves are found in Moreton Bay and major areas of mangroves are located throughout the Bay and in particular along the Pimpama River, Coomera River, North Arm and the wetlands and waterways of McCoys Creek and Woogoompah Creek. Mangroves are the nursery areas and ultimate source of food for many commercial and recreational fish species and are necessary for the prevention of erosion, the provision of habitat, landscape value and to provide roosting areas for wildlife (Arthington and Hegerl, 1988). Four main types of shore bird roosts are identifiable in Moreton Bay (Thompson, 1991):

1. open sandy island or beach: found mainly on Moreton and North Stradbroke Islands with only two similar roosts known on, or adjacent to, the western side of Moreton Bay. These types of roosts are used by most species;

2. salt and clay pan: scattered within and behind the mangrove fringe. Birds may find cover under mangrove trees or shelter within clumps of samphire and sedge. These roosts are also used by most species;

3. inland freshwater marshes: restricted to the western side of the bay and used by species such as the sharp-tailed sandpiper, greenshank and the black-winged stilt at all stages of the tidal cycle;

4. mangroves: this is the preferred roosting situation of the grey-tailed tattler which roost standing on the branches of the mangrove trees. The whimbrel, curlew, sandpiper, terek sandpiper and the greenshank may also roost in this situation.

Saltmarsh and saltpan areas are integral with and generally adjacent to mangrove areas. Apart from providing valuable feeding and crucial roosting areas for waders (Thompson and Kikkawa, 1989), these areas also represent buffers for the mangroves and function as a source of material for detrital food chains.

North and South Stradbroke Islands are barrier islands feeding sand sediments from ancient dune deposits into the eastern part of Moreton Bay (Maxwell, 1970). The two islands are separated by an opening nearly 2 kilometres wide at Jumpinpin; this bar and the Southport Bar at the southern end of South Stradbroke Island are fairly unstable and do not allow a seagrass population to establish. At the northern end of North Stradbroke Island a different situation occurs. Here the orientation of this island and Moreton Island allow for large sheltered sand banks flushed twice daily by oceanic water.

From Amity Point to the northern end of Canaipa Passage shallow sand and muddy sand flats with protection from prevailing winds and strong currents make a good habitat for seagrasses. At South Passage sand has formed a fan-shaped bank known as Amity Banks. Further south the sand becomes muddier with clay and silt from the mainland and low offshore islands.

Between Canaipa Passage and the Southport Bay at the southern end of South Stradbroke Island a series of low, small islands form the deltaic complexes of the Logan, Albert, Coomera and Pimpama Rivers. Between these islands are shallow mud flats and deeper channels. These areas, protected on one side by Stradbroke Island and on the other by the mainland or offshore islands, offer excellent habitats for seagrasses (Kirkman, 1975).

Intertidal and shallow waters support seven species of seagrass which occur over an area of 6522 ha. This provides food and habitat for turtles, dugong, commercially and recreationally important fish and invertebrate populations in the bay.

Research indicates that seagrass meadows are particularly vulnerable to disturbance by humans and are very slow to recover (Poiner, 1989).

South Passage and the Rous Channel plus the sand banks of the bay, particularly the Moreton and Amity Banks area, represent an internationally significant habitat for dugong. Population estimates of at least 600 have been made for this species, a high number considering the proximity of their habitat to a major city such as Brisbane (Preen et al, 1989). Dugong feed mainly on seagrass and their survival is closely linked to the protection of these seagrass communities.

Three species of turtle inhabit Moreton Bay year round. Hawksbill turtles occur only occasionally while loggerhead turtles occur in their thousands and feed on molluscs, crabs and sponges (Bustard, 1972). Moreton Bay is also a significant site for feeding green turtles (Limpus,C in press).

Seagrass is a significant feature and likely to have influenced feeding behaviour and distribution of shore birds. Seagrass coverage is highest in those sites around Moreton Island and North Stradbroke Island where clean oceanic waters promote high rates of photosynthesis. Seagrass coverage is reduced in the muddy waters along the mainland of Moreton Bay and in sites with coral substrate.

The sewage affected sites in Bramble Bay are entirely devoid of seagrass, as are a few sites in Pumicestone Passage and Southern Moreton (Thompson, 1991).

Driscoll (1991), found that the substrate and conditions in Pumicestone Passage were not uniform throughout and that different locations had variations in the numbers of wader species present.

Most species showed a preference for particular locations but great knots and curlew sandpipers were not as consistent and habitat links for these species were hard to define.

The differences were related to:

- the pattern of substrate deposition;
- the extent of feeding areas; and
- the peculiarities of the tidal range in the Passage.

One third of all waders counted were bar-tailed godwits but data from Thompson (1990c) suggests that the numbers of this species present in the Passage decrease in autumn.

Conversely the number of grey-tailed tattlers was found to be higher in autumn and this was reflected in data from the Great Sandy Strait further north (Driscoll 1990).

It is possible that the numbers of grey-tailed tattlers present in south-east Queensland increase during their northward migration.

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**21. Noteworthy flora:**

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14, Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Species dependent on mangrove estuarine areas comprise up to 67% of the entire commercial catch of fisheries in eastern Australia. Mangroves form a fringe around much of the shoreline of Moreton Bay. Seven species have been identified but only three are considered abundant - *Avicennia marina, Aegiceras corniculata, Ceriops tagal.* Other species of mangrove include *Rhizophora stylosa, Excoecaria agallocha* and *Bruguiera gymnorhiza.*

Fifty-five species of algae are associated with mangroves in the bay and 2000 ha of salt marsh vegetation have been identified.

Saltmarsh includes samphires, sedges, salt couch, bare saltflats and stunted mangroves. Important saltmarsh species include *Suaeda australia, Salicornia quinquelflora.* Threatened communities consisting of Wallum woodland *(Melaleuca quinquenervia)* grow in saturated areas close to the shores of Moreton Bay.

The high diversity of marine plants include seven species of seagrass belonging to five different communities. Species are: *Zostera capricorni, Halodule uninervis, Syringodium isoetifolium, Halophila ovalis, Halophila spinulosa, Cymodocea serrulata, Halophila dicipiens.* Seagrasses have been shown to be important in the life history stages of commercially important fishes and crustaceans (Hyland. 1988,1989). Dugongs, turtles, swans, waders, fishes feed in or on seagrasses. Seagrass allows long-billed waders (e.g. bar-tailed godwit) to penetrate deeply into the substrate. Seagrasses provide important settlement areas for the post-larval stage of penaeid prawns.

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**22. Noteworthy fauna:**

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

With the combination of muddy habitats (western side), sandy habitats (eastern side), coral and seagrass habitats, Moreton Bay is extremely important as a site for shorebird species (Thompson 1991). At least 43 species of wading birds use intertidal habitats in the bay, including 30 migratory species listed by JAMBA and CAMBA. More than 50 000 wintering and staging waders depend on Moreton Bay during the non-breeding season (Thompson, 1990b). The bay is particularly significant for the Eastern curlew *Numenius madagascariensis* (3000 to 5000 birds) and the Grey-tailed tattler *Tringa brevepes (*> 10 000 birds) in winter.

This diversity of habitats and species utilising the area indicates the importance of both sides of the bay when considering conservation measures. Moreton Bay also has particularly large populations of cormorants and terns, white herons, spoonbills, ibises and egrets. The bay is ranked among the top ten dugong habitats in Australia and together with the Gulf of Carpentaria and Torres Strait is considered one of the most important areas for dugong in Queensland. Herds of dugong of up to 104 individuals have been observed.

Three species of sea turtles inhabit Moreton Bay in significant numbers. Of these species, the hawksbill and green turtles are considered to be endangered and the loggerhead is regarded as threatened in a world context. However within Australia the loggerhead is listed as an endangered species while the green and hawksbill turtles are listed as vulnerable.

Feeding green turtles are found in Princess Charlotte Bay, Moreton Bay, Shoalwater Bay, Hervey Bay and Repulse Bay. Of these locations, Moreton Bay has the largest concentration of feeding green turtles in Australia. Tagging studies have shown that the green turtles resident in Moreton Bay migrate to the southern Great Barrier Reef (Lady Musgrave, Heron, Wreck and North West Islands) and the northern Great Barrier Reef (Raine Island) to breed.

Major concentrations of loggerhead turtles are found in Moreton and Hervey Bays and the southern part of the Great Barrier Reef. Significant numbers of young and mature loggerhead turtles inhabit Moreton Bay. This is the most significant concentration of loggerheads in Australia (C. Limpus in press).

A total of 175 species of fish are listed for Flinders Reef off Cape Moreton and at least 100 species occur inside the bay. In excess of 80 species of echinoderms have been recorded from Moreton Bay and adjacent reefs. One study identified 355 invertebrate species from 400 subtidal sites within the bay.

Chestnut teal and Pied oystercatchers breed on the shores of the bay and Fruit bats roost in mangroves during the day. A small number of Humpback whales enter the bay, probably accidentally, each year on their way north to their breeding grounds at Hervey Bay, north of Fraser Island. Nine species of birds are dependent on mangrove vegetation. Many first year-birds of migratory species remain in the bay during the breeding season when the number of migratory species present in the bay increases as they move northwards with the onset of winter. Large populations of resident birds depend on the fringing wetlands and large populations of marine birds feed in the open waters of the bay. Moreton Bay provides significant habitat for the water mouse (false water rat) *Xeromys myoides* which is listed as Vulnerable in EPBC and NCA.

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**23. Social and cultural values:**

**a)** Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

Some of the best remaining evidence of Aboriginal adaptation to a marine-based resource is to be found on Moreton Island. Other sites of significant Aboriginal cultural heritage are located on Bribie, North Stradbroke, Peel, St Helena, Macleay, Lamb, Karragarra and Russell Islands as well as Toorbul Point, Caboolture River and Victoria Point. Types of sites include middens, fish traps, artefact scatters, quarries and scarred trees.

The shoreline of Moreton Bay was the first area in the Brisbane region to be settled by Europeans. Coochie Mudlo Island was the site of the first landing by Matthew Flinders during his exploration of Moreton Bay and the Brisbane River. St Helena Island which was used as a prison and quarantine station at different periods was the first historical area in Queensland to be reserved as a National Park solely because of its historic ruins. Other areas settled by Europeans include Peel Island, used first as a quarantine station and then as a leper colony, Dunwich and Amity Point on North Stradbroke Island and Redcliffe on the mainland which was the site initially chosen for the penal colony before it was moved up the Brisbane River to the site now occupied by the business centre of Brisbane.

**b)** Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning?

If Yes, tick the box ❑ and describe this importance under one or more of the following categories:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

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**24. Land tenure/ownership:**
**a) within the Ramsar site:**
Moreton Bay lies within Queensland waters. Most of the land fronting the bay consists of land under the control of the Government of the State of Queensland but there are substantial areas of privately owned land along the western shore. A number of canal estates have access to the bay and some of the privately held land is also proposed for canal estates.

**b) in the surrounding area:**
This incorporates Moreton Island National Park and on the mainland a greater proportion of privately owned land and commercial forests.

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**25. Current land (including water) use:**
**a) within the Ramsar site:**
**Fishing and collecting:** The Moreton Bay region supports one of the most productive fisheries in Queensland, representing just under three percent of the Queensland coastline while annually producing about 20 percent of Queensland's commercial seafood catch by weight (Williams, 1991). The Bay is also a popular recreational fishing area. A variety of species is targeted, including yellowfin bream, whiting, tailor, flathead, black bream, mackerel, snapper and mullet. Eight species of prawn and four species of crab are commercially important, with mud and blue swimmer crabs also being of recreational importance.

Commercial collection of fish, invertebrates, anemones and live corals for aquarium purposes occurs within the Bay and the offshore reefs while bait collection, food gathering and viewing of coral and aquarium fish species are popular recreational pursuits. Commercial oyster banks operated by licensed oyster growers, commercial baitworm and shell collection also occurs.

During 1986, expenditure on commercial and recreational fishing activities was estimated at more than $100 million, while the retail value of the commercial fishing haul has been estimated at $100 million (McDonald and others, 1989).

**Recreation and tourism:** The Bay is a major area for recreational boating and water related activities offering opportunities for a wide range of water-based recreation including fishing, sailing, power boating, water skiing, parasailing, jet-skiing, sail-boarding, scuba diving, bird watching, marine study and snorkeling. The southern area of the bay receives the heaviest boating use for most activities because of its sheltered waters and proximity to many boat launching facilities.

The three barrier islands (Moreton, North Stradbroke and South Stradbroke) have unspoilt beaches, topographic diversity within the dunal system and largely undisturbed natural scenery, forest and wetlands .

**Port facilities:** The Port of Brisbane is the fastest growing capital city port on the east coast (POBA, 1990), and is expanding its capabilities to handle a wide variety of cargoes. The Moreton Bay Strategic Plan seeks to integrate the operation and development of shipping channels and other areas of port expansion with the natural environment.

**Sand mining and extraction:** Silica and heavy mineral sands are extracted primarily from North Stradbroke Island. Silica deposits used include the northern bay banks, Middle Banks and Rous Channel. These sources are highly valued in a regional sense due to the diminishing resources available from mainland streams and terrestrial areas. Rutile and zircon exist in offshore deposits for which exploration leases are being considered.

**Water extraction:** Redland Shire Council's mainland water supply is supplemented by water extracted from an unconfined aquifer on North Stradbroke Island.

**Education and research:** The bay is an important environmental and historical education resource for primary, secondary and tertiary education due to its range of undisturbed ecosystems. The University of Queensland has a field station at Dunwich. CSIRO has research facilities at Cleveland.

The Department of Primary Industries has research facilities at Deception Bay and Bribie Island. The Environmental Protection Agency has research facilities on South Stradbroke Island and educational facilities on St Helena and Moreton Islands. The Department of Education runs environmental education centres at Nudgee Beach, Darling Point and Jacobs Well for educating children on coastal and environmental matters The mangrove boardwalk at Wynnum North is also a significant educational resource.

**Transport:** Several of the Bay's marinas and harbours provide bases for the transport operations which service surrounding locations and the bay islands, servicing commercial, recreational and residential demands.

**b) in the surroundings/catchment:**

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**26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:**
**a) within the Ramsar site:**
Land reclamation and soil dumping or urban and industrial development and shipping and port activities are occurring at various sites in the Bay. Up to 1M tonnes of coral and 150 000 m3 of sand per annum are extracted from the Bay for use in the building, foundry and manufacturing industries. Most pressure from human activities is being exerted on the western shoreline, which also attracts large numbers of wader species that favour muddy habitats. A series of localised problems such as the occasional 'red tides' at Bramble Bay (Moss et al, 1989) have occurred due to a combination of concentrations of phosphorus and nitrogen higher than background levels combined with large quantities of treated industrial and domestic waste waters and contaminated storm water runoff. Such affects are to be reduced by minimising waste inputs from direct discharges and treating contaminated runoff.

**b) in the surrounding area:**

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**27. Conservation measures taken:**
**a)** List national and/or international category and legal status of protected areas, including boundary relationships with the Ramsar site:
In particular, if the site is partly or wholly a World Heritage Site and/or a UNESCO Biosphere Reserve, please give the names of the site under these designations.
Legislative protection:
National Parks in the Moreton Bay region and managed by the Queensland Parks and Wildlife Service of the Environmental Protection Agency are:

- Blue Lake NP on North Stradbroke Island
- Bribie Island NP
- Moreton Island NP
- St Helena Island NP

Conservation Parks administered by the Queensland Parks and Wildlife Service, but which may have the Local Government as trustee are:

- Beachmere CP on the western mainland side of the Bay
- Bird Island CP
- Buckleys Hole CP
- Cobby Cobby Island CP
- Coomera Island CP
- Goat Island CP
- Kangaroo Island CP
- King Island CP
- Myora CP (North Stradbroke Island)
- South Stradbroke Island Conservation Park 1

- South Stradbroke Island Conservation Park 2
- Woogoompah Island CP

Fish Habitat Areas administered by the Department of Primary Industries, cover approximately 15.3% of the Bay.

**b)** If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate):

Ia ❑;Ib ❑; II ❑; III ❑; IV ❑; V ❑; VI ❑

**c)** Does an officially approved management plan exist; and is it being implemented?:
Management plans for the National Parks referred to above as well as National Parks in the catchment area have or are currently being prepared.

Moreton Bay has been declared a Marine Park and a Strategic Plan has been prepared with the goal "to provide for economically sustainable use of Moreton Bay and for protection of its natural, recreation, cultural heritage and amenity values". The Marine Park Zoning Plan has been approved as subordinate legislation under the Marine Parks Act 1982, and forms the basis of management of most of the site.

**d)** Describe any other current management practices:

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**28. Conservation measures proposed but not yet implemented:**
e.g. management plan in preparation; official proposal as a legally protected area, etc.

Because of the complex pattern of shore bird distribution in Moreton Bay some species that are common on the western shores of Moreton Bay, such as the terek sandpiper, lesser golden plover, sharp-tailed sandpiper, black-tailed godwit and the marsh sandpiper, are seldom seen in the eastern sector of the bay. Therefore conservation measures need to deal with both sides of the bay to ensure sufficient habitat for all waders (Thompson, 1991) Shorebird Management Plans are currently being developed.

Further areas of North Stradbroke Island are proposed as National Park. Treatment of domestic effluent discharge is being upgraded to secondary level with tertiary level contemplated for the future.

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**29. Current scientific research and facilities:**
e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Queensland University, CSIRO and Department of Primary Industries have research stations in the Moreton Bay region. Other universities and colleges use Moreton Bay for research and education. Projects are underway for tracking certain species (e.g. eastern curlew). The Environmental Protection Agency is researching the population dynamics of loggerhead turtles within Moreton Bay.

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**30. Current communications, education, participation and awareness (CEPA) activities related to or benefiting the site:**
e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

University of Queensland's research station on North Stradbroke Island is regularly used by High School groups. Interpretation facilities are available on Moreton Island and St Helena Islands.

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**31. Current recreation and tourism:**
State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

An estimated 300 000 recreational fishers spend 1.5 person days in Moreton Bay. An estimated 2000 people visit Brisbane each year specifically to watch waders in Moreton Bay (RAOU data). Other activities include yachting, water skiing, sail boarding, scuba diving, picnicking, camping and boating.

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**32. Jurisdiction:**
Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

| | |
|---|---|
| National Parks | Environmental Protection Agency (Queensland Parks and Wildlife Service) |
| Conservation Parks | Environmental Protection Agency (Queensland Parks and Wildlife Service) and Local Governments where they are the trustees |
| Coastal Protection | Environmental Protection Agency |
| Monitoring environment | Environmental Protection Agency |
| Fish Habitat Reserves | Department of Primary Industries |
| Unallocated Crown Land | Department of Natural Resources |
| Local Government Reserves | Local Governments |

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**33. Management authority:**
Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Environmental Protection Agency (Queensland Parks and Wildlife Service)
Local Governments for areas under their jurisdiction

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**34. Bibliographical references:**
Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

A list of relevant references is provided in **Appendix 2.**

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# Appendix 1.

Not present.

# Appendix 2.

Not present.

**DEPARTMENT OF THE ENVIRONMENT AND ENERGY**

**COMMONWEALTH ENVIRONMENTAL WATER OFFICE**

**EPBC ACT REFERRAL ADVICE FROM WETLANDS SECTION**

**REFERRAL: EPBC 2017/7939**

**DATE DUE BACK TO EACD: 22/5/2017**

# TOONDAH HARBOUR DEVELOPMENT, MORETON BAY, QLD

## Brief Description of Proposal

The proposed action involves the filling in of marine areas for urban development and public open space, the excavation of a marina and the widening, deepening and lengthening of Fison Channel, which is the existing entrance channel to Toondah Harbour, on the foreshore of Moreton Bay about 30km southeast of Brisbane (Figure 1). The maximum development footprint (including land reclamation) is approximately 73 hectares with the reclamation component approximately 40 hectares (Figure 2).

The project is expected to take 15 to 20 years, with the initial dredging and reclamation occurring intermittently over a 3-5 year period.

The project involves:

- New ferry terminals to improve access to North Stradbroke Island
- Mixed use development including (high rise) residential, retail, commercial and tourism uses;
- A marina;
- Public open space and boardwalks providing foreshore access;
- Dredging of the existing Toondah Harbour marine access (Fison Channel) to allow for safe navigation for all vessels; and
- Reclamation of areas within Moreton Bay

There is no detailed description of the development in the referral, for example it does not provide the number of residential dwellings (style, height etc), commercial and tourism activities, boat movements, number of berths in marina and details of reclamation.

## Issues Checklist

### *How far is the proposal from a Ramsar site?*

The proposed action is both within and adjacent to the Ramsar site. The boundary of the Ramsar site and the Priority Development Area (within which much of the development is contained) is at Figure 3. Areas of reclamation will extend beyond the PDA to the east. The referral does not provide an area in hectares of the Ramsar site that overlaps with the proposed development.

The Moreton Bay Ramsar site is located in and around Moreton Bay, east of Brisbane in Queensland and was listed in 1993 under six of the 9 Ramsar criteria (details from 1999 RIS):

- **Criterion 1:** contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region – one of largest estuarine bays, enclosed by barrier island of vegetated sand dunes.
- **Criterion 2:** supports vulnerable, endangered, or critically endangered species or threatened ecological communities – supports vulnerable green and hawksbill turtles, the endangered loggerhead turtle and ranked among the top 10 dugong habitats in Queensland.

- **Criterion 3:** supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region – supports over 355 species of marine invertebrates, at least 43 species of shorebirds, 55 species of algae associated with mangroves, seven species of mangrove and seven species of seagrass.
- **Criterion 4:** supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions – significant feeding ground for green turtles, and feeding and breeding ground for dugong. Also has the most significant concentration of young and mature loggerhead turtles in Australia.
- **Criterion 5:** regularly supports 20,000 or more waterbirds – supports more than 50,000 wintering and staging shorebirds during the non-breeding season.
- **Criterion 6:** regularly supports 1% of the individuals in a population of one species or subspecies of waterbird – significant for population of wintering eastern curlews (3,000 to 5.000) and the grey-tailed tattler (more than 10,000), both substantially more than 1% of Flyway population.

Moreton Bay is a semi-enclosed basin bounded on its eastern side by two large sand islands. Islands in the site include all of Moreton Island, and parts of North and South Stradbroke Islands, Bribie Island and the Southern Bay Islands. Other parts of the site include waters and tributaries of Pumicestone Passage, some intertidal and subtidal areas of the western bay, southern bay and sandy channels of the Broadwater region, marine areas and sand banks within the central and northern bay and some ocean beach habitats.

Wetlands on the site include seagrass and shoals in the eastern banks, tidal flats and associated estuarine assemblages within the Pumicestone Passage, mangroves and saltmarsh in the southern bay, coral communities of the eastern bay, freshwater wetlands and peatland habitats on the Bay Islands and ocean beaches and foredunes on Moreton Island.

The extensive mangrove and tidal flats provide a nursery for fish and crustaceans, and also support birds and other marine life. The sandflats provide roosting sites for migratory birds.

The seagrass areas provide food and habitat for fish, crustaceans, the internationally vulnerable dugong, and the nationally threatened loggerhead turtles, hawksbill turtle and green turtle.

The site supports more than 50,000 migratory waders during their non-breeding season. At least 43 species of wading birds use the intertidal habitats, including 30 migratory species listed on international conservation agreements. Moreton Bay is one of only two Ramsar in Australia that supports the critically endangered eastern curlew all year round, with juvenile birds not migrating until they are 2-3 years old.

***Is there a real chance or possibility that the proposed action will result in:***

| Issue | Y | N |
|---|---|---|
| areas of the wetland being destroyed or substantially modified? | X | |
| a substantial and measurable change in the hydrological regime of the wetland? | X | |
| the habitat or lifecycle of native species dependent upon the wetland being seriously affected? | X | |
| a substantial and measurable change in the physico-chemical status of the wetland? | X | |
| an invasive species that is harmful to the ecological character of the wetland being established or encouraging the spread of existing invasive species? | | X |

**Issues to note**

***Potential impacts***

***Areas of the wetland being destroyed or substantially modified***

Major elements of the proposed action are located inside the Ramsar site, with areas of the Moreton Bay Ramsar site to be destroyed or substantially modified. The size of the area within the Ramsar site to be affected by both dredging and reclamation is not provided in the referral.

The project involves 40 hectares of reclamation and 10.5 hectares of marina (to be dredged to 13 metres deep) and access channel (dredged to 4.25 metres deep), a large proportion of which will be within the Ramsar site. A total of 20 hectares will be subject to maintenance dredging. These activities will destroy or substantially modify wetlands within those areas, and this involves a permanent change. In addition, the development would alter the hydrodynamics of the local area, which could affect the flora and fauna in a much larger area than the development footprint itself. For instance, the mangroves on Cassim Island, adjacent to the development may be subject to significantly greater amplitude and frequency of waves. Hydrodynamic modelling would be required to confirm the area of direct impact on the Ramsar site.

If there is a net excess of material from dredging/reclamation, the proponent states it may be disposed of offshore, onshore or re-used. Mud Island is mentioned as a possible disposal site – and it is part of the Moreton Bay Ramsar site. If this material is disposed of anywhere within the Ramsar site, it may destroy or modify further areas of wetland.

Areas of the Moreton Bay Ramsar wetland in the immediate vicinity of the project are also likely to be affected by an intensively developed residential/commercial tourist hub, with expected impacts on hydrology, water quality and on threatened species, both during construction and operation (due to noise, light, vibration, pollution and pedestrian and boating activity).

The referral does not address the option of a smaller scale development (eg smaller marina, area or height of residential buildings), with a smaller footprint, which would reduce the impact on the Ramsar wetland.

**The proposed action will have a substantially adverse impact in terms of destruction and modification of areas of the wetland.**

***A substantial and measurable change in the hydrological regime of the wetland***

As the reclaimed land extends into Moreton Bay, it is possible that the proposed reclamation, marina and channel dredging could affect coastal currents in the area. These changes could result in changes to sand and sediment movement in the adjacent areas of the Ramsar site which could impact the biota in those areas, including through changes to light penetration and smothering of seagrasses.

The proponent identifies a number of studies to be undertaken to better understand the risks, but has made no commitments to particular mitigating measures to address those potential impacts.

**The proposed action may have a substantially adverse impact on the hydrological regime of the wetland.**

***A substantial and measurable change in the physico-chemical status of the wetland***

Any action involving the clearing of vegetation, dredging, excavation and/or reclamation creates the potential for sediments and/or other contaminates to be discharged. Regardless of the amount of disturbance or final design for any action, physico-chemical changes will occur and need to be managed to reduce the risk of impacts to the ecological character of a Ramsar site. These impacts have potential to impact well beyond the development site.

The proposed action will also expose coastal marine sediments to air which creates the risk of the exposure of acid sulphate soils (ASS), the associated acidification of water and the potential release of metals and other contaminants, dissolved in the acidified water. This may result in algal blooms, which have occurred in other parts of Moreton Bay.

The proponent has identified some of these risks but has not provided sufficient information on proposed management measures to assess whether they would be sufficient to mitigate the risks to the physico-chemical status of the wetland and potential impacts on the ecological character of the Moreton Bay Ramsar site.

**The proposed action may have a substantially adverse impact on the physico-chemical status of the wetland.**

***The habitat or lifecycle of native species dependent on the wetland being seriously affected***

The referral area contains intertidal and shallow subtidal habitats including:

- mangrove forests
- intertidal and subtidal mudflats and sand banks
- seagrass meadows
- subtropical coastal saltmarsh community.

These habitats are important for the ecological character of the Moreton Bay Ramsar site and support a range of native species dependent upon the wetland. They provide intertidal feeding habitat for migratory shorebirds, including the critically endangered eastern curlew and the vulnerable bar-tailed godwit. These areas of foraging habitat cover a large proportion of the development site, are within the Moreton Bay Ramsar site, and will be removed through construction of the marina and reclamation for construction of residential/commercial buildings.

Two high tide roost sites are adjacent to the development area, at the Nandeebie Claypan (to the south west) and Cassim Island (to the east). Oyster Point is also another roost site (600 m from the proposed action) which forms part of a network of feeding and roosting sites. These sites are of high importance to shorebirds in the region.

The proponent has identified a number of mitigating measures for these bird habitats, including measures to reduce sediment during construction, management of acid sulfate soils, buffers, barriers, management of public access, lighting, vegetation screening and sound attenuation and signage.

However, the impacts to these habitats will be difficult to mitigate, particularly disturbance during the construction period (over 3 years), including noise, light, vibration, sediment, etc. Development is proposed to come within 100 metres of the roosting sites. A separation of at least 200 metres is recommended for the eastern curlew, which is easily disturbed. In addition, these roosting sites will be overlooked by large high-rise developments and be impacted long-term, due to increase in numbers of residents and visitors, and increase in boating traffic.

The increased numbers of boats and visitors using the upgraded harbour and marina are also likely to access other less-developed areas of the Moreton Bay Ramsar site, such as North Stradbroke Island, creating broader impacts on native species within the Ramsar site.

The site and its surrounds also support important foraging habitat for green and loggerhead turtles, as well as dugongs, including 32.7 hectares of seagrass. Loss of this seagrass and increased recreational boat traffic are likely to have adverse impacts on turtles and dugongs within the Bay.

If the proposed action leads to a substantial increase in vessel traffic, there may be adverse impacts on whales and dolphins within Moreton Bay.

The referral does not address potential impacts on the adjacent coastal saltmarsh community (which is listed as vulnerable under the EPBC Act). While disturbed, this community is important as so much of it has already been lost.

It is not clear who will take responsibility for management actions in the longer term (operational phase), as the marina and residential sites will be sold to private owners.

The proponent has identified some of these risks but has not provided sufficient information on proposed management measures to assess whether they would be sufficient to mitigate the risks to habitat or life cycle of native species dependent upon the wetland and the potential impacts on the ecological character of the Moreton Bay Ramsar site.

**The proposed action will seriously disrupt the lifecycle of an ecologically significant proportion of the population of eastern curlews and bar-tailed godwits, as well as the listed migratory species whimbrels and grey-tailed tattlers, and may adversely affect populations of turtles and dugongs.**

***An invasive species that is harmful to the ecological character of the wetland being established or encouraging of existing invasive species***

The proposed action has a low risk of establishing new invasive species or encouraging existing invasive species.

**Conclusion**

On the basis of the available information, the proposed action is likely to result in substantially adverse impacts due to loss of areas of wetland, changes to the hydrological regime and physico-chemical status of the wetland and impacts on the habitat and life cycle of a number of species, including migratory shorebirds.

Although detailed project specification and/or environmental assessment has not been undertaken, the scale and nature of the action is such that a substantially adverse impact on the ecological character of the Moreton Bay Ramsar site is not only likely, but unavoidable. It is further concluded that impacts on the ecological character of the site, will be difficult to mitigate or offset.

Thus, on the basis of the available information, there is a real chance or possibility that there will be an adverse impact on the ecological character of the Moreton Bay Ramsar site as a result of the proposed action.

| | |
|---|---|
| **Advice prepared by:** | s22 |
| **Other DoEE areas consulted:** | Migratory Species |
| **Is OWS providing advice?** | No |
| **EACD Referral Officer:** | s22 |

Cleared by: s22, Director: Wetlands Section

Signature:....s22.......

Date: 22 May 2017.

Cleared by: Mark Taylor, Assistant Secretary: Wetlands, Policy and Northern Basin Branch

Signature: .................................................

Date: 22 May 2017

**Sources:**

- ArcGIS
- Moreton Bay Ramsar Information Sheet
- Draft ECD
- Environment Management Mapping Application
- Referral Documentation

## Location of Toondah Harbour proposal and Moreton Bay Ramsar site

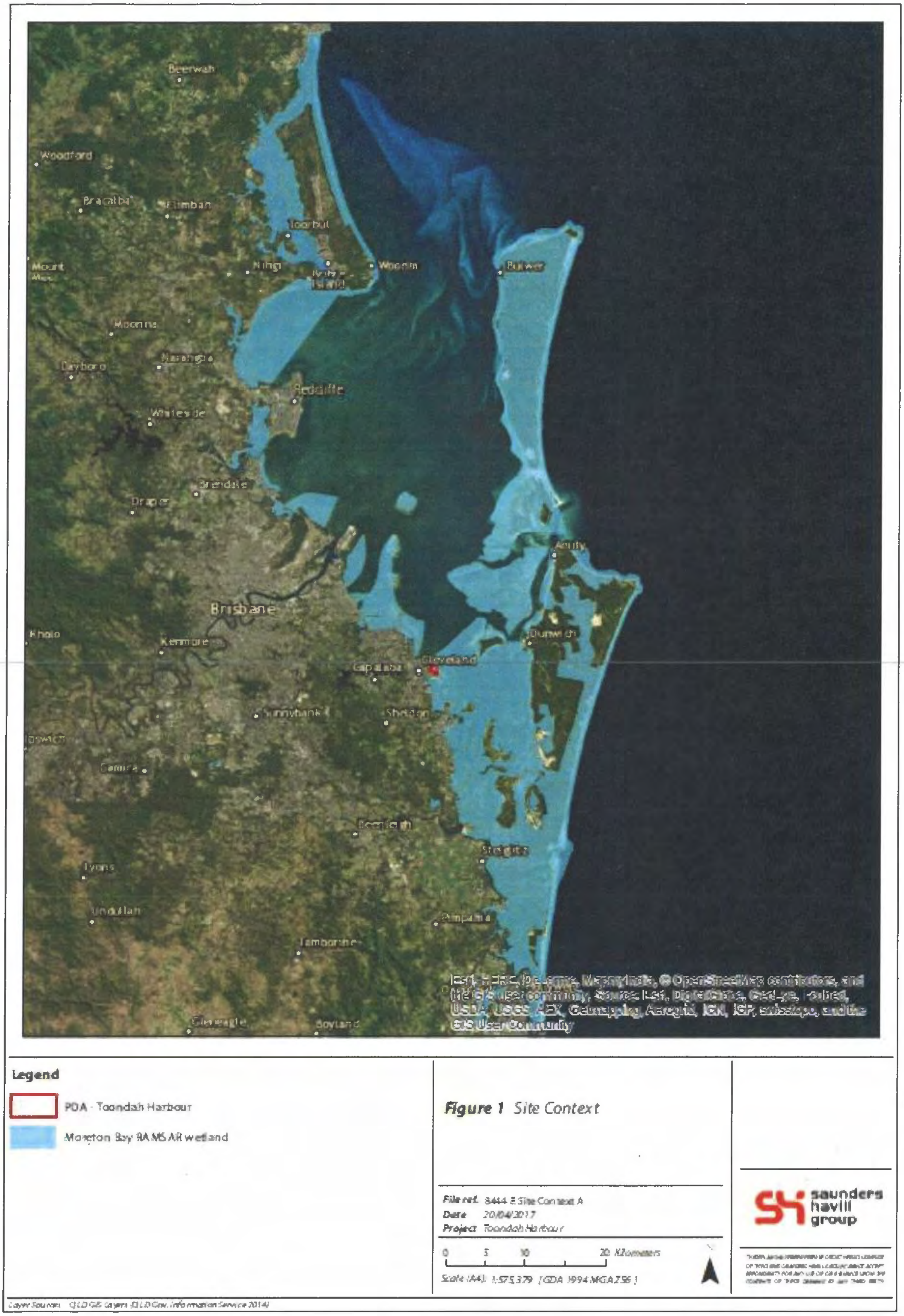

Figure 2

## Toondah Harbour proposal, Moreton Bay


**Legend**

- PDA - Toondah Harbour
- Referral Area
- Indicative Dredge Area

***Figure 2*** *Site Aerial*

***File ref.*** *8444 E Site Aerial E*
***Date*** *11/05/2017*
***Project*** *Toondah Harbour*

0 50 100 200 300 Meters

*Scale (A4): 1:8,000 (GDA 1994 MGA Z56)*

*Layer Sources: QLD GIS Layers (QLD Gov. Information Service 2014)*

Figure 3

## Boundary of Ramsar site in vicinity of Priority Development Area

Legend

QLD DSDIP EDQ PDA

Ramsar

FOI 180411
Document 14m

**Department of the Environment and Energy**

**Wildlife Heritage and Marine Division**

**EPBC Act Referral Advice from the Migratory Species Section**

**Toondah Harbour Project, QLD (EPBC 2017/7939)**

## Proposed action

The proposed action involves the filling in of marine areas for urban development and public open space, the excavation of a marina and the widening, deepening and lengthening of Fison Channel, which is the existing entrance channel to Toondah Harbour, on the foreshore of Moreton Bay about 30km southeast of Brisbane. The maximum development footprint (including land reclamation) is approximately 73 hectares with the reclamation component approximately 40 hectares.

The project involves:

- New ferry terminals to improve access to North Stradbroke Island;
- Mixed use development including (high rise) residential, retail, commercial and tourism uses;
- A marina;
- Public open space and boardwalks providing foreshore access;
- Dredging of the existing Toondah Harbour marine access (Fison Channel) to allow for safe navigation for all vessels; and
- Reclamation of areas within Moreton Bay

The project footprint contains intertidal and shallow subtidal habitats including: mangrove forests; intertidal and subtidal un-vegetated mudflats and sand banks; seagrass meadows; and subtropical coastal saltmarsh community.

## Migratory Birds

Moreton Bay supports more than 50,000 migratory waterbirds during their non-breeding season. At least 43 species of waterbirds use the intertidal habitats, including 30 migratory species listed on international conservation agreements. Moreton Bay is one of only two Ramsar sites in Australia that supports the critically endangered eastern curlew all year round, with juvenile birds not migrating until they are 2-3 years old. This means that the juveniles are residents in Moreton Bay until they reach maturity and are ready to migrate.

Migratory shorebirds need to maintain an energy intake greater than their energy expenditure to recover from the southward migration, and to build fat reserves in preparation for the northward migration. Relative amounts of time spent feeding and resting, and the distances between their feeding and roosting areas, are important factors in the energy budgets of individual shorebirds.

The Moreton Bay Ramsar site provides an important network of foraging and roosting habitats. Shorebirds move within these areas depending on the time of day, availability of resources, levels of disturbance and environmental conditions. Some habitats are important refuges during extreme high tides or when weather conditions prohibit occupancy of more commonly used habitats.

Because migratory shorebirds mostly feed on intertidal mudflats, they require safe roosting areas to rest during high tide periods. The high energy demands on migratory shorebirds resulting from their migratory lifecycle means that resting is critical when not breeding. Generally, migratory shorebirds prefer roosting areas in open habitat on slightly elevated ground so they can watch for potential predators.

The proposal is considered likely to result in adverse impacts to the EPBC listed eastern curlew (critically endangered; migratory), bar-tailed godwit (vulnerable/critically endangered; listed migratory), whimbrel (migratory) and grey-tailed tattler (migratory).

**Eastern curlew (*Numenius madagascariensis*) (EPBC Act critically endangered; migratory)**

Usually, eastern curlews feed singly or in loose flocks. Occasionally, this species is seen in large feeding flocks of hundreds (Marchant & Higgins, 1993). Moreton Bay Ramsar site is one of the most important areas for eastern curlew in Australia (maximum count 3,500 individuals on 1 January 1996). It remains internationally important all year round because of the high number of juvenile birds during the Austral winter.

Eastern curlew are sensitive to certain development activities due to their high site fidelity, tendency to aggregate, very high energy demands, and need for habitat networks containing both roosting and foraging sites (DotE 2015). The eastern curlew is extremely wary and will take flight at the first sign of danger, long before other nearby shorebirds become nervous. The minimum recommended distance between a disturbance event (stimuli) and important eastern curlew habitat is 200m. (http://www.avianbuffer.com/)

The proposed development will remove a substantial amount of foraging habitat of this species and impact two known roosting sites (Nandeebie claypan and offshore mangrove roost), one of which has recorded a maximum count of 180 individuals (Nandeebie claypan). The mosaic of roost sites and foraging sites should be maintained.

The proposed development will:

- reduce the area of occupancy of the species by removing a considerable area of foraging habitat.
- adversely affect important habitat critical to the survival of the species, such as roosting habitat (Nandeebie claypan and Mangrove roost)
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, such as the proximity of the residential development and tourism providing humans and animals with greater access to foraging and roosting areas, thus increasing stressors on the birds.
- result in invasive species that are harmful to a critically endangered species becoming established in the species' habitat by linking the offshore mangrove roost sites to the mainland.
- interfere with the recovery of the species by removing important habitat and causing increased disturbance.
- will seriously disrupt the lifecycle (feeding, migration and resting behaviour) of an ecologically significant proportion of a population of eastern curlew.

**Bar-tailed godwit (EPBC Act spp. *baueri* vulnerable; spp *menzbieri* critically endangered; listed migratory)**

The bar-tailed godwit (both subspecies combined) has been recorded in the coastal areas of all Australian states. Moreton Bay Ramsar site is likely to provide habitat for *Limosa lapponica baueri* (western Alaskan subspecies) but may also contain *Limosa lapponica menzbieri* (northern Siberian subspecies). In Australia, *L. l. baueri* mainly occur along the north and east coasts (Garnett et al.

2011) such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. The bar-tailed godwit (western Alaskan) usually forages near the edge of water or in shallow water, mainly in tidal estuaries and harbours. They prefer exposed sandy or soft mud substrates on intertidal flats, banks and beaches. The bar-tailed godwit (western Alaskan) usually roosts on sandy beaches, sandbars, spits and also in near-coastal saltmarsh (Higgins & Davies 1996).

Migratory shorebirds, such as the bar-tailed godwit (western Alaskan), are sensitive to certain development activities due to their: high site fidelity, tendency to aggregate, very high energy demands, and need for habitat networks containing both roosting and foraging sites (Department of the Environment 2015a,b). Threats in Australia, especially eastern and southern Australia, include ongoing human disturbance as well as habitat loss and degradation from pollution, changes to the water regime and invasive plants (Rogers et al. 2006; Garnett et al. 2011; Department of the Environment 2015a,b).

*Habitat loss and degradation*

In Australia, the loss of important habitat reduces the availability of foraging and roosting sites. This affects the ability of the birds to build up the energy stores required for successful migration and breeding. Some sites are important all year round for juveniles who may stay in Australia throughout the breeding season until they reach maturity. A variety of activities may cause habitat loss. These include direct losses through land clearing, inundation, infilling or draining. Indirect loss may occur due to changes in water quality, hydrology or structural changes near roosting sites (Department of the Environment 2015a,b). Anthropogenic nutrient enrichment of wetland areas can cause cyanobacterium blooms that may impact the prey species of bar-tailed godwits (e.g. at Roebuck Bay; Estrella et al. 2011).

*Disturbance*

Human disturbance can cause shorebirds to interrupt their feeding or roosting and may influence the area of otherwise suitable feeding or roosting habitat that is actually used. Disturbance from human recreation activities may force migratory shorebirds to increase the time devoted to vigilance and anti-predator behaviour and/or may compel the birds to move to alternative, less favourable feeding areas (Goss-Custard et al. 2006; Glover et al., 2011; Weston et al., 2012). Human disturbance can interrupt feeding and may restrict the area of feeding habitat available for bar-tailed godwits. Bar-tailed godwits (western Alaskan) at Phillip Island, Victoria, were recorded taking flight when humans approached within 10–70 m of them (Taylor & Bester 1999). The minimum recommended distance between a disturbance event (stimuli) and important bar-tailed godwit habitat is 50m. (http://www.avianbuffer.com/)

The proposed development will remove a substantial amount of foraging habitat of this species and impact two known roosting sites (Nandeebie claypan and offshore mangrove roost). The maximum count of bar-tailed godwits on Nandeebie claypan is 2,300 birds (approximately 20% of bar-tailed godwits recorded in Moreton Bay (Bamford et al. 2008)). Birds using the Nandeebie Claypan also use the nearby Oyster Point shoreline roost, moving between the two roost sites depending on the height of the tide and extent of disturbance at Oyster Point. The mosaic of roost sites and foraging sites should be maintained.

The proposed development will:

- reduce the area of occupancy of the species by removing a considerable area of foraging habitat.
- adversely affect important habitat critical to the survival of the species, such as roosting habitat (Nandeebie claypan, Oyster Point and Mangrove roost)
- modify, destroy, remove isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, such as the proximity of the residential development and tourism providing humans and animals with greater access to foraging and roosting areas, thus increasing stressors on the birds.
- interfere with the recovery of the species by removing important habitat and causing increased disturbance.
- will seriously disrupt the lifecycle (feeding, migration and resting behaviour) of an ecologically significant proportion of a population of bar-tailed godwit.

**Migratory shorebirds (whimbrel, grey-tailed tattler, bar-tailed godwit, eastern curlew)**

The proposed development is in an area of nationally important habitat for migratory shorebirds. At this site, >0.1% of the flyway population of eastern curlew, whimbrel, grey-tailed tattler and bar-tailed godwit occur, particularly at Nandeebie claypan and the Cassin Island roosting sites (see EPBC Act Policy Statement 3.21).

The proposed development:

- will substantially modify, destroy or isolate nationally important habitat for eastern curlew, whimbrel, grey-tailed tattler and bar-tailed godwit.
- could result in an invasive species that is harmful to listed migratory species becoming established in an area of important habitat by linking the offshore mangrove roost sites to the mainland (Cassin Island).
- will seriously disrupt the lifecycle (feeding, migration and resting behaviour) of an ecological significant proportion of the population of eastern curlew, whimbrel, grey-tailed tattler and bar-tailed godwit.

**Marine turtle**

Moreton Bay supports important foraging populations of green, hawksbill and loggerhead turtles and is close to the southern-most extent of their range. The area is considered a significant feeding ground for the green turtle (Australian Wetlands Database).

***Loggerhead turtle* (EPBC Act endangered; migratory)**

Loggerhead turtles in Australia are divided into two genetically distinct populations. Those found in Moreton Bay are part of the East Australian breeding stock (Limpus 2008) and are referred to as the loggerhead south-west Pacific stock (Recovery Plan for Marine Turtles in Australia, 2017). The *Marine Bioregional Plan for the Temperate East Marine Region* (2012) (bioregional plan) states that large concentrations of foraging loggerhead turtles have been found in Moreton Bay. Minor breeding aggregations occur in Moreton Bay, including Moreton Island and Stradbroke Island (Limpus 2008). The bioregional plan identifies the waters between Bustard Head QLD and Ballina in NSW as being biologically important for nesting loggerhead turtles. Moreton Bay forms the southern extent of their foraging range making this foraging population an important population.

Adults and large juvenile loggerhead turtles inhabit environments with both hard and soft substrata, including rocky and coral reefs, muddy bays, sand flats, estuaries and seagrass meadows (*Marine Bioregional Plan for the Temperate East Marine Region*, 2012). Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates including gastropod molluscs, clams and small amounts of jellyfish, starfish, corals, crabs and fish (SPRAT). In Moreton Bay, loggerhead turtles inhabit seagrass beds and are often found resting in channels.

Currently, the recovery plan (2017) identifies chemical and terrestrial discharge, vessel disturbance and habitat modification (through dredging/trawling and infrastructure/coastal development) as moderate threats for this species. The categorisation of these threats as moderate means that while they have not begun to reduce the population in their own right they are cumulatively acting with other threats to undermine population viability.

In addition, the Australian Government led the development of the Convention on the Conservation of Migratory Species (CMS) *Single Species Action Plan for Loggerhead Turtles (*Caretta caretta*) in the Pacific Ocean* (Loggerhead Plan). The Loggerhead Plan was unanimously adopted by the CMS Convention of the Parties in 2014 and calls on Australia to address threats to this population. The Loggerhead Plan identifies dredging and marina construction within foraging areas as a threat to the stock. In accordance with Australia's international obligations impacts to important loggerhead habitat in Moreton Bay should be minimised.

The proposed action is likely to reduce the area of occupancy of an important population of loggerhead turtles and may interfere with the recovery of the species. Adverse impacts to loggerhead turtles are considered likely.

***Green turtle* (EPBC Act vulnerable; migratory)**

Green turtles that occur in Moreton Bay are part of the southern Great Barrier Reef breeding stock (Recovery Plan for Marine Turtles in Australia, 2017). Important nesting sites for this stock generally occur from the Fraser Coast area north to the Capricornia Bunker Islands, however very low density nesting may occur on beaches in the Moreton Bay area.

Green turtles can be found in shallow waters where they forage principally on seagrass, algae and mangrove fruits, living in coral and rocky reefs, seagrass beds and algal mats. The *Marine Bioregional Plan for the Temperate East Marine Region* (2012) identifies Moreton Bay as being biologically important for foraging green turtles. The referral states that extensive areas of intertidal seagrass beds occur within and adjacent to the project footprint.

Currently, the recovery plan (2017) identifies light pollution, vessel disturbance and habitat modification (through dredging/trawling and infrastructure/coastal development) as moderate threats for this species. The categorisation of these threats as moderate means that while they have not begun to reduce the population in their own right they are cumulatively acting with other threats to undermine population viability.

The proposed action will result in the loss of important foraging habitat from dredging and reclamation activities. This will result in a reduced area of occupancy for an important population. Further, interactions with dredge vessels, construction and operational disturbance may lead to mortality of individuals within the population and changes to water quality may affect seagrass habitat outside the proposed footprint, thus reducing available foraging habitat further.

The project is also likely to facilitate activities that will adversely impact green turtles within the greater area such as disturbance from and collision with vessels and increased potential for the ingestion of marine debris. It is unclear if the project will result in additional ferry services which may also increase disturbance and the risk of vessel strike.

The proposed action is likely to reduce the area of occupancy of an important population of green turtle. Further, it is likely to modify, destroy, remove or isolate, or decrease the availability or quality of green turtle habitat to the extent that this important population is likely to decline. Adverse impacts to green turtles are considered likely.

***Hawksbill turtle* (EPBC Act vulnerable; migratory)**

Moreton Bay represents the southernmost extent of hawksbill distribution. Hawksbills forage in seagrass beds and coral reefs and as such may utilise areas within the proposed development. Hawksbills foraging in SE Queensland may be part of the north Queensland genetic stock, or may come from stocks nesting in other areas throughout the Pacific.

The proposed action may impact on a small number of foraging hawksbill turtles, but is unlikely to have an adverse impact on the north Queensland genetic stock, or other regional hawksbill stocks.

**Dugong (EPBC Act migratory)**

In Australia, dugongs occur from Shark Bay in Western Australia across the northern coastline to Moreton Bay in Queensland (Marsh, H., et al. (2011)).

In Moreton Bay, the eastern Amity Banks, Moreton Banks and areas adjacent to these sandbanks are considered the most important habitats with Rous Channel and east of South Passage also important in cooler months (SPRAT).

An assessment by Marsh et al (2011) on the status of the 'urban coast of Queensland' (Cooktown to Moreton Bay) dugong population indicates that this population meets the IUCN criteria for Critically Endangered. Delisle et al (2014) states that if the urban coast population is to recover it is essential that all anthropogenic sources of direct dugong mortality be minimised.

Dugongs are seagrass community specialists and the range of the dugong is broadly coincident with the distribution of seagrasses. There is also evidence that dugongs use specialised habitats for various activities, such as avoiding shark attack by resting on the edge of sandbanks (SPRAT).

Dugong have traits that make them susceptible to threats, including being long-lived with low reproductive potential, delayed sexual maturity, high female investment in each offspring, and a reliance on inshore habitats (GBRMPA 2014).

The Dugong Vulnerability Assessment for the GBR (GBRMPA 2014) identifies the following threats to the 'urban coast dugong management unit':

Incidental drowning in nets used by commercial fishing.

- Cumulative pressures to their primary food, seagrasses, from habitat loss and degradation as a result of extreme weather events (i.e. floods), coastal development (ports/mariners/harbours development and land reclamation), reduced water quality due to coastal development (ports/mariners/harbours operations and dredging).
- Increased occurrence of boat strike and disturbance.

- Ingestion of and entanglement in marine debris.
- Dugong face a variety of pressures that may reduce their resilience to current and future impacts of climate change and impede their capacity to adapt including, accelerated rates of climate change, depleted population, cumulative impacts of human related threats and a reduction of alternative habitats for foraging along the developing urban coast.

The proposed action is likely to substantially modify, destroy or isolate an area of important habitat for dugong; seriously disrupt the lifecycle of an ecologically significant proportion of a population of dugong. Adverse impacts to dugong are considered likely.

**Cetaceans**

***Southern right whale* (EPBC Act endangered; migratory)**

The core range of the southern right whale includes the coastal waters of southern Australia from Sydney to Perth, however they are known to occur further north with the extremities of their range recorded as far north as Hervey Bay in QLD (*Southern Right Whale recovery Plan 2012), and are known to visit Moreton Bay (Department of National Parks, Sport and Racing). Within their range they generally occur within two km off shore.

Preliminary data suggests that the south-eastern and south-western Australian whales may represent distinct genetic stocks. Southern right whales in south-western Australia appear to be increasing at the maximum biological rate, however there is limited evidence of increase in south-eastern waters (Recovery Plan 2012).

High risk threats identified in the Recovery Plan (2012) include:

- Vessel collision.
- Noise interference – loud noise or long exposure may lead to avoidance of important habitat areas. Potential forms of noise interference include industrial noise such as pile driving and dredging, and vessel noise.
- Habitat modification – through the development of infrastructure such as ports and marinas could lead to the displacement of whales from preferred habitat or disruption to behaviour.

The Recovery Plan (2012) states that vessel collision is greater for the southern right whale when they are in costal zones due to the higher probability of encountering vessels and that as shipping traffic increases '*the impact on an individual, especially in south east Australia, is likely to have a significant, potentially population-scale effect, if further evidence confirms this as a small demographically discrete population*'.

Southern right whales appear to be the primary whales species involved in vessel collision in the southern hemisphere (Van Waerebeek et al, 2007). According to media reports (http://www.abc.net.au/news/2014-08-17/whale-washes-up-in-moreton-bay-with-propeller-cuts-to-head/5676732 ) a southern right whale was killed in 2014 when it was struck by a ferry travelling between the existing Toondah harbour and Stradbroke Island.

In conclusion the proposed development may:

- Reduce the area of occupancy of the species: The proposed action may result in the disturbance and interference of whales due to an increase in vessel traffic and pilling

activities. Southern right whales that occur in Moreton Bay are part of a population that is at the limit of the species range.
- Interfere with the recovery of the species: A potential increase in ferry traffic is likely to increase the risk of vessel collision to the southern right whale.

There is insufficient information in the referral to understand the potential threats to this species, especially the risks associated with increased vessel traffic. The proposed action may result in adverse impacts to the southern right whale.

* The Conservation Management Plan for the Southern Right Whale is recognised as a Recovery Plan under section 269A of the EPBC Act.

***Humpback Whale*** **(EPBC Act vulnerable; migratory)**

Humpback whales are frequent visitors to Moreton Bay as they migrate from the southern feeding grounds to breed in warmer waters. The *Marine Bioregional Plan for the Temperate East Marine Region* (2012) identifies Moreton Bay as being biologically important for migration, peaking in June–July (northbound) and August– mid-October (southbound). Resting females and calves can be present from August –October.

Threats identified in the Humpback Whale Conservation Advice (2015) include:

- Noise Interference – e.g. industrial noise (pile driving, some forms of dredging, use of explosives, blasting and drilling) and shipping noise;
- Habitat degradation including coastal development and port expansion; and
- Vessel disturbance and strike.

The referral lacks sufficient information to understand the expected increase of vessel traffic and how this might impacts on migrating or resting humpback whales. There is also insufficient information on the expected level of noise in the marine environment.

In the absence of adequate information, it is likely that the action will increase the likelihood of vessel disturbance and strike, and increase the level of anthropogenic noise, at times when humpback whales are present in Moreton Bay.

**Dolphin**

*Indo-Pacific humpback dolphin* (EPBC listed Migratory)

Indo-Pacific humpback dolphins are found in coastal and estuarine areas of Queensland and New South Wales, generally at depths less than 20 m, including inshore reefs, tidal and dredged channels, mangroves and river mouths (SPRAT).

The *Marine Bioregional Plan for the Temperate East Marine Region* (2012) identifies the waters off Cooloola National Park to the New South Wales border (including Moreton Bay) within the 20 m depth contour as being biologically important for foraging and breeding Indo-Pacific humpback dolphins.

The Plan states that pressures of concern for inshore dolphins in this region include physical habitat modification while pressures of potential concern include noise pollution and collision with vessels.

The referral lacks sufficient information to determine the presence of this species in the local and greater region and the potential impacts.

*Australian snubfin dolphin* (EPBC listed migratory) *dusky dolphin* (EPBC listed Migratory)

The Australian snubfin dolphin occur in coastal water off the northern half of Australia, including as far south as the Brisbane River on the east coast. This species shares similar habitat preferences as the Indo-Pacific humpback dolphins (SPRAT). While the dusky dolphin may occur in Moreton Bay, it is primarily found in temperate and sub-Antarctic waters. Adverse impacts are considered unlikely.

The referral lacks sufficient information to determine the presence of these species in the local and greater region and the potential impacts.

Advice prepared by: [redacted] (x [redacted]), [redacted] (x [redacted]), [redacted] (x [redacted]).

Checked by: [redacted], Director Migratory Species Section

Cleared by: Geoff Richardson, Assistant Secretary Protected Species and Communities Branch.

Signature:.........................................

Date: 23/5/17

**References**


- Australian Wetlands Database- Moreton Bay RAMSAR Site https://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=41
- Conservation Management Plan for the Southern Right Whale – A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* – (2011- 2021).
- Department of National Parks, Sport and Racing (QLD) http://www.nprsr.qld.gov.au/parks/moreton-bay/culture.html
- Humpback Whale Conservation Advice (2015) http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf
- *Marine Bioregional Plan for the Temperate East Marine Region* (2012)
- Marsh, H., et al. (2011). *Ecology and Conservation of the Sirenia. Dugong and Sirenia* Cambridge, University Press.
- Species Profile and Threat Database (SPRAT)
- Van Waerebeek et al (2007) Vessel collision s with small cetaceans worldwide and large whales in the Southern Hemisphere, and initial assessment, Latin American Journal of Aquatic Mammals.

- Great Barrier Reef Marne Park Authority: Vulnerability Assessment for the GBR – Dugong (2014)
http://elibrary.gbrmpa.gov.au/jspui/bitstream/11017/2867/1/gbrmpa_VA_Dugong_15%20September%202014_final.pdf

Queensland Government
Department of
**Environment and Heritage Protection**

Ref CTS 101/0003868-005

22 May 2017

s22 [redacted]
Queensland Major Projects Section
Assessments (Qld, Tas, Vic) & Policy Implementation Branch
Department of the Environment and Energy
GPO Box 787
CANBERRA ACT 2601

Dear s22 [redacted]

**Invitation to comment on referral EPBC 2017/7939 – Toondah Harbour Development, Qld**

Thank you for your letter dated 11 May 2017 requesting advice on whether the above action will be assessed in a manner described in Schedule 1 of the Agreement between the Commonwealth of Australia and the State of Queensland (the Bilateral Agreement) developed under Section 45 of the *Environment Protection and Biodiversity Conservation Act 1999*.

I advise the proposal will not be assessed using the EIS process in chapter 3 of the *Environmental Protection Act 1994*.

The Department of State Development has reviewed the referral documentation and advised that the Coordinator-General has not received a request for declaration of this proposal as a coordinated project under Part 4 of the *State Development and Public Works Organisation Act 1971*.

The Department of Infrastructure, Local Government and Planning has not advised that the proposed development will be assessed under Chapter 9, Part 2 of the *Sustainable Planning Act 2009*.

Should you have any further enquiries, please contact me on telephone (07) 3330 s22 [redacted]

Yours sincerely

s22 [redacted]

**Director, Impact Assessment and Operational Support**



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intranet
DEPARTMENT OF THE ENVIRONMENT AND ENERGY

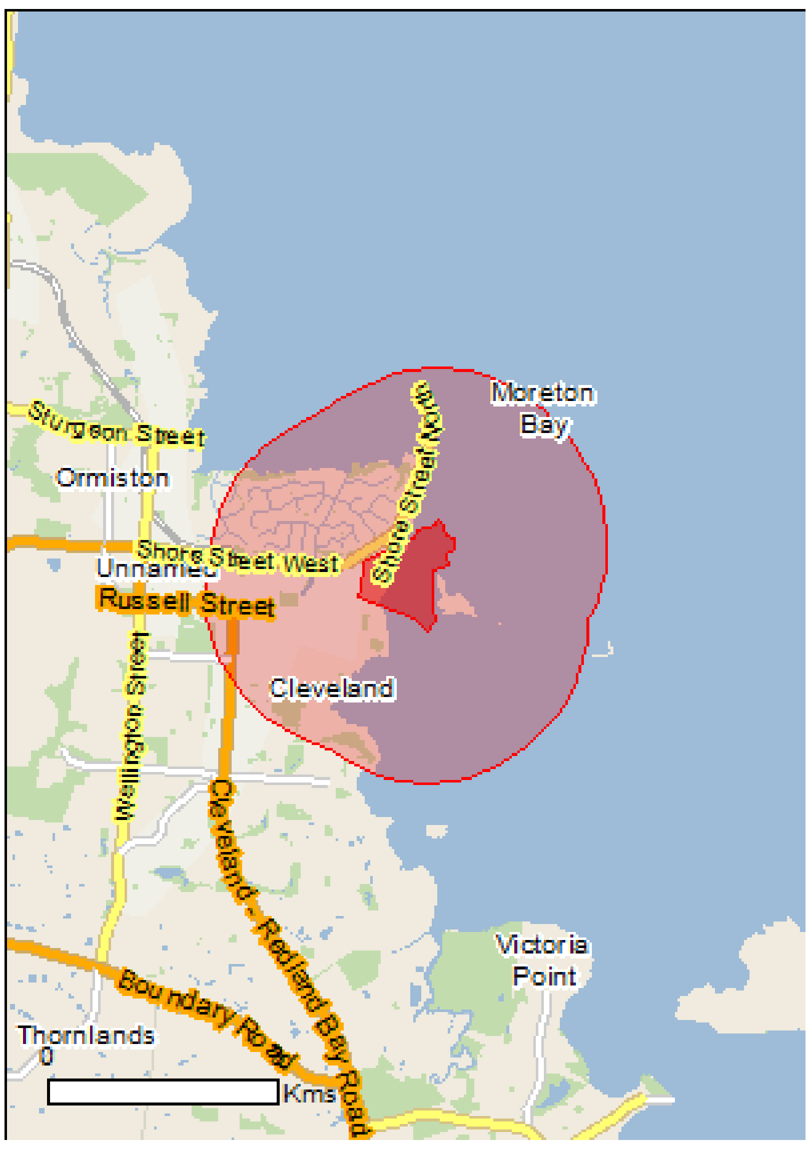
FOI 180411
Document 14o

# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 11/05/17 14:12:08





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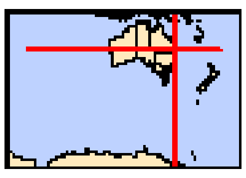

# Summary

## Matters of National Environment Significance

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance: | 1 |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | None |
| Listed Threatened Ecological Communities: | 1 |
| Listed Threatened Species: | 57 |
| Listed Migratory Species: | 72 |

## Other Matters Protected by the EPBC Act

| | |
|---|---|
| Commonwealth Land: | None |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 111 |
| Whales and Other Cetaceans: | 14 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Commonwealth Reserves Marine: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| State and Territory Reserves: | None |
| Regional Forest Agreements: | None |
| Invasive Species: | 36 |
| Nationally Important Wetlands: | 1 |
| EPBC Act Referrals: | 8 |
| Key Ecological Features (Marine) | None |

# Details

## Matters of National Environmental Significance

| Wetlands of International Importance (Ramsar) | [ Resource Information ] |
|---|---|
| Name | Proximity |
| Moreton bay | Within Ramsar site |

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Subtropical and Temperate Coastal Saltmarsh | Vulnerable | Community likely to occur within area |

### Listed Threatened Species [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| **Birds** | | |
| Anthochaera phrygia | | |
| Regent Honeyeater [82338] | Critically Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Botaurus poiciloptilus | | |
| Australasian Bittern [1001] | Endangered | Species or species habitat known to occur within area |
| Calidris canutus | | |
| Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea | | |
| Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris tenuirostris | | |
| Great Knot [862] | Critically Endangered | Roosting known to occur within area |
| Charadrius leschenaultii | | |
| Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Roosting known to occur within area |
| Charadrius mongolus | | |
| Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Dasyornis brachypterus | | |
| Eastern Bristlebird [533] | Endangered | Species or species habitat may occur within area |
| Diomedea antipodensis | | |
| Antipodean Albatross [64458] | Vulnerable | Species or species habitat may occur within area |
| Diomedea antipodensis  gibsoni | | |
| Gibson's Albatross [82270] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans | | |
| Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |
| Erythrotriorchis radiatus | | |
| Red Goshawk [942] | Vulnerable | Species or species habitat likely to occur within area |
| Fregetta grallaria  grallaria | | |
| White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438] | Vulnerable | Species or species habitat likely to occur within area |
| Lathamus discolor | | |
| Swift Parrot [744] | Critically Endangered | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Limosa lapponica  baueri<br>Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380] | Vulnerable | Species or species habitat known to occur within area |
| Limosa lapponica  menzbieri<br>Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432] | Critically Endangered | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur  subantarctica<br>Fairy Prion (southern) [64445] | Vulnerable | Species or species habitat likely to occur within area |
| Poephila cincta  cincta<br>Southern Black-throated Finch [64447] | Endangered | Species or species habitat may occur within area |
| Pterodroma neglecta  neglecta<br>Kermadec Petrel (western) [64450] | Vulnerable | Foraging, feeding or related behaviour may occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area |
| Thalassarche cauta  cauta<br>Shy Albatross, Tasmanian Shy Albatross [82345] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta  steadi<br>White-capped Albatross [82344] | Vulnerable | Foraging, feeding or related behaviour likely to occur within area |
| Thalassarche eremita<br>Chatham Albatross [64457] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Species or species habitat may occur within area |
| Turnix melanogaster<br>Black-breasted Button-quail [923] | Vulnerable | Species or species habitat likely to occur within area |
| Fish | | |
| Epinephelus daemelii<br>Black Rockcod, Black Cod, Saddled Rockcod [68449] | Vulnerable | Species or species habitat may occur within area |
| Mammals | | |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Species or species habitat may occur within area |
| Chalinolobus dwyeri<br>Large-eared Pied Bat, Large Pied Bat [183] | Vulnerable | Species or species habitat may occur within area |
| Dasyurus maculatus  maculatus (SE mainland population)<br>Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat may occur within |

| Name | Status | Type of Presence |
|---|---|---|
| | | area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Congregation or aggregation known to occur within area |
| Petauroides volans<br>Greater Glider [254] | Vulnerable | Species or species habitat may occur within area |
| Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)<br>Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104] | Vulnerable | Species or species habitat known to occur within area |
| Pteropus poliocephalus<br>Grey-headed Flying-fox [186] | Vulnerable | Roosting known to occur within area |
| Xeromys myoides<br>Water Mouse, False Water Rat, Yirrkoo [66] | Vulnerable | Species or species habitat likely to occur within area |
| **Plants** | | |
| Arthraxon hispidus<br>Hairy-joint Grass [9338] | Vulnerable | Species or species habitat may occur within area |
| Cryptocarya foetida<br>Stinking Cryptocarya, Stinking Laurel [11976] | Vulnerable | Species or species habitat may occur within area |
| Cryptostylis hunteriana<br>Leafless Tongue-orchid [19533] | Vulnerable | Species or species habitat may occur within area |
| Phaius australis<br>Lesser Swamp-orchid [5872] | Endangered | Species or species habitat likely to occur within area |
| Samadera bidwillii<br>Quassia [29708] | Vulnerable | Species or species habitat likely to occur within area |
| Thesium australe<br>Austral Toadflax, Toadflax [15202] | Vulnerable | Species or species habitat may occur within area |
| **Reptiles** | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Delma torquata<br>Adorned Delma, Collared Delma [1656] | Vulnerable | Species or species habitat may occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| **Sharks** | | |
| Carcharias taurus (east coast population)<br>Grey Nurse Shark (east coast population) [68751] | Critically Endangered | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat known to occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Breeding may occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Species or species habitat may occur within area |

## Listed Migratory Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| **Migratory Marine Birds** | | |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat likely to occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat may occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat known to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [1043] | | Species or species habitat likely to occur within area |
| Sterna albifrons<br>Little Tern [813] | | Species or species habitat may occur within area |
| Thalassarche cauta<br>Tasmanian Shy Albatross [89224] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| **Migratory Marine Species** | | |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat may occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Species or species habitat may occur within area |
| Carcharodon carcharias<br>White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat known to occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Dugong dugon<br>Dugong [28] | | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat may occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat known to occur within area |
| Manta alfredi<br>Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994] | | Species or species habitat may occur within area |
| Manta birostris<br>Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Congregation or aggregation known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Orcaella brevirostris<br>Irrawaddy Dolphin [45] | | Species or species habitat likely to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Breeding may occur within area |
| Rhincodon typus<br>Whale Shark [66680] | Vulnerable | Species or species habitat may occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Breeding known to occur within area |
| Migratory Terrestrial Species | | |
| Cuculus optatus<br>Oriental Cuckoo, Horsfield's Cuckoo [86651] | | Species or species habitat known to occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| Monarcha trivirgatus<br>Spectacled Monarch [610] | | Species or species habitat likely to occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat likely to occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | | Roosting known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Roosting known to occur within area |
| Calidris alba<br>Sanderling [875] | | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat likely to occur within area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area |
| Calidris tenuirostris<br>Great Knot [862] | Critically Endangered | Roosting known to occur within area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Roosting known to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Charadrius veredus<br>Oriental Plover, Oriental Dotterel [882] | | Roosting known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Roosting known to occur within area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting likely to occur within area |
| Heteroscelus brevipes<br>Grey-tailed Tattler [59311] | | Roosting known to occur within area |
| Heteroscelus incanus<br>Wandering Tattler [59547] | | Roosting known to occur within area |
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area |
| Limnodromus semipalmatus<br>Asian Dowitcher [843] | | Roosting known to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | | Roosting known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting known to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Philomachus pugnax<br>Ruff (Reeve) [850] | | Roosting known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | | Roosting known to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Roosting known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |
| Xenus cinereus<br>Terek Sandpiper [59300] | | Roosting known to occur within area |

## Other Matters Protected by the EPBC Act

### Listed Marine Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat likely to occur within area |
| Anseranas semipalmata<br>Magpie Goose [978] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea alba<br>Great Egret, White Egret [59541] | | Breeding known to occur within area |
| Ardea ibis<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| Arenaria interpres<br>Ruddy Turnstone [872] | | Roosting known to occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Roosting known to occur within area |
| Calidris alba<br>Sanderling [875] | | Roosting known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species habitat likely to occur within area |
| Calidris ruficollis<br>Red-necked Stint [860] | | Roosting known to occur within area |
| Calidris tenuirostris<br>Great Knot [862] | Critically Endangered | Roosting known to occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat may occur within area |
| Charadrius bicinctus<br>Double-banded Plover [895] | | Roosting known to occur within area |
| Charadrius leschenaultii<br>Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Roosting known to occur within area |
| Charadrius mongolus<br>Lesser Sand Plover, Mongolian Plover [879] | Endangered | Roosting known to occur within area |
| Charadrius ruficapillus<br>Red-capped Plover [881] | | Roosting known to occur within area |
| Charadrius veredus<br>Oriental Plover, Oriental Dotterel [882] | | Roosting known to occur within area |
| Cuculus saturatus<br>Oriental Cuckoo, Himalayan Cuckoo [710] | | Species or species habitat known to occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |
| Diomedea gibsoni<br>Gibson's Albatross [64466] | Vulnerable* | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat known to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Roosting known to occur within area |
| Gallinago megala<br>Swinhoe's Snipe [864] | | Roosting likely to occur within area |
| Gallinago stenura<br>Pin-tailed Snipe [841] | | Roosting likely to occur within area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat known to occur within area |
| Heteroscelus brevipes<br>Grey-tailed Tattler [59311] | | Roosting known to occur within area |
| Heteroscelus incanus<br>Wandering Tattler [59547] | | Roosting known to occur within area |
| Himantopus himantopus<br>Black-winged Stilt [870] | | Roosting known to occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Limicola falcinellus<br>Broad-billed Sandpiper [842] | | Roosting known to occur within area |
| Limnodromus semipalmatus<br>Asian Dowitcher [843] | | Roosting known to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | | Roosting known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| Monarcha trivirgatus<br>Spectacled Monarch [610] | | Species or species habitat likely to occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Numenius minutus<br>Little Curlew, Little Whimbrel [848] | | Roosting known to occur within area |
| Numenius phaeopus<br>Whimbrel [849] | | Roosting known to occur within area |
| Pachyptila turtur<br>Fairy Prion [1066] | | Species or species habitat likely to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Philomachus pugnax<br>Ruff (Reeve) [850] | | Roosting known to occur within area |
| Pluvialis fulva<br>Pacific Golden Plover [25545] | | Roosting known to occur within area |
| Pluvialis squatarola<br>Grey Plover [865] | | Roosting known to occur within area |
| Puffinus carneipes<br>Flesh-footed Shearwater, Fleshy-footed Shearwater [1043] | | Species or species habitat likely to occur within area |
| Recurvirostra novaehollandiae<br>Red-necked Avocet [871] | | Roosting known to occur within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat likely to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Endangered* | Species or species habitat likely to occur within area |
| Sterna albifrons<br>Little Tern [813] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Thalassarche cauta<br>Tasmanian Shy Albatross [89224] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche eremita<br>Chatham Albatross [64457] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable* | Foraging, feeding or related behaviour likely to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Roosting known to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Roosting known to occur within area |
| Xenus cinereus<br>Terek Sandpiper [59300] | | Roosting known to occur within area |
| Fish | | |
| Acentronura tentaculata<br>Shortpouch Pygmy Pipehorse [66187] | | Species or species habitat may occur within area |
| Campichthys tryoni<br>Tryon's Pipefish [66193] | | Species or species habitat may occur within area |
| Corythoichthys amplexus<br>Fijian Banded Pipefish, Brown-banded Pipefish [66199] | | Species or species habitat may occur within area |
| Corythoichthys ocellatus<br>Orange-spotted Pipefish, Ocellated Pipefish [66203] | | Species or species habitat may occur within area |
| Festucalex cinctus<br>Girdled Pipefish [66214] | | Species or species habitat may occur within area |
| Filicampus tigris<br>Tiger Pipefish [66217] | | Species or species habitat may occur within area |
| Halicampus grayi<br>Mud Pipefish, Gray's Pipefish [66221] | | Species or species habitat may occur within area |
| Hippichthys cyanospilos<br>Blue-speckled Pipefish, Blue-spotted Pipefish [66228] | | Species or species habitat may occur within area |
| Hippichthys heptagonus<br>Madura Pipefish, Reticulated Freshwater Pipefish [66229] | | Species or species habitat may occur within area |
| Hippichthys penicillus<br>Beady Pipefish, Steep-nosed Pipefish [66231] | | Species or species habitat may occur within area |
| Hippocampus kelloggi<br>Kellogg's Seahorse, Great Seahorse [66723] | | Species or species habitat may occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Hippocampus kuda<br>Spotted Seahorse, Yellow Seahorse [66237] | | Species or species habitat may occur within area |
| Hippocampus planifrons<br>Flat-face Seahorse [66238] | | Species or species habitat may occur within area |
| Hippocampus trimaculatus<br>Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720] | | Species or species habitat may occur within area |
| Hippocampus whitei<br>White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240] | | Species or species habitat may occur within area |
| Lissocampus runa<br>Javelin Pipefish [66251] | | Species or species habitat may occur within area |
| Maroubra perserrata<br>Sawtooth Pipefish [66252] | | Species or species habitat may occur within area |
| Micrognathus andersonii<br>Anderson's Pipefish, Shortnose Pipefish [66253] | | Species or species habitat may occur within area |
| Micrognathus brevirostris<br>thorntail Pipefish, Thorn-tailed Pipefish [66254] | | Species or species habitat may occur within area |
| Microphis manadensis<br>Manado Pipefish, Manado River Pipefish [66258] | | Species or species habitat may occur within area |
| Solegnathus dunckeri<br>Duncker's Pipehorse [66271] | | Species or species habitat may occur within area |
| Solegnathus hardwickii<br>Pallid Pipehorse, Hardwick's Pipehorse [66272] | | Species or species habitat may occur within area |
| Solegnathus spinosissimus<br>Spiny Pipehorse, Australian Spiny Pipehorse [66275] | | Species or species habitat may occur within area |
| Solenostomus cyanopterus<br>Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183] | | Species or species habitat may occur within area |
| Solenostomus paegnius<br>Rough-snout Ghost Pipefish [68425] | | Species or species habitat may occur within area |
| Solenostomus paradoxus<br>Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184] | | Species or species habitat may occur within area |
| Stigmatopora nigra<br>Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277] | | Species or species habitat may occur within area |
| Syngnathoides biaculeatus<br>Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279] | | Species or species habitat may occur within area |
| Trachyrhamphus bicoarctatus<br>Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280] | | Species or species habitat may occur within area |
| Urocampus carinirostris<br>Hairy Pipefish [66282] | | Species or species habitat may occur within area |
| Vanacampus margaritifer<br>Mother-of-pearl Pipefish [66283] | | Species or species habitat may occur within area |
| Mammals | | |
| Dugong dugon<br>Dugong [28] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat known to occur within area |
| Reptiles | | |
| Aipysurus laevis<br>Olive Seasnake [1120] | | Species or species habitat may occur within area |
| Astrotia stokesii<br>Stokes' Seasnake [1122] | | Species or species habitat may occur within area |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Breeding known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Hydrophis elegans<br>Elegant Seasnake [1104] | | Species or species habitat may occur within area |
| Laticauda laticaudata<br>a sea krait [1093] | | Species or species habitat may occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Species or species habitat known to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Pelamis platurus<br>Yellow-bellied Seasnake [1091] | | Species or species habitat may occur within area |

## Whales and other Cetaceans [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Mammals | | |
| Balaenoptera acutorostrata<br>Minke Whale [33] | | Species or species habitat may occur within area |
| Balaenoptera edeni<br>Bryde's Whale [35] | | Species or species habitat may occur within area |
| Balaenoptera musculus<br>Blue Whale [36] | Endangered | Species or species habitat may occur within area |
| Delphinus delphis<br>Common Dophin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area |
| Eubalaena australis<br>Southern Right Whale [40] | Endangered | Species or species habitat likely to occur within area |
| Grampus griseus<br>Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area |
| Lagenorhynchus obscurus<br>Dusky Dolphin [43] | | Species or species habitat may occur within area |
| Megaptera novaeangliae<br>Humpback Whale [38] | Vulnerable | Congregation or aggregation known to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Orcaella brevirostris<br>Irrawaddy Dolphin [45] | | Species or species habitat likely to occur within area |
| Orcinus orca<br>Killer Whale, Orca [46] | | Species or species habitat may occur within area |
| Sousa chinensis<br>Indo-Pacific Humpback Dolphin [50] | | Breeding known to occur within area |
| Stenella attenuata<br>Spotted Dolphin, Pantropical Spotted Dolphin [51] | | Species or species habitat may occur within area |
| Tursiops aduncus<br>Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area |
| Tursiops truncatus s. str.<br>Bottlenose Dolphin [68417] | | Species or species habitat may occur within area |

# Extra Information

## Invasive Species [ Resource Information ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Acridotheres tristis<br>Common Myna, Indian Myna [387] | | Species or species habitat likely to occur within area |
| Anas platyrhynchos<br>Mallard [974] | | Species or species habitat likely to occur within area |
| Carduelis carduelis<br>European Goldfinch [403] | | Species or species habitat likely to occur within area |
| Columba livia<br>Rock Pigeon, Rock Dove, Domestic Pigeon [803] | | Species or species habitat likely to occur within area |
| Lonchura punctulata<br>Nutmeg Mannikin [399] | | Species or species habitat likely to occur within area |
| Passer domesticus<br>House Sparrow [405] | | Species or species habitat likely to occur within area |
| Streptopelia chinensis<br>Spotted Turtle-Dove [780] | | Species or species habitat likely to occur within area |
| Sturnus vulgaris<br>Common Starling [389] | | Species or species habitat likely to occur within area |
| Frogs | | |
| Rhinella marina<br>Cane Toad [83218] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Mammals | | |
| Bos taurus<br>Domestic Cattle [16] | | Species or species habitat likely to occur within area |
| Canis lupus  familiaris<br>Domestic Dog [82654] | | Species or species habitat likely to occur within area |
| Felis catus<br>Cat, House Cat, Domestic Cat [19] | | Species or species habitat likely to occur within area |
| Lepus capensis<br>Brown Hare [127] | | Species or species habitat likely to occur within area |
| Mus musculus<br>House Mouse [120] | | Species or species habitat likely to occur within area |
| Oryctolagus cuniculus<br>Rabbit, European Rabbit [128] | | Species or species habitat likely to occur within area |
| Rattus norvegicus<br>Brown Rat, Norway Rat [83] | | Species or species habitat likely to occur within area |
| Rattus rattus<br>Black Rat, Ship Rat [84] | | Species or species habitat likely to occur within area |
| Sus scrofa<br>Pig [6] | | Species or species habitat likely to occur within area |
| Vulpes vulpes<br>Red Fox, Fox [18] | | Species or species habitat likely to occur within area |
| Plants | | |
| Alternanthera philoxeroides<br>Alligator Weed [11620] | | Species or species habitat likely to occur within area |
| Anredera cordifolia<br>Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643] | | Species or species habitat likely to occur within area |
| Asparagus aethiopicus<br>Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425] | | Species or species habitat likely to occur within area |
| Cabomba caroliniana<br>Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171] | | Species or species habitat likely to occur within area |
| Chrysanthemoides monilifera<br>Bitou Bush, Boneseed [18983] | | Species or species habitat may occur within area |
| Chrysanthemoides monilifera subsp. rotundata<br>Bitou Bush [16332] | | Species or species habitat likely to occur within area |
| Cryptostegia grandiflora<br>Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913] | | Species or species habitat likely to occur within area |
| Eichhornia crassipes<br>Water Hyacinth, Water Orchid, Nile Lily [13466] | | Species or species habitat likely to occur within area |
| Hymenachne amplexicaulis<br>Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754] | | Species or species habitat likely to occur within area |
| Lantana camara<br>Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Parthenium hysterophorus | | |
| Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566] | | Species or species habitat likely to occur within area |
| Protasparagus densiflorus | | |
| Asparagus Fern, Plume Asparagus [5015] | | Species or species habitat likely to occur within area |
| Sagittaria platyphylla | | |
| Delta Arrowhead, Arrowhead, Slender Arrowhead [68483] | | Species or species habitat likely to occur within area |
| Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii | | |
| Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497] | | Species or species habitat likely to occur within area |
| Salvinia molesta | | |
| Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665] | | Species or species habitat likely to occur within area |
| Senecio madagascariensis | | |
| Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624] | | Species or species habitat likely to occur within area |
| Reptiles | | |
| Hemidactylus frenatus | | |
| Asian House Gecko [1708] | | Species or species habitat likely to occur within area |

## Nationally Important Wetlands

[ Resource Information ]

| Name | State |
|---|---|
| Moreton Bay | QLD |

## EPBC Act Referrals

[ Resource Information ]

Further details about the referral or advice - including its current status if still active - are available in its PINK report; click on the title.

| Title | Reference | Referral Outcome | Assessment Status |
|---|---|---|---|
| Referral | | | |
| Eprapah Heights Bushland Residential Subdivision | 2001/286 | NCA | Referral Decision Made-Completed |
| Prawn Aquaculture Enterprise Expansion | 2001/294 | NCA | Referral Decision Made-Completed |
| Eddie Santagiuliana Way Boardwalk | 2005/2049 | NCA | Referral Decision Made-Completed |
| establishment of a car wash and service station facility on Lot 12 RP 57455 | 2005/2077 | NCA | Referral Decision Made-Completed |
| Residential estate Bunker Rd | 2005/2130 | NCA | Referral Decision Made-Completed |
| works within the Black Swamp | 2005/2334 | NCA | Referral Decision Made-Completed |
| Breeding program for Grey Nurse Sharks | 2007/3245 | | Withdrawn-Completed |
| Toondah Harbour Project, Moreton Bay, Qld | 2015/7612 | | Withdrawn-Close |

# Caveat
The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods.  Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc).  In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates
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# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environment and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-Forestry Corporation of NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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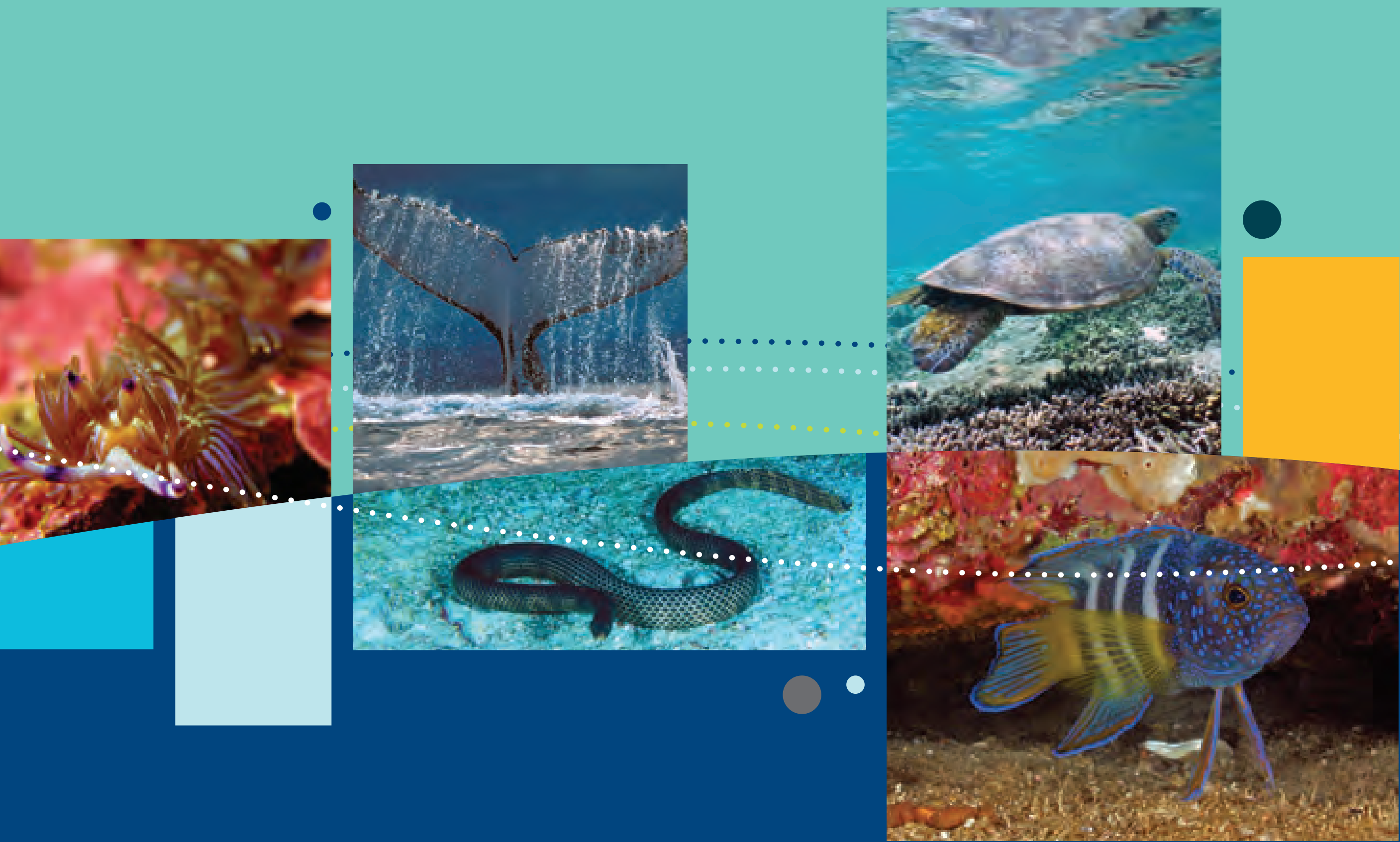


# Marine bioregional plan for the Temperate East Marine Region

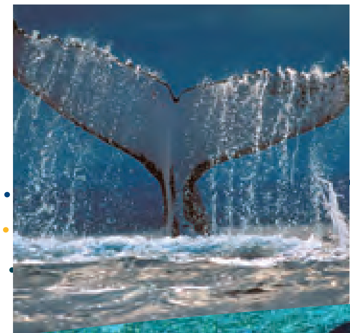
prepared under the *Environment Protection and Biodiversity Conservation Act 1999*

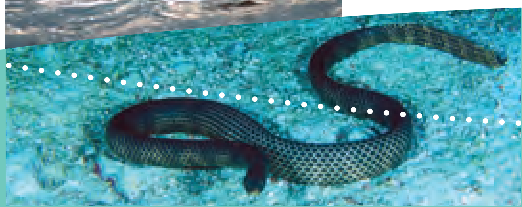
**Disclaimer**



Images:
A Green turtle swims in shallows over reef top – GBRMPA, Blue Devil – D.Harasti, Nudibranch – M.Lawrence, Dubois' Sea Snake – GBRMPA, Whale tail – D.Paton, Olive sea snake searching for food over coral and algae – GBRMPA, Flesh-footed shearwater and Balls Pyramid – I.Hutton, Runic wreck on Middleton Reef – Director of National Parks, Black-browed Albatross – M.Double, Acropora species – R.Chesher Ph.D, Red Sea Star – M.Lawrence

Australian Government
Department of Sustainability, Environment,
Water, Population and Communities




# Marine bioregional plan for the Temperate East Marine Region

prepared under the *Environment Protection and Biodiversity Conservation Act 1999*

# MINISTERIAL FOREWORD

## Temperate East Marine Bioregional Plan

For generations, Australians have enjoyed a unique relationship with the sea.

Our oceans play a massive role in Australian life – they provide us with fish to eat, a place to fish, business and tourism opportunities and a place for families to enjoy.

Australians know, better than anyone, how important it is that our oceans remain healthy and sustainable.

Right now, our iconic marine environment is coming under more and more pressure from industry, from pollution and, increasingly, from climate change.

That is why the Australian Government has committed to creating a network of Commonwealth marine reserves around the country. We will protect our precious ecosystems in our oceans as we have done on land with our national parks.

The Temperate East Marine Region runs from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, and includes the waters surrounding Lord Howe and Norfolk Islands.

It is home to the critically endangered east coast population of grey nurse shark and has important offshore reef habitat at Elizabeth and Middleton Reefs and Lord Howe Island that support the threatened black cod.

It includes the southern-most extent of many reef-building coral species. A number of seamount chains run parallel to the coast in this region, and scientists have recently discovered that these features support hundreds of species, including some previously unknown to science.

These plans have been developed under the *Environment Protection and Biodiversity Conservation Act 1999* and backed by the best available science.

During the statutory consultation period, submissions were received from a wide range of stakeholders in the Temperate East Marine Region. The comments and information provided by communities and industries have informed the finalisation of the plan.

Our oceans contain a diversity of species and ecosystems which deserve protection. In this Temperate East Marine Bioregional Plan, you will find information about this extraordinary array of marine life and ecosystems.

Tony Burke

Tony Burke
Minister for the Environment

# CONTENTS

# 1 THE TEMPERATE EAST MARINE BIOREGIONAL PLAN

## 1.1 Introduction to Marine Bioregional Planning

Australia has one of the largest marine jurisdictions of any nation in the world. Australian waters cover 14.7 million square kilometres, including waters around the external territories of Cocos (Keeling), Christmas, Heard and McDonald Islands as well as waters adjacent to Australia's Antarctic Territory. Within that area, Commonwealth waters surrounding the Australian continent and Tasmania cover 7.4 million square kilometres. The biodiversity of Australia's vast marine jurisdiction has been recognised as globally significant. Australia's oceans provide a home to a diverse array of marine species including marine mammals and reptiles, more than 4000 species of fish and tens of thousands of species of invertebrates, plants and micro-organisms. Many of Australia's marine species are endemic, and therefore occur nowhere else in the world. Others utilise Australian waters as part of their global migrations.

As well as being home to an amazing diversity of marine environments, Australia's oceans support a range of marine industries, providing a significant contribution to the national economy. These industries include commercial fishing and aquaculture, petroleum and mineral exploration and production, shipping, ports, recreational and charter fishing, and tourism.

With 80 per cent of Australia's population living in the coastal zone, the marine environment has important social and cultural values, including recreational opportunities, amenity, cultural heritage, conservation and scientific significance. Many Aboriginal and Torres Strait Islander peoples have a close, long-standing relationship with coastal and marine environments and continue to rely on these environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies.

Marine bioregional planning is about improving the way Australia's marine environment is managed and helping our oceans to remain healthy and productive. Marine bioregional plans have been prepared under section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the South-west, North-west, North and Temperate East marine regions in Commonwealth waters around Australia (Figure 1.1) and relate to a number of matters of national environmental significance (Box 1.1).

A draft marine bioregional plan was released for the Temperate East Marine Region in November 2011 for a 90 day statutory consultation period. This final plan has been informed by comments received from a range of stakeholders including Commonwealth and state government agencies, industry, recreational and conservation organisations and members of the public. The Australian Government will work with stakeholders to achieve the objectives of the plan.

The preparation of marine bioregional plans represents an important step towards a genuine “ecosystem approach” (Box 1.2) to biodiversity conservation and marine resource management. The plans provide a basis for the recognition and valuation of the many essential and largely irreplaceable ecosystem services provided by the Australian marine environment, including food production, waste management, climate stabilisation and recreation.

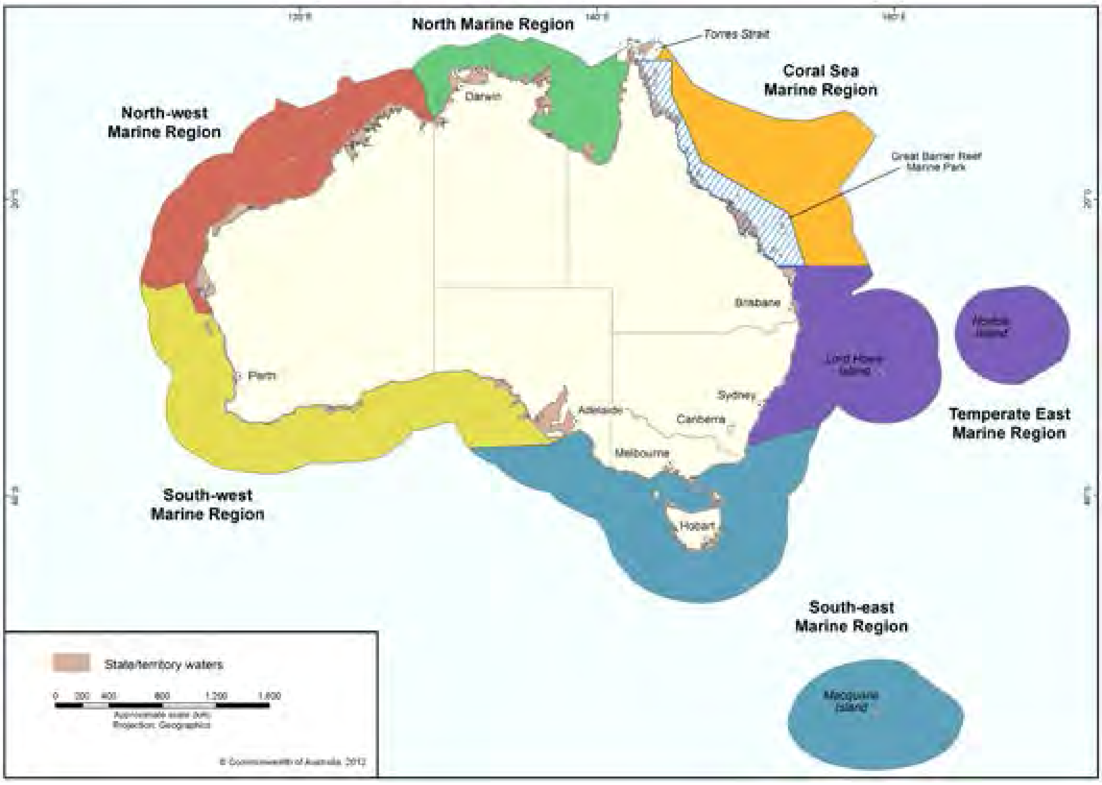



Figure 1.1: Australia’s Marine Regions

### Box 1.1 Matters of national environmental significance

Under the EPBC Act actions that have or are likely to have a significant impact on matters of national environmental significance require approval by the environment minister. There are currently eight matters of national environmental significance protected under the EPBC Act:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species (except those listed as extinct or conservation dependent) and ecological communities (except those listed as vulnerable)
- migratory species protected under international agreements
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- nuclear actions, including uranium mines.

### Box 1.2 The ecosystem approach

*What is it?*

The ecosystem approach is one of the most important principles of sustainable environmental management. Essentially, it recognises that all elements of an ecosystem are interconnected and requires that the effects of actions on the different elements of an ecosystem be taken into consideration in decision-making.

*Why do we do it?*

Ecosystems are complex and interconnected—what affects one species or habitat will have cascading and possibly unpredictable implications for other species or habitats. In addition, different activities within a marine environment may affect different parts of the interconnected whole or amplify the impacts on particular parts of the natural system.

We wish to prevent problems rather than react to them. This is why we want to address the drivers of biodiversity loss, rather than their symptoms. A focus on building and maintaining the resilience of ecosystems is more efficient and effective than trying to address problems after they have occurred.

## 1.2 Goal and objectives of the plan

The Temperate East Marine Bioregional Plan aims to strengthen the operation of the EPBC Act in the region to help ensure that the marine environment remains healthy and resilient. The plan will be used by government and industry to improve the way the marine environment is managed and protected.

Consistent with the objectives of the EPBC Act, and in the context of the principles for ecologically sustainable development as defined in the Act, the plan sets the following objectives for the region:

- conserving biodiversity and maintaining ecosystem health
- ensuring the recovery and protection of threatened species
- improving understanding of the region's biodiversity and ecosystems and the pressures they face.

The marine bioregional plan will contribute to these objectives by:

- supporting strategic, consistent and informed decision-making under Commonwealth environment legislation in relation to Commonwealth marine areas
- supporting efficient administration of the EPBC Act to promote the conservation and ecologically sustainable use of the marine environment and its resources
- providing a framework for strategic intervention and investment by government to meet its policy objectives and statutory responsibilities.

The Temperate East Marine Bioregional Plan describes the marine environment and conservation values of the region, identifies and characterises the pressures affecting these conservation values, identifies regional priorities and outlines strategies to address them, and provides advice to decision-makers and people planning to undertake activities in the Temperate East Marine Region in relation to some of the region's conservation values.

## 1.3 Application of the plan

This plan is for the Temperate East Marine Region, which covers the Commonwealth marine area (Box 1.3) extending from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, as well as the waters surrounding Lord Howe and Norfolk islands (Figure 1.2). The plan does not cover state or territory waters but, where relevant, does include information about inshore environments and the way they interact with species and habitats of the Commonwealth marine area.

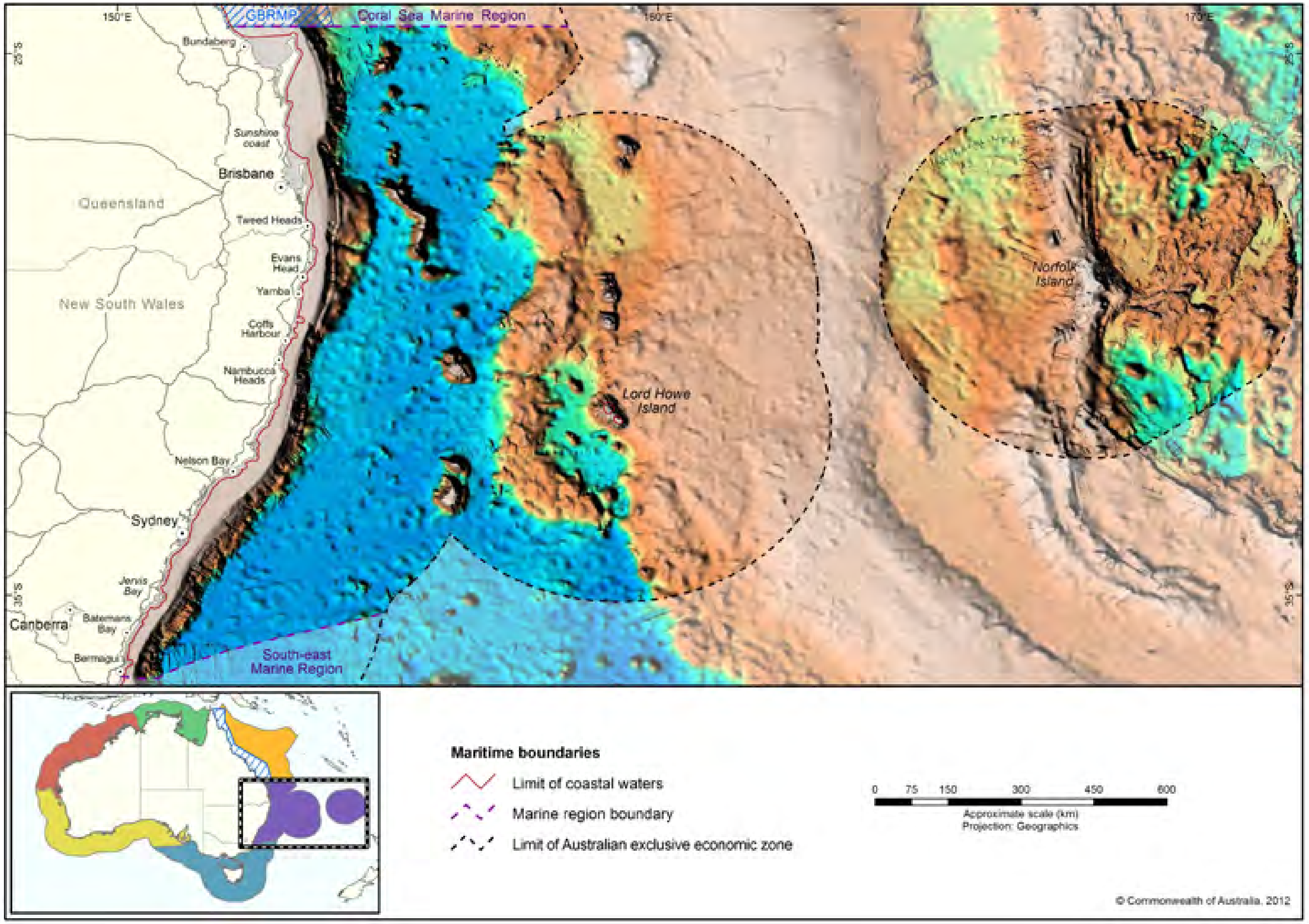



**Figure 1.2: Temperate East Marine Region**

Under section 176 of the EPBC Act, once a bioregional plan has been prepared, the minister responsible for the environment must have regard to it when making any decision under the Act to which the plan is relevant. The plan does not alter the scope of the minister's statutory responsibilities or narrow the matters the minister is required to take into account or may wish to take into account in making decisions. The EPBC Act provides that this plan is not a legislative instrument. This plan will commence six weeks after it is approved by the minister.

### Box 1.3 Commonwealth marine areas

The Australian Government is responsible for the Commonwealth marine area (also known as Commonwealth waters) as defined in section 24 of the EPBC Act (glossary **www.environment.gov.au/marineplans**). The Commonwealth marine area extends beyond the outer edge of state/territory waters, generally some 3 nautical miles (or 5.5 kilometres) from the coast, to the boundary of Australia's exclusive economic zone, generally around 200 nautical miles (or 370 kilometres) from shore (Figure 1.3). In this plan, the Commonwealth marine environment refers to the environment in a Commonwealth marine area.

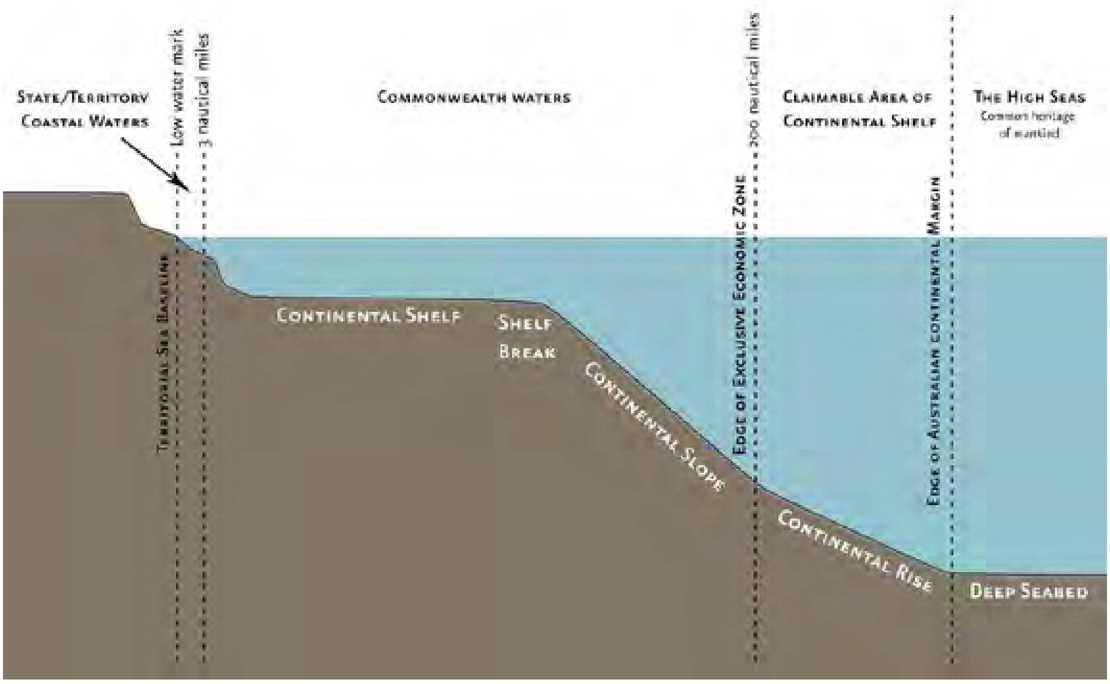



**Figure 1.3: Australia's maritime zones**

## 1.4 Key elements of the plan and supporting information

There were five key steps in the preparation of this marine bioregional plan.

1. Characterisation of the marine region

Currently available scientific and other information were used to describe the bio-physical environment and socio-economic characteristics of the marine region and its conservation values, including key ecological features, protected places and species and species groups protected by the EPBC Act. This information was combined in a Bioregional Profile for the region.

2. Regional analysis of the conservation values

The pressures potentially affecting conservation values were identified and characterised against a scale *of concern* in relation to their impacts on the values. The regional pressure analysis was informed by peer reviewed scientific literature, and its findings subject to external review by experts in the relevant fields. The outcomes of the regional pressure analysis are described in schedule 1 and informed both the identification of regional priorities (Part 4) and regional advice on matters of national environmental significance (Schedule 2).

3. Development of regional priorities

The regional pressure analysis assisted in the identification of conservation values that were, or potentially were, adversely affected by multiple pressures, as well as pressures that were impacting on multiple conservation values. Where warranted by the level *of concern*, these conservation values or pressures have been identified as regional priorities and consideration given to the strategies required to address them (Part 4).

4. Development of regional advice

The regional pressure analysis has also informed the development of regional advice in relation to matters of national environmental significance. This advice has been developed to assist people planning to undertake activities in Commonwealth marine areas to better understand and comply with their obligations under the EPBC Act, including helping them to decide whether to refer their proposed activity and determine what information would most usefully accompany any referral.

5. Public consultation on the draft marine bioregional plan

This marine bioregional plan was released in draft form for a 90 day public consultation period. The comments received have been taken into account in finalising this plan.

The plan is made up of a number of parts and is supported by a suite of information resources.

## The plan

Part 1 (this part) of the plan provides context about marine bioregional plans. Part 2 of the plan describes the conservation values of the Temperate East Marine Region. Part 3 presents a summary of the analysis of pressures affecting conservation values in the region, undertaken to inform the development of regional priorities. Part 4 introduces the regional priorities and outlines strategies and actions to address them.

## Schedules

Schedule 1 of the plan presents a full description of the pressures on conservation values of the Temperate East Marine Region that have been assessed as being *of concern* or *of potential concern*. Schedule 2 provides specific advice on matters of national environmental significance in the region. This regional advice will assist people who plan to undertake activities in, or potentially impacting on, the Commonwealth marine environment to better understand and meet their obligations under the EPBC Act. It will also assist in deciding whether a proposed action should be referred to the minister for assessment, and identify any information that is likely to be required as part of the referral.

## Glossary

A glossary of terms used in this plan and relevant to marine bioregional planning is located at **www.environment.gov.au/marineplans**.

## Conservation values report cards

The conservation values report cards contain comprehensive information about the conservation values of the Temperate East Marine Region. Conservation values include species and places protected under the EPBC Act and key ecological features. There are three types of conservation value report cards:

- protected species groups
- Commonwealth marine environment (including key ecological features)
- protected places.

The report cards support the information provided in this plan and are available at **www.environment.gov.au/marineplans/temperate-east**. They include:

- a description of the conservation values of the region
- an overview of the vulnerabilities and pressures on the conservation values (*of concern* and *of potential concern*)
- a list of relevant protection measures
- references.

## Conservation Values Atlas

The Department of Sustainability, Environment, Water, Population and Communities, as the Australian Government department responsible for administering the EPBC Act, maintains a suite of interactive tools that allow users to search, find and generate reports on information and data describing matters of national environmental significance and other conservation values in the marine environment.

The Conservation Values Atlas is designed to provide a visual representation of the conservation values in each marine region. It shows the location and spatial extent of conservation values (where sufficient information exists) and is available at **www.environment.gov.au/cva**.

## Other resources

A number of important reference documents for the Temperate East Marine Region are available at **www.environment.gov.au/marineplans**.

## 1.5 Who will use the plan?

### People who have responsibility for, or interest in, management of marine based activities, environment protection and marine science

The Temperate East Marine Bioregional Plan is an important document for individuals and organisations with an interest in the region and the way national environmental law is administered within Commonwealth waters. The plan provides information that enables people to better understand the Australian Government's marine environment protection and biodiversity conservation responsibilities, objectives and priorities in the region.

### People planning to undertake activities in Commonwealth waters, or planning to undertake activities that are likely to have a significant impact on the Commonwealth marine environment

The plan is not a legislative instrument and therefore does not alter the EPBC Act referrals process. People planning to undertake activities within the Temperate East Marine Region can use the plan and supporting information to help decide whether their proposal should be referred in accordance with the EPBC Act.

### The minister and department administering the EPBC Act

The minister must have regard to the Temperate East Marine Bioregional Plan in making any decision under the EPBC Act to which the plan is relevant.

### Other government agencies

The requirement to have regard to the Temperate East Marine Bioregional Plan in making decisions applies only to the Commonwealth minister administering the EPBC Act. However, the plan provides comprehensive information about the region that assists government decision-making relevant to the Commonwealth marine environment. The plan is underpinned by an ecosystem approach (Box 1.2). This approach requires government decision-makers to consider issues across jurisdictional, sectoral and disciplinary boundaries, so that actions are not considered in isolation from one another. The information provided in the plan assists decision-makers in the Australian Government and other jurisdictions to collaborate more effectively across jurisdictional and sectoral boundaries.

# 2 THE TEMPERATE EAST MARINE REGION AND ITS CONSERVATION VALUES

The Temperate East Marine Region comprises Commonwealth waters from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales. It also includes the waters surrounding Lord Howe and Norfolk islands (Figure 1.2). The region covers approximately 1.47 million square kilometres of temperate and subtropical waters and abuts the coastal waters of southern Queensland and New South Wales. It extends from shallow waters on the continental shelf, 3 nautical miles (5.5 kilometres) from shore, to the deep ocean environments at the edge of Australia's exclusive economic zone, 200 nautical miles from shore.

The main physical features of the region are:

- three seamount chains that run parallel to the East coast—the Tasmantid and Lord Howe seamount chains and the Norfolk Ridge
- the East Australian Current, which dominates the oceanography of the region. The East Australian Current brings warm waters from the Coral Sea south along the outer edge of the continental shelf until it moves offshore at approximately 33 degrees south (offshore from the central coast of New South Wales). Along its path, it gives rise to large eddy features that support important areas of enhanced productivity
- the Tasman Front, which forms between 20 and 30 degrees south and represents the meeting point for two distinct bodies of water—the warm, nutrient-poor Coral Sea and the cold, nutrient-rich Tasman Sea. Localised oceanographic processes along the Tasman Front trap nutrients and plankton, creating an important region of enhanced productivity and connectivity pathways
- the canyons of the eastern continental slope, which add critical habitat diversity to the region.

The remainder of this chapter describes the conservation values of the region, including the Commonwealth marine environment and its protected species and places.

## 2.1 Identification of conservation values

A range of conservation values have been identified in the Temperate East Marine Region. Conservation values are defined as those elements of the region that are:

- key ecological features of the Commonwealth marine area
- species listed under Part 13 of the EPBC Act that live in the Commonwealth marine area or for which the Commonwealth marine area is necessary for a part of their life cycle
- protected places including marine reserves, heritage places and historic shipwrecks in the Commonwealth marine area.

## 2.2 Conservation values—the Commonwealth marine environment

### Biodiversity

The Temperate East Marine Region is characterised by a narrow continental shelf, significant variation in sea-floor features (including seamount chains and canyons), dynamic oceanography, and a unique mix of tropical and cold water reef systems. Temperate species dominate the southern parts of the region, and tropical species become progressively more common towards the north.

The region supports high levels of species richness and diversity, particularly among corals, crustaceans, echinoderms, molluscs, sea sponges and fish. Due to the latitudinal range of the region, this diversity includes both tropical and temperate species. Oceanography is a strong driver for the region's biodiversity. This is particularly true in places like Lord Howe Island and the Elizabeth and Middleton reefs where both warm and cold water species flourish alongside each other. These unusual communities are mainly supported by the tongue of warm water that is driven southwards by the East Australian Current, extending the geographic range of the tropical species.

Further offshore, the East Australian Current influences biodiversity by connecting remote communities, such as those found on the seamounts, through the transport of species between areas. Our understanding of these deeper areas is constantly developing; current data suggests that these areas support exceptional levels of species endemism (as high as 34 per cent) with little overlap in distribution across seafloor features. The varied sea-floor features in the region may function as isolated systems and could support species that may be new to science.

## Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment in the Temperate East Marine Region that, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity.

The criteria used to identify KEFs in the region are:

- a species, group of species or community with a regionally important ecological role, where there is specific knowledge about why the species or species group is important to the ecology of the region, and the spatial and temporal occurrence of the species or species group is known
- a species, group of species or community that is nationally or regionally important for biodiversity, where there is specific knowledge about why the species or species group is regionally or nationally important for biodiversity, and the spatial and temporal occurrence of the species or species group is known
- an area or habitat that is nationally or regionally important for
  - enhanced or high biological productivity
  - aggregations of marine life
  - biodiversity and endemism
- a unique seafloor feature with ecological properties of regional significance.

KEFs were first described in the bioregional profile for each region and have since been modified as a result of further analysis and review by scientific experts.

Eight key ecological features have been identified in the Temperate East Marine Region (Figure 2.1 and Table 2.1). Further information on the KEFs can be found in the Commonwealth marine environment report card (**www.environment.gov.au/marineplans/temperate-east**). Understanding of KEFs may evolve as new scientific information emerges.

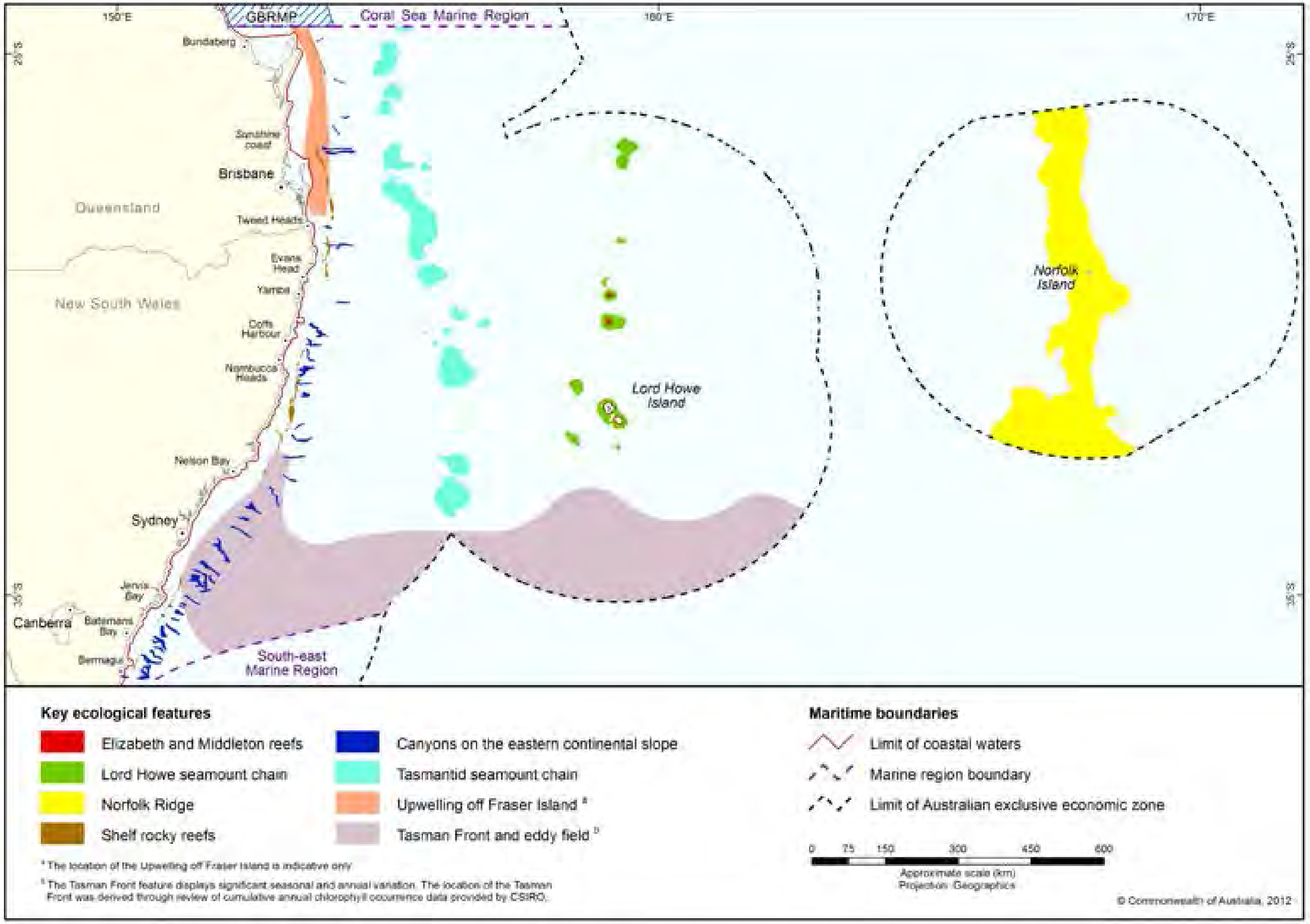



**Figure 2.1: Key ecological features of the Temperate East Marine Region**

**Table 2.1: Key ecological features of the Temperate East Marine Region**

| Feature | Values | Description |
|---|---|---|
| **Shelf rocky reefs** | Unique sea-floor feature with ecological properties of regional significance | Along the continental shelf south of the Great Barrier Reef, communities associated with the shift from algae-dominated sea-floor communities to those dominated by attached invertebrates (including large sponges, moss animals and soft corals). This shift generally occurs at a depth of 45 m. These invertebrates create a complex habitat that supports a multitude of animals including crabs, snails, worms and starfish. The habitats also contain a diverse assemblage of bottom-dwelling fishes that show distinct patterns of association with shelf-reef habitats. |
| **Canyons on the eastern continental slope** | Unique sea-floor feature with ecological properties of regional significance | Canyon systems have a marked influence on the diversity and abundance of species, driven by the combined effects of steep and rugged topography, ocean currents, sea-floor types and nutrient availability. They significantly contribute to the overall habitat diversity of the sea floor, by providing hard surfaces in depth zones where soft sediment habitats prevail. Large benthic animals such as sponges and feather stars are abundant, with particularly high diversity found in the upper slope regions (150–700 m). Canyons also create localised changes in productivity in the water column above them, providing feeding opportunities for a range of species, many of which are commercially important or threatened. |
| **Tasman Front and eddy field** | High productivity; aggregations of marine life; biodiversity and endemism | The Tasman Front is a region of intermediate productivity that separates the warm, nutrient-poor waters of the Coral Sea from the cold, nutrient-rich waters of the Tasman Sea. The front is located between 27º S and 33º S, moving north during winter and south in summer. It is associated with warm-core eddies, a number of which are semipermanent features. |

| Feature | Values | Description |
|---|---|---|
| **Upwelling off Fraser Island** | High productivity; aggregations of marine life | In two areas near Fraser Island, upwellings of cold, deep waters mix with surface waters. Tides, wind and currents draw these nutrient-rich waters onto the shelf, where they generate blooms of phytoplankton that support animals higher in the food chain, including a number of commercially valuable and threatened species. |
| **Tasmantid seamount chain** | High productivity; aggregations of marine life; biodiversity and endemism | The Tasmantid seamount chain is a prominent chain of underwater volcanic mountains, plateaux and terraces that runs north–south at approximately 155° E, extending into the Tasman Basin. At the deepest point of the chain, features rise to a depth of 1400–900 m below sea level. At the northernmost extent, features rise to a depth of 400–150 m below sea level, with some breaking the surface to form islands. The Tasmantid seamount chain contains a range of habitats, from deep sea sponge gardens to near-pristine tropical coral reef systems. Collectively, these are biological hotspots with high species diversity. They are also known feeding and breeding grounds for a number of open ocean species (e.g. billfish, marine turtles, marine mammals) and have high species endemism. |
| **Lord Howe seamount chain** | High productivity; aggregations of marine life; biodiversity and endemism | The Lord Howe seamount chain runs for approximately 1000 km along the western margin of the Lord Howe Rise, extending from Lord Howe Island in the south to Nova Bank in the north. It supports tropical shallow coral reefs and deep cold water corals. |

| Feature | Values | Description |
|---|---|---|
| **Norfolk Ridge** | High productivity; aggregations of marine life; biodiversity and endemism | The Norfolk Ridge occurs in a region of remnant volcanic arcs, plateaux, troughs and basins. The ridge runs southward from New Caledonia to New Zealand, between the New Caledonia Trough to the west and the Norfolk Basin to the east. There are likely to be high levels of diversity in seamount communities, caused by relatively productive sea-floor habitats that support population densities far higher than surrounding areas. Benthic habitats along the Norfolk Ridge are also thought to act as 'stepping stones' for animal dispersal, connecting deep water species from New Caledonia to New Zealand. |
| **Elizabeth and Middleton reefs** | Aggregations of marine life; biodiversity and endemism | Elizabeth and Middleton reefs are small, isolated, oceanic platform reefs that occur on top of the volcanic seamounts of the Lord Howe seamount chain. The reefs are impacted by the East Australian Current, exposing the area to its warm waters as well as the surrounding cooler ocean. This key ecological feature supports tropical and temperate marine life, including both warm and cold water corals and over 300 fish species. The lagoons of both reefs are important areas for populations of black cod and the Galapagos shark. |

## 2.3 Conservation values—protected species

The Temperate East Marine Region is an important area for protected species. Species listed under the EPBC Act are commonly referred to as protected species and can be listed as threatened species (critically endangered, endangered, vulnerable, conservation dependent), migratory species, cetaceans and marine species (see glossary for a full definition). An individual species may be listed under more than one category.

**Threatened species** are, in broad terms, those species that have been identified as being in danger of becoming extinct. Species may be listed in the following categories:

- conservation dependent
- vulnerable
- endangered
- critically endangered
- extinct in the wild
- extinct.

(see the glossary for further explanation of these categories).

**Migratory species** are those species that are listed under:

- the *Convention on the Conservation of Migratory Species of Wild Animals 1979* (CMS or Bonn Convention)
- the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA)
- the *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA)
- the *Agreement between the Government of Australia and the Government of the Republic Of Korea on the Protection of Migratory Birds 2007* (ROKAMBA)
- any other international agreement, or instrument made under other international agreements approved by the environment minister.

Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at **www.environment.gov.au/biodiversity/migratory/index.html**

**Cetaceans** (whales, dolphins and porpoises) are all are protected under the EPBC Act in the Australian Whale Sanctuary and, to some extent, beyond its outer limits.

**Marine species** belong to taxa that the Australian Government has recognised as requiring protection to ensure their long-term conservation (in accordance with sections 248–250 of the EPBC Act). (Refer to Table A in Schedule 2 for listed marine species in the region).

The lists of protected species established under the EPBC Act are updated periodically. This plan refers to the lists of protected species in the region and includes detailed information about species distribution and ecology in the Temperate East Marine Region. Species groups identified as conservation values in the Temperate East Marine Region are:

- bony fishes (10 species)
- cetaceans (9 species)
- marine reptiles (families Cheloniidae, Dermochelyidae, Hydrophiidae and Laticaudidae) (24 species)
- seabirds—(i.e. bird species that occur naturally in Commonwealth marine areas) (34 species)
- sharks (6 species).

Report cards describe the protected species (as of May 2012) and include detailed information about species distribution and ecology in the Temperate East Marine Region.

**Biologically important areas** have been identified for some of the region's protected species. These are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour such as breeding, foraging, resting or migration. They have been identified using expert scientific knowledge about species' distribution, abundance and behaviour in the region. The presence of the observed behaviour is assumed to indicate that the habitat required for the behaviour is also present. The selection of species for which biologically important areas have been identified was informed by the availability of scientific information, the conservation status of listed species and the importance of the region for the species. The range of species for which biologically important areas are identified will continue to expand as reliable spatial and scientific information becomes available.

The process for identifying biologically important areas involves mapping proposed areas digitally, based on expert advice and published literature, then obtaining independent scientific review of the maps and descriptions of the proposed areas.

Biologically important area maps and descriptions are available in the Temperate East Marine Region Conservation Values Atlas (**www.environment.gov.au/cva**).

## 2.4 Conservation values—protected places

Protected places are those places protected under the EPBC Act as matters of national environmental significance—places listed as World Heritage, National Heritage, or wetlands of international importance. Protected places may also include Commonwealth marine reserves and places deemed to have heritage value in the Commonwealth marine environment such as places on the Commonwealth heritage list or shipwrecks under the *Historic Shipwrecks Act 1976*.

Protected places in the region are shown in Figure 2.2 and described in Table 2.2.

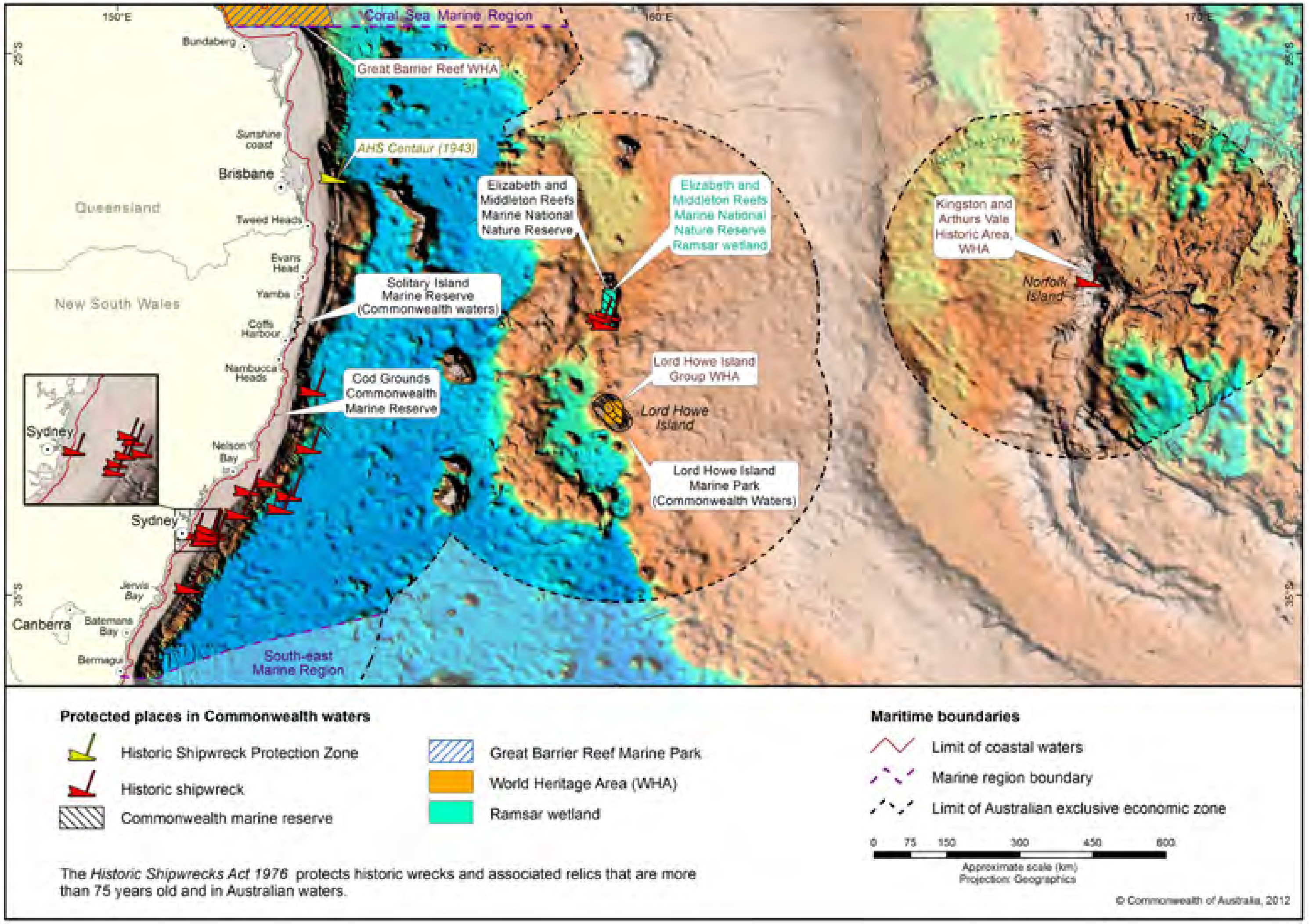



**Figure 2.2: Protected places in the Temperate East Marine Region as of May 2012**

**Table 2.2: Protected places in the Temperate East Marine Region as of May 2012**

| Protected place | Protection measure | Relevant key ecological feature |
|---|---|---|
| **Elizabeth and Middleton Reefs Marine National Nature Reserve** | Commonwealth marine reserve<br>Ramsar site | Elizabeth and Middleton Reefs |
| **Solitary Islands Marine Reserve (Commonwealth waters)** | Commonwealth marine reserve | |
| **Cod Grounds Commonwealth Marine Reserve** | Commonwealth marine reserve | |
| **Lord Howe Island Marine Park (Commonwealth waters)** | Commonwealth marine reserve<br>World Heritage List<br>National Heritage List | Lord Howe seamount chain |

Commonwealth marine reserves are relevant in EPBC Act decision making on referred matters and explicitly referenced in the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines*.

# 3 PRESSURES AFFECTING CONSERVATION VALUES

## 3.1 Analysis of pressures on conservation values

The pressure analysis assessed present and emerging pressures affecting conservation values in the Temperate East Marine Region and the effectiveness of mitigation and management arrangements that are currently in place to address these pressures. The analysis enabled pressures to be categorised in terms of their relative importance or concern, and has informed the identification of regional conservation priorities and the development of regional advice. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values.

The analysis considered pressures affecting all key ecological features and protected places and a number of species belonging to the species groups bony fishes, cetaceans, reptiles, seabirds and sharks. Considerations used for selecting the species for analysis were specific to the biological characteristics of the species groups, but broadly centred on the relative significance of the region to the conservation of the particular species. In assessing the significance of the region for a species' conservation, key considerations included the species' conservation status, distribution, population structure within the region and life history characteristics, and the potential for the population(s) in the region to be genetically distinct from populations elsewhere. Table 3.1 lists and provides an explanation of the species selected for inclusion in the pressure analysis for the Temperate East Marine Region.

A range of pressures from a range of sources was considered in the pressure analysis. Table S1.1 in Schedule 1 provides a list of the type and source of pressures available for inclusion in the analysis. Not every type and source of pressure in this list was assessed against every conservation value. Only those pressures relevant to the conservation value being analysed were considered.

The analysis included a review of scientific and expert literature, and was informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion. The pressure analysis considered, for each selected conservation value, information derived from available reports and research about:

- the spatial location and intensity of the pressure(s), both current and anticipated
- the location of the conservation value—that is, its distribution and the location of areas important to it

- current understanding of impacts (at relevant scales) resulting from the interaction between the pressure(s) and the conservation value
- the effectiveness of current management and impact mitigation measures.

**Table 3.1: Protected species selected for the pressure analysis**

| Species group | Group-specific considerations for selection | Species selected for detailed pressure analysis |
|---|---|---|
| **Bony fishes** | Species were selected on the basis of their occurrence in the region, their listing under the EPBC Act, and the importance of the region to their survival. | **Eastern gemfish**<br>**Orange roughy**<br>**Black cod**<br>**Big-bellied or pot-bellied seahorse**<br>**Bullneck seahorse**<br>**Duncker's pipehorse**<br>**Great (Kellogg's) seahorse**<br>**Hardwick's pipehorse**<br>**Sad seahorse**<br>**Weedy seadragon** |
| **Cetaceans** | Species were selected on the basis of their occurrence in the region, their listing as threatened and/or migratory and/or cetacean species under the EPBC Act, and the importance of the region to their survival.<br>The two inshore dolphin species selected, although generally coastal species, also occur in the Commonwealth marine environment of the Temperate East Marine Region. The Indo-Pacific humpback dolphin occurs in a variety of habitats, usually less than 20 m deep, including inshore reefs, tidal and dredged channels, mangroves and river mouths. The Indo-Pacific bottlenose dolphin occurs in riverine and coastal waters, shallow waters on the continental shelf and around oceanic islands. | **Blue whale**<br>**Dwarf minke whale**<br>**Humpback whale**<br>**Killer whale**<br>**Fin whale**<br>**Sei whale**<br>**Southern right whale**<br>**Indo-Pacific (coastal) bottlenose dolphin**<br>**Indo-Pacific humpback dolphin** |

| Species group | Group-specific considerations for selection | Species selected for detailed pressure analysis |
|---|---|---|
| **Marine Reptiles** | Marine turtle species were selected on the basis of their occurrence in the region, their listing as threatened species under the EPBC Act, and the presence of important breeding or foraging areas for the species in and adjacent to the region.<br>Sea snake species were selected on the basis of their occurrence in the region, and their listing under the EPBC Act as marine species. | **Green turtle**<br>**Hawksbill turtle**<br>**Leatherback turtle**<br>**Loggerhead turtle**<br>**Beaked seasnake**<br>**Blue-lipped sea krait**<br>**Colubrine sea krait**<br>**Dubois' seasnake**<br>**Elegant seasnake**<br>**Horned seasnake**<br>**Laboute's seasnake**<br>**Little file snake**<br>**Marbled or spine-tailed seasnake**<br>**Olive-headed seasnake**<br>**Olive seasnake**<br>**Plain-banded seasnake**<br>**Small-headed seasnake**<br>**Spectacled seasnake**<br>**Spotted seasnake**<br>**Stokes' seasnake**<br>**Turtle-headed seasnake**<br>**White-bellied mangrove snake**<br>**Yellow seasnake**<br>**Yellow-bellied seasnake** |

| Species group | Group-specific considerations for selection | Species selected for detailed pressure analysis |
|---|---|---|
| **Seabirds** | Seabird species were selected on the basis of their occurrence in the region, their listing as threatened and/or migratory and/or marine species under the EPBC Act, and the presence of important breeding or foraging areas for the species in and adjacent to the region.<br><br>The Lord Howe Island group and Norfolk Island group support internationally and nationally significant breeding sites for a number of seabirds in the region. | **Black noddy**<br>**Common noddy**<br>**Crested tern**<br>**Roseate tern**<br>**Sooty tern**<br>**White tern**<br>**Grey ternlet**<br>**Flesh-footed shearwater**<br>**Little shearwater**<br>**Short-tailed shearwater**<br>**Sooty shearwater**<br>**Wedge-tailed shearwater**<br>**Black petrel**<br>**Black-winged petrel**<br>**Gould's petrel**<br>**Great-winged petrel**<br>**Kermadec petrel**<br>**Providence petrel**<br>**White-bellied storm-petrel**<br>**White-faced storm-petrel**<br>**White-necked petrel**<br>**Wilson's storm-petrel**<br>**Northern giant-petrel**<br>**Southern giant-petrel**<br>**Antipodean albatross**<br>**Black-browed albatross**<br>**Campbell albatross**<br>**Indian yellow-nosed albatross**<br>**Salvin's albatross**<br>**Wandering albatross**<br>**White-capped albatross**<br>**Little penguin**<br>**Masked booby**<br>**Red-tailed tropicbird** |

| Species group | Group-specific considerations for selection | Species selected for detailed pressure analysis |
|---|---|---|
| **Sharks** | Shark species were selected on the basis that they were protected under the EPBC Act and have or are presumed to have important feeding, breeding or nursery areas within the region. They include species under consideration for listing under the EPBC Act known to occur in the Temperate East Marine Region. | **Grey nurse shark**<br>**Porbeagle shark**<br>**Longfin mako shark**<br>**Shortfin mako shark**<br>**Whale shark**<br>**White shark** |

## 3.2 Outcome of pressure analysis

Human pressures on marine ecosystems and biodiversity in the Temperate East Marine Region are, by global standards, low. However, the region is adjacent to the highly populated coasts of New South Wales and southern Queensland, and parts of the region closest to the coast will be subject to higher impact. These pressures are addressed, in part, by Australia's generally sound management of the marine environment.

A number of sources of pressures nevertheless exist in the region. The main drivers and sources of anthropogenic pressure on conservation values in the region are:

- climate change and associated large-scale effects, including shifts in major currents, rising sea levels, ocean acidification, and changes in the variability and extremes of climatic features (e.g. sea temperature, winds, storm frequency and intensity)
- extraction of living resources
- increasing urban and industrial development in areas adjacent to the region
- increasing shipping and port activities.

The findings of the pressure analysis are presented in Schedule 1 of the plan and in the Temperate East Marine Region conservation value report cards (**www.environment.gov.au/marineplans/temperate-east**).

# 4 REGIONAL PRIORITIES, STRATEGIES AND ACTIONS

## 4.1 Regional priorities

Regional priorities are key areas of focus that have been identified to inform decision-making about marine conservation and planning, as well as industry development and other human activities. The regional priorities provide context for implementing the government's statutory responsibilities, such as recovery planning for threatened species and the development and implementation of threat abatement measures. They also point to where future government initiatives and future investments in marine conservation, including in research and monitoring, would be best directed.

The identification of regional priorities for the Temperate East Marine Region has been guided by the outcomes of the pressure analysis. In identifying regional priorities, consideration has been given to the following:

- conservation values that are subject to
  - a pressure considered *of concern* for the conservation value, and
  - pressures that together are likely to result in cumulative impacts on the value, and/or
  - pressure(s) that are likely to increase substantially in intensity and extent over the next 5–10 years
- pressures that are considered *of concern* for multiple conservation values
- areas where better knowledge would improve the government's capacity to meet conservation and ecologically sustainable use objectives
- Australian Government policy priorities for the marine region.

Only a subset of conservation values and pressures assessed as being *of concern* or *of potential concern* has been identified as regional priorities. Generally, when a pressure affects multiple values and its effects are *of concern* for at least some of these values, then the pressure is identified as a regional priority. Similarly, if a conservation value is, or is likely to be, affected detrimentally by multiple pressures, and at least one of the pressures has been assessed as *of concern*, it is considered to be a regional priority. Other key considerations in determining pressure-based regional priorities included issues of scale, legislative responsibility, conservation status, effectiveness of existing management arrangements, and level of uncertainty about distribution, abundance and status of conservation values and the pressures acting on them.

## Temperate East Marine Region priorities

This plan identifies 16 regional priorities for the Temperate East Marine Region: 12 conservation values and four pressures, which are further discussed in Tables 4.1 and 4.2 respectively. The strategies and actions to address these priorities are detailed in Section 4.2.

Building on the identification of regional priorities, available information and existing administrative guidelines, this plan provides advice to assist decision-makers, marine industries and other users to understand and meet the obligations that exist with respect to these priorities under the EPBC Act (Schedule 2).

**Table 4.1: Conservation values of regional priority for the Temperate East Marine Region**

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| **1** | **Inshore dolphins**<br>Indo Pacific humpback dolphin<br>(EPBC Act listed as cetacean and migratory)<br>Indo Pacific bottlenose dolphin<br>(EPBC Act listed as cetacean) | The Indo-Pacific humpback dolphin and Indo-Pacific bottlenose dolphin are known to occur in the Temperate East Marine Region. Both species are listed as cetacean, while the Indo-Pacific humpback is also listed as migratory under the EPBC Act. The Temperate East Marine Region and adjacent waters are known breeding and foraging/feeding areas for both species.<br>Dolphins are particularly vulnerable to impacts from human activities because of the overlap between their preferred inshore habitats and the highly populated coastal fringe. This vulnerability is compounded by biological characteristics such as late-age sexual maturation and low reproduction rates.<br>Inshore dolphin species in the Temperate East Marine Region are subject to a number of pressures assessed as *of concern*: physical habitat modification (urban and coastal development), bycatch (commercial fishing) and bycatch (bather protection). A further suite of pressures are *of potential concern*. These are physical habitat modification (dredging and dredge spoil), climate change (ocean acidification, sea level rise, changes in sea temperature, changes in oceanography, changes in hydrological regimes), oil pollution (shipping), chemical pollution (onshore activities e.g. agriculture) and nutrient pollution (onshore activities e.g. agriculture), noise pollution (shipping, urban development), collision with the vessels and marine debris. | Strategy A, Action 3 and 6<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Action 1 and 5<br>Strategy E, Action 3 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 2 | **Marine turtles**<br>Green turtle<br>Hawksbill turtle<br>(EPBC Act listed as vulnerable, migratory and marine)<br>Leatherback turtle<br>Loggerhead turtle<br>(EPBC Act listed as endangered, migratory and marine) | Four of the world's seven marine turtles are known to inhabit the Temperate East Marine Region. All four species are listed as threatened under the EPBC Act. The region and adjacent areas are known to support important nesting and/or foraging areas for all four species. The varied use of the marine environment by marine turtles across different developmental stages (e.g. juvenile, young adult) means that they are exposed to a wide range of pressures.<br>In the Temperate East Marine Region, marine turtles are subject to a number of pressures assessed as *of concern* and *of potential concern*, with differences in the two ratings varying between the four species. For example, bycatch was assessed as *of concern* to green, loggerhead and leatherback turtles, and *of potential concern* to hawksbill turtles. Climate change, including sea level rise, changes in sea temperatures and sand temperatures was assessed as *of concern* to loggerhead turtles. Changes in sea temperatures and oceanography are *of potential concern* to green, hawksbill and leatherback turtles, while sea level rise is *of potential concern* to green turtles. Other pressures, such as chemical pollution/ contaminants, nutrient pollution, marine debris, light pollution, physical habitat modification, extraction of living resources, invasive species and oil pollution were rated *of potential concern* to one or more of the four species assessed.<br>The conservation status of marine turtles, the significance of the Temperate East Marine Region to their recovery, and the pressures facing them in the region make this species group a priority for conservation effort. | Strategy A, Actions 2, 3 and 6<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Action 1 and 5<br>Strategy E, Actions 1 and 2<br>Strategy G, Action 1 |
| 3 | **Grey nurse shark** *(east coast population)*<br>(EPBC Act listed as critically endangered) | The Temperate East Marine Region and adjacent state waters are known to support aggregation, mating and pupping areas for the grey nurse shark. The Cod Grounds and Solitary Islands are also recognised as important areas for this species in Commonwealth waters. The eastern grey nurse shark population is subject to bycatch from both the commercial and recreational sectors; these pressures are assessed as *of concern*. Pressures *of potential concern* include climate change (changes in sea temperature, changes in oceanography) and human presence at sensitive sites. The grey nurse shark is a regional priority because of the species' conservation status, the importance of the region to the species and the pressures impacting the population in the region. | Strategy A, Actions 2 and 3<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Action 1<br>Strategy E, Actions 1 and 2 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 4 | **White shark**<br>(EPBC Act listed as vulnerable) | The Temperate East Marine Region and adjacent waters are known to support aggregations of the white shark. White sharks move seasonally along the coast between temporary residence sites which typically correspond to regions of high prey density. The Stockton Beach–Hawks Nest area and Fraser Island are recognised as aggregation areas.<br>The white shark is vulnerable to a number of pressures. Bycatch from the recreational fishing sector is considered *of concern*, while a range of additional pressures are considered *of potential concern*. These include bycatch (commercial fishing), extraction of living resources (non-domestic commercial fisheries), extraction of living resources (illegal, unreported and unregulated fishing) and climate change (changes in sea temperature and oceanography).<br>The white shark is a regional priority because of the species' conservation status, the importance of the region to the species and the pressures impacting the population in the region. | Strategy A, Actions 2, 3 and 6<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Action 1<br>Strategy E, Actions 1 and 2 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 5 | **Seabirds breeding on islands in the Temperate East Marine Region**<br>**Terns *(including noddies)***<br>Black noddy<br>Common noddy<br>Crested tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>**Shearwaters**<br>Flesh footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Wedge-tailed shearwater<br>**Petrels**<br>Black-winged petrel | A number of islands across the region support globally important nesting sites, most notably the Lord Howe and Norfolk Island groups, as well as a series of smaller islands along the NSW coast, including Cabbage Tree, Broughton, Little Broughton and Montague islands. In addition to nesting activity, the surrounding waters support foraging areas for parents to provide food for chicks.<br>Seabirds breeding in the region are subject to a range of pressures. Invasive species are considered to be *of concern*. Pressures rated *of potential concern* are: climate change (changes in sea temperature and oceanography, ocean acidification), oil and chemical pollution and contaminants (shipping), marine debris, light pollution (for selected petrel and shearwater species), bycatch (for selected shearwater species) associated with commercial and recreational fishing and human presence at sensitive sites. The analysis of these pressures varied across the twenty species, and these rating examples have not been applied uniformly.<br>Breeding seabirds are a regional priority because of their conservation status, the importance of the region in the provisioning of young, the pressures impacting populations in the region, and their status as an Australian Government policy priority. | Strategy A, Actions 2, 3 and 6<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D Actions 1 and 5<br>Strategy E, Actions 1 and 2<br>Strategy G, Action 1 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| **5** | Gould's petrel (EPBC Act listed as endangered)<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>(EPBC Act listed as vulnerable)<br>White-faced storm-petrel<br>White-necked petrel<br>Other<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | A number of islands across the region support globally important nesting sites, most notably the Lord Howe and Norfolk Island groups, as well as a series of smaller islands along the NSW coast, including Cabbage Tree, Broughton, Little Broughton and Montague islands. In addition to nesting activity, the surrounding waters support foraging areas for parents to provide food for chicks.<br>Seabirds breeding in the region are subject to a range of pressures. Invasive species are considered to be *of concern*. Pressures rated *of potential concern* are: climate change (changes in sea temperature and oceanography, ocean acidification), oil and chemical pollution and contaminants (shipping), marine debris, light pollution (for selected petrel and shearwater species), bycatch (for selected shearwater species) associated with commercial and recreational fishing and human presence at sensitive sites. The analysis of these pressures varied across the twenty species, and these rating examples have not been applied uniformly.<br>Breeding seabirds are a regional priority because of their conservation status, the importance of the region in the provisioning of young, the pressures impacting populations in the region, and their status as an Australian Government policy priority. | Strategy A, Actions 2, 3 and 6<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D Actions 1 and 5<br>Strategy E, Actions 1 and 2<br>Strategy G, Action 1 |
| **6** | **Shelf rocky reefs** | Shelf rocky reefs of the Temperate East Marine Region support a range of complex benthic habitats that, in turn, support diverse benthic communities.<br>The ecosystem functioning and integrity of Temperate East shelf rocky reefsare subject to a number of pressures rated as *of potential concern*: bycatch and extraction of living resources (commercial fishing), physical habitat modification (fishing gear), climate change (ocean acidification, changes to sea temperature and oceanography) and marine debris. It has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Actions 1 and 2<br>Strategy F, Action 1 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 7 | **Canyons on the eastern continental slope** | The canyons on the eastern continental slope provide habitat (through changes in topography and productivity) that supports a diverse range of benthic, demersal and pelagic species.<br><br>The ecosystem functioning and integrity of the canyons are subject to a number of pressures rated as *of potential concern*: physical habitat modification, bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and oil and chemical pollution/contaminants (shipping).<br><br>The canyons on the eastern continental slope have been identified as a regional priority on the basis of their important contribution to the region's biodiversity. This selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br><br>Strategy B, Action 1<br><br>Strategy C, Action 3<br><br>Strategy D, Actions 1 and 2<br><br>Strategy F, Action 1 |
| 8 | **Tasman Front and eddy field** | The Tasman Front and eddy field contains complex and dynamic oceanographic processes support transient patches of enhanced productivity that, in turn, attract aggregations of species across trophic levels, including top predators such as tuna and sharks. This feature also supports biological connectivity with seamount habitats further offshore.<br><br>The ecosystem functioning and integrity of this key ecological feature is subject to a number of pressures rated as *of potential concern*: bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and shipping-related oil and chemical pollution/contaminants.<br><br>This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br><br>Strategy B, Action 1<br><br>Strategy C, Action 3<br><br>Strategy D, Actions 1 and 2<br><br>Strategy F, Action 1 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 9 | **Upwelling off Fraser Island** | The upwelling off Fraser Island provides nutrient-rich waters which support a range of species, including a number of commercially valuable and protected species.<br>The ecosystem functioning and integrity of the upwelling are subject to a number of pressures rated as *of potential concern*: bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and ship-related oil and chemical pollution.<br>The upwelling has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br>Strategy C, Action 3<br>Strategy D, Actions 1 and 2<br>Strategy F, Action 1 |
| 10 | **Tasmantid seamount chain** | The Tasmantid seamount chain supports aggregations of marine life, biodiversity and endemism. The feature supports a range of habitats in temperate and subtropical waters, significant demersal and pelagic diversity, important feeding and breeding sites for a number of open ocean species (e.g. billfish, marine turtles, marine mammals) and high levels of endemism.<br>The ecosystem functioning and integrity of this key ecological feature is subject to a number of pressures rated as *of potential concern*: bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and shipping-related oil and chemical pollution.<br>This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity and endemism. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br>Strategy B, Action 1<br>Strategy C, Action 3<br>Strategy D, Actions 1 and 2<br>Strategy F, Action 1 |

| | Conservation value | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| **11** | **Lord Howe seamount chain** | The Lord Howe seamount chain supports aggregations of marine life, biodiversity and endemism. It provides important benthic habitat diversity and is thought to act as an important biological 'stepping stone', connecting deepwater fauna from New Caledonia to New Zealand.<br><br>The ecosystem functioning and integrity of the seamount chain are subject to a number of pressures rated *of potential concern*: bycatch and extraction of living resources (commercial fishing activities), climate change (ocean acidification, changes to sea temperature and oceanography), marine debris, and shipping-related oil and chemical pollution.<br><br>The Lord Howe seamount chain has been identified as a regional priority on the basis of its important contribution to the region's biodiversity and endemism. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning. | Strategy A, Actions 3 and 4<br><br>Strategy B, Action 1<br><br>Strategy C, Action 3<br><br>Strategy D, Actions 1 and 2<br><br>Strategy F, Action 1 |
| **12** | **Elizabeth and Middleton reefs** | The Elizabeth and Middleton reefs support aggregations of marine life, biodiversity and endemism. A small and isolated area, the reefs supports a diverse range of tropical and temperate marine life, including both warm water and cold water corals, and over 300 fish species. The lagoons of both reefs are strongholds for populations of black cod and the Galapagos shark.<br><br>The ecosystem functioning and integrity of the reefs are vulnerable to climate change impacts, particularly changes in sea temperature and ocean acidification, pressures that have been rated as *of concern*. Pressures rated *of potential concern* are: sea level rise, changes in oceanography, marine debris, and shipping-related oil, chemical and light pollution.<br><br>The Elizabeth and Middleton reefs are identified as a regional priority on the basis of their important contribution to the region's biodiversity and endemism, the pressures impacting on those values, and its status as an Australian Government priority as an existing Commonwealth marine reserve. | Strategy A, Actions 3 and 4<br><br>Strategy B, Action 1<br><br>Strategy C, Action 3<br><br>Strategy F, Action 1 |

**Table 4.2: Pressures of regional priority for the Temperate East Marine Region**

| | Pressure | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 13 | **Climate change** | Climate change-related pressures including changes in sea temperature and oceanographic processes, ocean acidification, sea level and storm intensity, are predicted to increase in the Temperate East Marine Region, with the potential to impact the region's conservation values (key ecological features and protected species) to varying extents.<br><br>There is considerable variation in the ratings *of concern* and *of potential concern* across the conservation values. Overall, changes in sea temperatures and oceanography were considered *of potential concern* to many of the key ecological features and species, with ocean acidification of greater significance for deep and shallow water reef features, cetaceans and seabirds and sea level rise more important for habitats associated with inshore dolphins and some breeding seabirds. Increasing sand temperature was identified as a pressure for nesting marine turtles.<br><br>Climate change has been identified as a priority because of the extent of predicted impacts on conservation values in the region, particularly the cumulative nature of these impacts. Its selection also acknowledges the need to prioritise research to further understand the nature and extent of climate change impacts in the region. | Strategy A, Action 3<br>Strategy B, Action 2<br>Strategy E, Action 1<br>Strategy G, Action 1 |

| | Pressure | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| 14 | **Marine debris** | The EPBC Act lists *'injury and fatality to vertebrate marine life caused by the ingestion of, or entanglement in, harmful marine debris'* as a key threatening process. Information on the extent and impact of marine debris in the Temperate East Marine Region is limited; however, a number of activities in and adjacent to the region increase the likelihood of the prevalence of marine debris, including commercial and recreational fishing, shipping, and urban and industrial development along the coast.<br><br>In the Temperate East Marine Region, marine debris has emerged as a pressure with the potential to impact on many of the region's conservation values to varying extents. It has been assessed as *of concern* for marine turtles (green and loggerhead) and *of potential concern* for cetaceans, seabirds, school shark and all key ecological features.<br><br>Marine debris has been identified as a priority because of its interaction with a range of conservation values across the region, and its status as an Australian Government policy priority. Its selection also acknowledges the need to prioritise research to further understand the nature and extent of its impacts in the region. | Strategy A, Action 5<br><br>Strategy B, Action 2<br><br>Strategy E, Actions 1 and 4<br><br>Strategy G, Action 1 |

| | Pressure | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| **15** | **Bycatch** | Bycatch associated with fishing activities is one of the most pervasive pressures on conservation values in the region. Bycatch refers to marine life that is accidentally caught during fisheries operations and cannot be retained, thereby impacting on species populations and the diversity associated with key ecological features.<br>The Temperate East Marine Region supports a significant commercial fishing industry and bycatch from commercial fishing activities has been assessed as *of concern* for inshore dolphins, killer whale, marine turtles (green, loggerhead and leatherback), the grey nurse shark and foraging seabirds (selected petrel, albatross and shearwater species). It is considered *of potential concern* for hawksbill turtle, white shark, , foraging seabirds (selected shearwater, albatross and petrel species) and a number of key ecological features (Tasman Front and eddy field, upwelling off Fraser Island, Norfolk Ridge, Tasmantid and Lord Howe seamount chains, shelf rocky reefs and canyons).<br>Bycatch from recreational fishing has also been identified as *of concern* for grey nurse and white sharks, and *of potential concern* for the fleshfooted shearwater. In addition, bycatch from bather protection schemes is *of concern* for the Indo-Pacific (coastal) bottlenose dolphin and the Indo-Pacific humpback dolphin and bycatch from illegal fishing activities is *of concern* to four turtle species, and *of potential concern* for the humpback whale.<br>Bycatch has been identified as a priority because of its interaction with a high number of priority conservation values across the region. | Strategy A, Action 5<br>Strategy B, Action 2<br>Strategy D, Action 1<br>Strategy E, Actions 1 and 4 |

| | Pressure | Rationale | Strategies and actions identified to address the priority (see Section 4.2) |
|---|---|---|---|
| **16** | **Extraction of living resources** | A number of conservation values in the Temperate East Marine Region are vulnerable to the extraction of living resources by commercial and recreational fishing and illegal, unregulated and unreported fishing. Commercial fishing effort overlaps with seven of the eight key ecological features in the region, and was assessed as *of potential concern* for these features. Currently, it is difficult to quantify the exact impacts of target and by-product species take at these features, however, depending on the intensity of effort and composition of catch, the extraction of living resources from these key ecological features has the potential to affect trophic structures and ecological functioning.<br>Extraction of living resources has been identified as a priority because it interacts with multiple conservation values, and because there is a limited understanding of its impacts on ecosystem function. | Strategy A, Action 5<br>Strategy B, Action 2<br>Strategy D, Action 2<br>Strategy E, Action 1 and 4<br>Strategy G, Action 1 |

## 4.2 Strategies and actions

The Temperate East Marine Bioregional Plan includes seven strategies to address its priorities:

**Strategy A:** Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision-making.

**Strategy B:** Establish and manage a Commonwealth marine reserve network in the Temperate East Marine Region as part of a national representative system of marine protected areas.

**Strategy C:** Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act.

**Strategy D:** Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species.

**Strategy E:** Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government and state and territory agencies with responsibilities for the marine environment.

**Strategy F:** Improve monitoring, evaluation and reporting on ecosystem health in the marine environment.

**Strategy G:** Participate in international efforts to manage conservation values and pressures of regional priority.

Within each strategy, actions have been designed to address one or more of the regional priorities. A few actions are not linked directly to regional priorities but have been included as enabling actions—that is, they provide the necessary foundation and/or mechanisms for addressing the regional priorities in a coordinated, effective and efficient way.

Actions under the strategies are classified in terms of their implementation timeframe:

- **immediate actions** are those expected to be implemented within 6–12 months (these usually relate to priorities where the level *of concern* is high and management responses are either under way or expected to begin in the near future)
- **short-term actions** are those expected to be implemented within 2 years
- **medium-term actions** are those expected to be implemented within 3–5 years
- **long-term actions** are those expected to be implemented within 8–10 years, and usually relate to research into ecological effects that involves observational studies requiring long timeframes
- **ongoing actions** commonly cover routine administrative decision-making under the EPBC Act (e.g. administration of the fisheries assessment provisions).

The actions identified to address the Temperate East Marine Region's priorities are listed under each strategy (in no particular order) below:

### Strategy A: Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision-making

1. Improve existing mechanisms and establish new mechanisms to facilitate the uptake of marine research findings so that they can inform administrative and management decisions (short term).

2. Support research undertaken through relevant recovery plans for marine turtles, seabirds, white shark and grey nurse shark (regional priorities 2–5— short term).

3. Support research to improve information on the impacts of climate change on protected species and key ecological features; in particular, their vulnerability and adaptive capacity to predicted changes (regional priorities 1–13—medium to long term).

4. Improve knowledge of the processes driving biodiversity and ecosystem functioning of priority key ecological features of the Temperate East Marine Region (regional priority 6–12—medium to long term).

5. Improve knowledge on the pressures of marine debris, bycatch and extraction of living marine resources on conservation values in the Temperate East Marine Region (regional priorities 14–16—short to medium term).

6. Improve information on biologically important areas for protected species and species considered under pressure within the Temperate East Marine Region, with priority given to:

– inshore dolphin (regional priority 1—short to medium term)
– marine turtles (regional priority 2—short to medium term)
– white shark (regional priority 4—short to medium term)
– seabirds (regional priority 5—short to medium term).

### Strategy B:
### Establish and manage a Commonwealth marine reserve network in the Temperate East Marine Region as part of the national representative system of marine protected areas

1. Ensure that management arrangements for marine reserves contribute to the protection and conservation of the region's biodiversity and ecosystem function and integrity (regional priorities 1–8 and 10–12—medium to long term).

2. Ensure that management arrangements for the reserves minimise, where appropriate, the risk and impacts of pressures rated as being *of concern* or *of potential concern* in the Temperate East Marine Region (regional priorities 13–16—medium to long term).

### Strategy C:
### Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act

1. Improve access to information, particularly spatial data, on the region's key ecological features and protected species and the pressures on them (short to medium term).

2. Assess the need for—and, if appropriate, promote—strategic assessments under the EPBC Act of coastal and inshore marine environments adjacent to the region that are expected to experience rapid change and have the potential to increase pressure on the Commonwealth marine environment (short to medium term).

3. Provide regional advice to assist in assessing and determining the significance of potential impacts on the region's conservation values to the extent that they are (or are components of) matters of national environmental significance (see Schedule 2) (regional priorities 1–12—immediate).

4. Evaluate the role of the plan and its supporting information resources in streamlining the decision-making under the EPBC Act at all levels (i.e. the environment minister, the environment department, or persons proposing to take actions likely to impact on matters of national environmental significance in the Temperate East Marine Region (short to medium term).

## Strategy D:
## Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species

1. Collaborate with relevant fisheries management organisations and industry to support research, information exchange and the development of improved management initiatives to address bycatch of protected species—particularly marine turtles, inshore dolphins, grey nurse shark, white shark, killer whale and breeding seabirds—focusing on improving information on the cumulative effects of bycatch across multiple fisheries and the establishment of ongoing monitoring indicators (regional priorities 1–4, 6–11 and 15—short to medium term).

2. Collaborate with relevant fisheries management organisations and industry to support research into the impacts of the extraction of living marine resources on key ecological features and improve management initiatives where appropriate (regional priorities 6–11 and 16—short to medium term).

3. Collaborate with industry and research organisations to improve mechanisms for data collection, management and reporting of interactions between industries and biodiversity (short to medium term).

4. Pursue, where feasible, collaborative agreements authorising the shared use of industry-gathered marine information, particularly spatial data (short to medium term).

5. Collaborate with industry to improve understanding of the effects of: vessel collision and marine debris on marine turtles; invasive species on breeding seabirds; and physical habitat modification arising from urban and coastal development on inshore dolphins (regional priorities 1, 2 and 5—short to medium term).

## Strategy E:
## Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government, state and territory agencies and coastal communities with responsibilities for the marine environment

1. Collaborate with relevant government agencies and coastal communities to implement mitigation measures to address the key pressures on marine turtles, seabirds, grey nurse and white shark, and assess their effectiveness in reducing the risk to the species' recovery (regional priorities 2–5, 13–16—short to medium term).

2. Collaborate with the Queensland and New South Wales governments and coastal communities to develop protection measures to limit disturbances during the nesting season for marine turtles and seabirds, the pupping season for grey nurse shark, and seasons of aggregation for white shark, focusing on areas in proximity to inhabited areas or areas where sources of disturbance exist or are emerging (regional priorities 2–5—short to medium term).

3. Collaborate with the Queensland and New South Wales governments to develop protection measures to minimise the impacts of bather protection programs on inshore dolphins (regional priority 1—short to medium term).

4. Increase information on the sources and impacts of marine debris, bycatch and extraction of living resources on the region's marine life and ecosystems, including supporting monitoring of these pressures at selected locations in and adjacent to the Temperate East Marine Region (regional priorities 14–16—short to medium term).

## Strategy F:
## Improve monitoring, evaluation and reporting on ecosystem health in the marine environment

1. Collate information on the ecosystem components, functioning, pressures and potential cumulative impacts on key ecological features in the region and develop effective ecological indicators that will facilitate future monitoring, evaluation and reporting of marine ecosystem health (medium to long term).

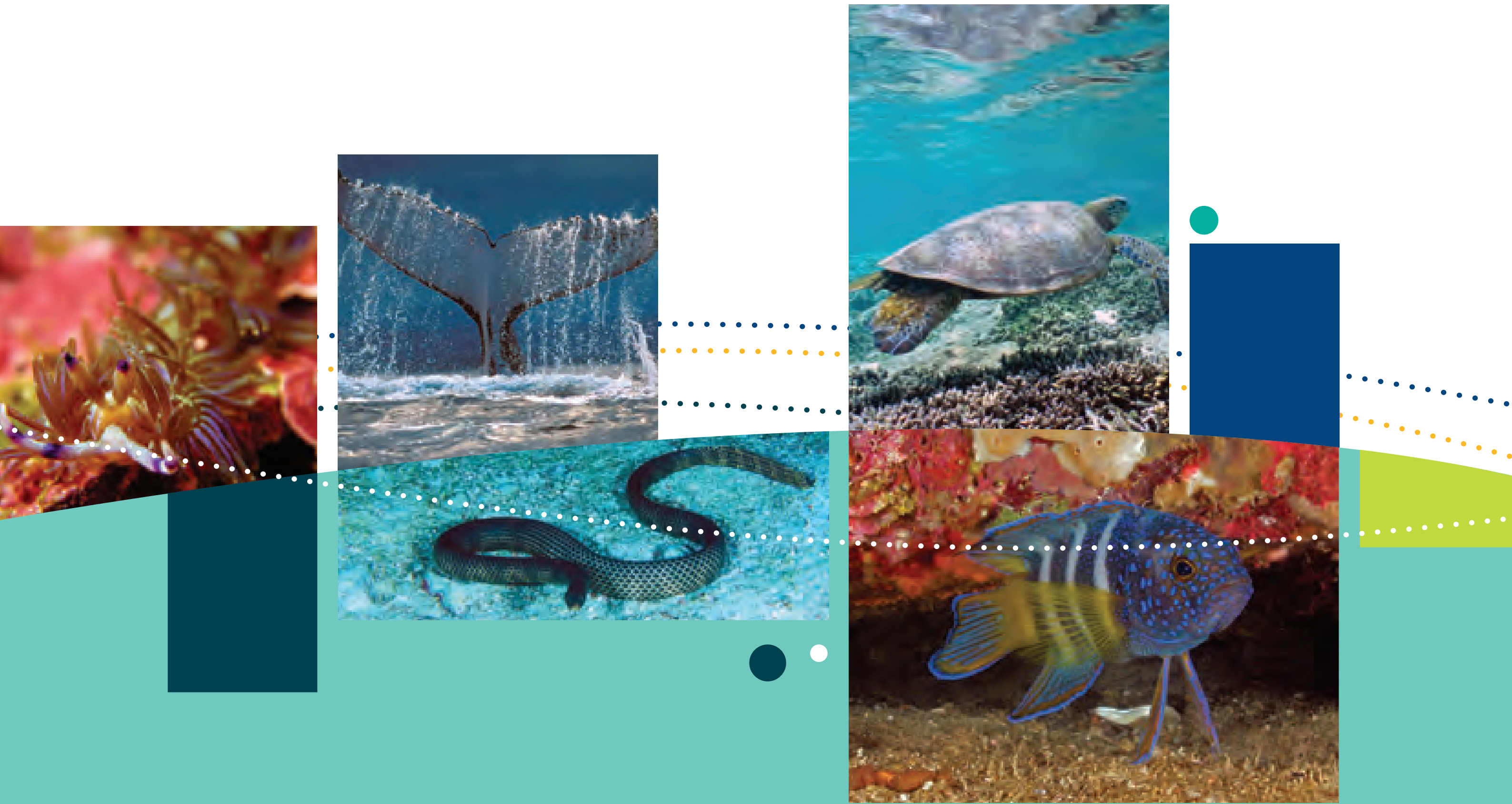
   Key ecological features to be investigated are:

   - shelf rocky reefs (regional priority 6)
   - canyons on the eastern continental slope (regional priority 7)
   - Tasman Front and eddy field (regional priority 8)
   - upwelling off Fraser Island (regional priority 9)
   - Tasmantid seamount chain (regional priority 10)
   - Lord Howe seamount chain (regional priority 11)
   - Elizabeth and Middleton reefs (regional priority 12).

## Strategy G:
## Participate in international efforts to manage conservation values and pressures of regional priority

1. Collaborate with government and non-government organisations through regional and international initiatives to protect conservation values and address pressures of regional priority (regional priority 2, 5, 13, 14, 16—ongoing).

The Australian Government will work towards implementing these strategies and actions in order to address the regional priorities for conservation effort identified for the Temperate East Marine Region.



# SCHEDULE 1

## Analysis of pressures affecting conservation values of the Temperate East Marine Region

# SCHEDULE 1
# ANALYSIS OF PRESSURES AFFECTING CONSERVATION VALUES OF THE TEMPERATE EAST MARINE REGION

This schedule summarises the methods and findings of the regional pressure analysis undertaken for the Temperate East Marine Region.

## S1.1 How were the pressures on conservation values analysed?

The pressure analysis process considered the impact of pressures on the region's conservation values, with a focused evaluation of the effectiveness of current mitigation and management arrangements in place to respond to those pressures. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values. Table S1.1 lists the type and source of pressures available for inclusion in the analysis. Only those pressures relevant to the conservation value being analysed were considered.

The analysis enabled pressures to be categorised in terms of their relative importance and has contributed to identification of regional priorities for the Temperate East Marine Region. Regional priorities are described in section 4.1 of the plan. The conservation values selected for the pressure analysis are discussed in Part 3 of the plan.

**Table S1.1: Pressures and sources of pressures available for selection in the Temperate East Marine Region pressure analysis**

| Pressure | Source |
|---|---|
| Sea level rise | Climate change |
| Changes in sea temperature | Climate change |
| | Urban development |
| Changes in oceanography | Climate change |
| Ocean acidification | Climate change |
| Changes in terrestrial sand temperature | Climate change |
| Chemical pollution/contaminants | Shipping |
| | Vessels (other) |
| | Aquaculture operations |
| | Renewable energy operations |
| | Urban development (urban and/or industrial infrastructure) |
| | Agricultural activities |
| | Onshore and offshore mining operations |
| Nutrient pollution | Aquaculture operations |
| | Agricultural activities |
| | Urban development |
| Changes in turbidity | Dredging (spoil dumping) |
| | Land-based activities |
| | Onshore and offshore mining operations |
| | Climate change (changes in rainfall, storm frequency) |
| Marine debris[1] | Land-based activities |
| | Fishing boats |
| | Shipping |
| | Vessels (other) |
| | Oil rigs |
| | Aquaculture infrastructure |
| | Renewable energy infrastructure |
| | Urban development |

| Pressure | Source |
|---|---|
| Noise pollution | Seismic exploration |
| | Urban development |
| | Defence/surveillance activities |
| | Shipping |
| | Vessels (other) |
| | Aquaculture infrastructure |
| | Renewable energy infrastructure |
| | Onshore and offshore mining operations |
| | Onshore and offshore construction |
| Light pollution | Oil and gas infrastructure |
| | Fishing boats |
| | Vessels (other) |
| | Land-based activities |
| | Onshore and offshore activities |
| | Renewable energy infrastructure |
| | Onshore and offshore mining operations |
| Physical habitat modification | Fishing gear (active and derelict) |
| | Dredging (and/or dredge spoil) |
| | Shipping (anchorage) |
| | Defence/surveillance activities |
| | Telecommunicatons cables |
| | Offshore construction and installation of infrastructure |
| | Onshore and offshore construction |
| | Offshore mining operations |
| | Ship grounding |
| | Tourism (diving, snorkelling) |
| | Climate change (changes in storm frequency etc.) |
| | Urban/coastal development |

| Pressure | Source |
|---|---|
| Human presence at sensitive sites | Aquaculture operations |
| | Seismic exploration operations |
| | Tourism |
| | Recreational and charter fishing (burleying) |
| | Research |
| | Defence/surveillance activities |
| | Aircraft |
| Nuisance species[2] | Aquaculture operations |
| Extraction of living resources[3] | Commercial fishing (domestic or non-domestic) |
| | Recreational and charter fishing |
| | IUU fishing (domestic or non-domestic) |
| | Indigenous harvest |
| | Commercial fishing—prey depletion |
| | Commercial, recreational and charter fishing—fisheries discards |
| Bycatch[4] | Commercial fishing |
| | Recreational and charter fishing |
| | IUU fishing (domestic or non-domestic) |
| Oil pollution | Shipping |
| | Vessels (other) |
| | Oil rigs |
| | Onshore and offshore mining operations |
| Collision with vessels | Shipping |
| | Fishing |
| | Tourism |
| Collision/entanglement with infrastructure | Aquaculture infrastructure |
| | Renewable energy infrastructure |
| | Oil and gas infrastructure |

| Pressure | Source |
|---|---|
| Disease | Aquaculture operations |
| | Fishing |
| | Shipping |
| | Tourism |
| Invasive species | Shipping |
| | Fishing vessels |
| | Vessels (other) |
| | IUU fishing and illegal immigration vessels |
| | Aquaculture operations |
| | Tourism |
| | Land-based activities |
| Changes in hydrological regimes | Land-based activities |
| | Aquaculture infrastructure |
| | Renewable energy infrastructure |
| | Climate change (e.g. changes in rainfall, storm frequency) |

IUU = illegal, unreported and unregulated

1 Marine debris is defined in the Threat Abatement Plan for the impacts of marine debris on vertebrate marine life May 2009 (**www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html**) and refers to 'land-sourced plastic garbage, fishing gear from recreational and commercial fishing abandoned into the sea, and ship-sourced, solid non-biodegradable floating materials disposed of at sea'. In concordance with International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), plastic material is defined as bags, bottles, strapping bands, sheeting synthetic ropes, synthetic fishing nets, floats, fiberglass, piping, insulation, paints and adhesives.

2 Nuisance species are opportunistic native species (e.g. seagulls) whose populations boom when humans modify the ecosystem by increasing food supply.

3 Extraction of living resources includes the removal of target and byproduct species.

4 Bycatch includes all non-targeted catch from fishing operations, including by-product, discards and gear interactions. By-product refers to the unintended catch that may be kept or sold by the fisher. Discards refer to the product that is returned to the sea. Gear interactions refer to all species and habitat affected by the fishing gear.

## Levels of concern for the interactions between pressures and conservation values

Based on a review of scientific and expert literature, and informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion, the interaction between selected conservation values and each pressure was assigned a level *of concern*. The levels *of concern* are:

- *of concern*
- *of potential concern*
- *of less concern*
- *not of concern*.

A pressure is *of concern* for a conservation value when:

- there is evidence that it interacts with the conservation value within the region and there are reasonable grounds to expect that it may result in a **substantial impact** (Box S1.1), and
- there are no management measures in place to mitigate the impact(s), or there is inadequate or inconclusive evidence of the effectiveness of management measures within the region.

A pressure is *of potential concern* for a conservation value when:

- there is evidence that the conservation value is vulnerable to the type of pressure, although there is limited evidence of a **substantial impact** within the region, and
- the pressure is widespread or likely to increase within the region, and
- there are no management measures in place to mitigate potential or future impacts, or there is inadequate or inconclusive evidence of the effectiveness of management measures.

A pressure is *of less concern* for a conservation value either when:

- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that the impacts are unlikely to be substantial, or
- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that current management measures in place are effective in minimising or mitigating the impact.

A pressure is *not of concern* for a conservation value when:

- the pressure is rare or absent from the region, or
- there are reasonable grounds to expect that the impacts are minimal or the pressure does not interact with the conservation value, or
- there is evidence that the pressure is managed effectively through routine management measures.

In some instances, where a pressure operating outside of the region is having a substantial impact on a region's conservation value, consideration has been given to it.

Only those interactions between conservation values and pressures assessed as being *of concern* and *of potential concern* are described in this Schedule. Further information on the findings of the pressure analyses can be found in the conservation value report cards (**www.environment.gov.au/marineplans/temperate-east**).

### Box S1.1 What is a substantial impact?

A pressure was considered likely to cause a substantial impact on a conservation value if there was a reasonable possibility that it would have any of the following effects:

- introduction of a known or potential pest or invasive species
- extensive modification, destruction, fragmentation, isolation or disturbance of habitat, which results in changes to community composition and/or trophic relationships and/ or ecosystem services
- modification, destruction, fragmentation, isolation or decline in availability of quality habitat important for a species of conservation value, to the extent that the species' conservation status is affected or its recovery is hindered
- substantial change in air or water quality, which may adversely impact biodiversity, ecological function or integrity, social amenity or human health
- introduction of persistent organic chemicals, heavy metals or potentially harmful chemicals, which adversely impact on biodiversity, ecosystem function or integrity, social amenity or human health
- change in community dynamics or structure that results in adverse impacts on biodiversity, ecological function or integrity, social amenity or human health
- increase in mortality of conservation values to an extent that may affect their conservation status or hinder recovery
- reduction in the area of occupancy of a species of conservation value, which may affect its conservation status or hinder recovery
- fragmentation of populations of conservation value
- reduced breeding success of a species or population of conservation value
- extensive or prolonged disturbance that affects the conservation status of a species or population of conservation value.

Note that the criteria above for defining substantial impact have been informed by *EPBC Act Policy Statement 1.1—Significant Impact Guidelines*.

## S1.2 Findings of the analysis

A summary of the pressure analysis findings on the key ecological features and historic shipwrecks of the Temperate East Marine Region is presented in Table S1.2. A summary of the pressure analysis findings on selected protected species in the Temperate East Marine Region is presented in Table S1.3.

A more detailed overview of the pressures assessed as *of concern* and *of potential concern* for these conservation values is presented in Tables S1.4–S1.14:

- Key ecological features of the Temperate East Marine Region
  - Pressures *of concern*—Table S1.4
  - Pressures *of potential concern*—Table S1.5
- Selected bony fish species
  - Pressures *of potential concern*—Table S1.6
- Selected cetacean species
  - Pressures *of concern*—Table S1.7
  - Pressures *of potential concern*—Table S1.8
- Selected marine reptile species
  - Pressures *of concern*—Table S1.9
  - Pressures *of potential concern*—Table S1.10
- Selected seabird species
  - Pressures *of concern*—Table S1.11
  - Pressures *of potential concern*—Table S1.12
- Selected shark species
  - Pressures *of concern*—Table S1.13
  - Pressures *of potential concern*—Table S1.14

Further information on the pressure analyses and their findings are provided in the conservation value report cards.

## Table S1.2: Summary of pressures on key ecological features and historic shipwrecks of the Temperate East Marine Region

| Key ecological feature | Pressure[5] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sea level rise | Changes in sea temperature | Change in oceanography | Ocean acidification | Chemical pollution / contaminants | Nutrient pollution | Marine debris | Noise pollution | Light pollution |
| 1. Shelf rocky reefs | not of concern | of potential concern | of potential concern | of potential concern | of less concern | of less concern | of potential concern | not of concern | not of concern |
| 2. Canyons on the eastern continental slope | not of concern | of potential concern | of potential concern | of less concern | of potential concern | of less concern | of potential concern | not of concern | not of concern |
| 3. Tasman Front and eddy field | not of concern | of potential concern | of potential concern | of less concern | of potential concern | not of concern | of potential concern | not of concern | of less concern |
| 4. Upwelling off Fraser Island | not of concern | of potential concern | of potential concern | of less concern | of potential concern | of less concern | of potential concern | not of concern | of less concern |
| 5. Tasmantid seamount chain | not of concern | of potential concern | of potential concern | of potential concern | of potential concern | not of concern | of potential concern | not of concern | not of concern |
| 6. Lord Howe seamount chain | not of concern | of potential concern | of potential concern | of potential concern | of potential concern | not of concern | of potential concern | not of concern | not of concern |
| 7. Elizabeth and Middleton reefs | of potential concern | of concern | of potential concern | of concern | of potential concern | not of concern | of potential concern | not of concern | of potential concern |
| 8. Norfolk Ridge | not of concern | of potential concern | of potential concern | of potential concern | of less concern | of less concern | of potential concern | not of concern | not of concern |
| **Historic Shipwrecks** | | | | | | | | | |
| On shelf shipwrecks | data deficient or not assessed | of potential concern | data deficient or not assessed | data deficient or not assessed | of less concern | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed |
| Off shelf shipwrecks | data deficient or not assessed | of less concern | data deficient or not assessed | data deficient or not assessed | not of concern | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.2 continued: Summary of pressures on key ecological features and historic shipwrecks of the Temperate East Marine Region

| Key ecological feature | Pressure[5] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Physical habitat modification | Human presence at sensitive sites | Extraction of living resources | Bycatch | Oil pollution | Collisions with vessels | Invasive species | Changes in hydrological regimes |
| 1. Shelf rocky reefs | of potential concern | not of concern | of potential concern | of potential concern | of less concern | of less concern | of less concern | of less concern |
| 2. Canyons on the eastern continental slope | of potential concern | not of concern | of potential concern | of potential concern | of potential concern | not of concern | not of concern | not of concern |
| 3. Tasman Front and eddy field | not of concern | not of concern | of potential concern | of potential concern | of potential concern | not of concern | not of concern | not of concern |
| 4. Upwelling off Fraser Island | not of concern | of less concern | of potential concern | of potential concern | of potential concern | of less concern | of less concern | of less concern |
| 5. Tasmantid seamount chain | of less concern | not of concern | of potential concern | of potential concern | of potential concern | not of concern | not of concern | not of concern |
| 6. Lord Howe seamount chain | of less concern | not of concern | of potential concern | of potential concern | of potential concern | not of concern | not of concern | not of concern |
| 7. Elizabeth and Middleton reefs | of less concern | of less concern | of less concern | of less concern | of potential concern | of less concern | of less concern | of less concern |
| 8. Norfolk Ridge | not of concern | not of concern | of potential concern | of potential concern | of less concern | not of concern | not of concern | not of concern |
| **Historic Shipwrecks** | | | | | | | | |
| On shelf shipwrecks | of less concern | of less concern | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed | of less concern | data deficient or not assessed | of less concern |
| Off shelf shipwrecks | not of concern | of less concern | data deficient or not assessed | data deficient or not assessed | data deficient or not assessed | not of concern | data deficient or not assessed | of less concern |

**Legend** of concern; of potential concern; of less concern; not of concern; data deficient or not assessed

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6]: Sea level rise | Changes in sea temperature | Changes in oceanography | Ocean acidification | Changes in terrestrial sand temperatures | Chemical pollution/ contaminants | Nutrient pollution | Marine debris | Noise pollution |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bony fishes** | Eastern gemfish | not of concern | of potential concern | of potential concern | of less concern | data deficient or not assessed | of less concern | of less concern | of less concern | not of concern |
| | Orange roughy | not of concern | of potential concern | of potential concern | of less concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | Black cod | of less concern | of potential concern | of potential concern | of less concern | data deficient or not assessed | of potential concern | of potential concern | of less concern | not of concern |
| | Seahorses, pipehorses and sea dragons | of less concern | of potential concern | of potential concern | of less concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| **Cetaceans** | Blue whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Dwarf Minke whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Humpback whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Killer whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Fin whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Sei whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Southern right whale | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of less concern | not of concern | of potential concern | of less concern |
| | Indo-Pacific (coastal) bottlenose dolphin | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of potential concern | of potential concern | of potential concern |
| | Indo-pacific humpback dolphin | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of potential concern | of potential concern | of potential concern |
| **Marine reptiles** <br> *Marine turtles* | Green turtle | of potential concern | of potential concern | of potential concern | of less concern | of potential concern | of potential concern | of potential concern | of potential concern | of less concern |
| *Sea snakes* | Hawksbill turtle | not of concern | of potential concern | of potential concern | of less concern | not of concern | of potential concern | of potential concern | of less concern | of less concern |
| | Leatherback turtle | not of concern | of potential concern | of potential concern | of less concern | not of concern | of potential concern | of less concern | of less concern | of less concern |
| | Loggerhead turtle | of concern | of concern | of potential concern | of less concern | of concern | of potential concern | of potential concern | of potential concern | of less concern |
| | Sea snakes | of less concern | of potential concern | not of concern | not of concern | not of concern | of less concern | not of concern | not of concern | of less concern |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Light pollution | Physical habitat modification | Human presence at sensitive sites | Extraction of living resources | Bycatch | Oil pollution | Collision with vessels | Invasive species | Changes in hydrological regimes |
| **Bony fishes** | Eastern gemfish | not of concern | not of concern | not of concern | of less concern | of less concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Orange roughy | not of concern | of potential concern | not of concern | of less concern | of less concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Black cod | not of concern | of potential concern | not of concern | of potential concern | of potential concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Seahorses, pipehorses and sea dragons | not of concern | of potential concern | not of concern | of less concern | of potential concern | of less concern | not of concern | of less concern | data deficient or not assessed |
| **Cetaceans** | Blue whale | not of concern | not of concern | not of concern | not of concern | not of concern | of less concern | not of concern | not of concern | not of concern |
| | Dwarf Minke whale | not of concern | not of concern | of less concern | not of concern | not of concern | of less concern | not of concern | not of concern | not of concern |
| | Humpback whale | not of concern | not of concern | of less concern | not of concern | of potential concern | of less concern | not of concern | not of concern | not of concern |
| | Killer whale | not of concern | not of concern | not of concern | not of concern | of concern | of less concern | not of concern | not of concern | not of concern |
| | Fin whale | not of concern | not of concern | not of concern | not of concern | not of concern | of less concern | not of concern | not of concern | not of concern |
| | Sei whale | not of concern | not of concern | not of concern | not of concern | not of concern | of less concern | not of concern | not of concern | not of concern |
| | Southern right whale | not of concern | not of concern | not of concern | not of concern | not of concern | of less concern | not of concern | not of concern | not of concern |
| | Indo-Pacific (coastal) bottlenose dolphin | not of concern | of concern | of less concern | not of concern | of concern | of potential concern | of potential concern | not of concern | of potential concern |
| | Indo-pacific humpback dolphin | not of concern | of concern | of less concern | not of concern | of concern | of potential concern | of potential concern | not of concern | of potential concern |
| **Marine reptiles** *Marine turtles* | Green turtle | of potential concern | of potential concern | of less concern | of potential concern | of concern | of potential concern | of concern | of potential concern | of less concern |
| *Sea snakes* | Hawksbill turtle | of less concern | of less concern | of less concern | of potential concern | of potential concern | of potential concern | of concern | of less concern | of less concern |
| | Leatherback turtle | of less concern | of less concern | not of concern | not of concern | of concern | of potential concern | of less concern | not of concern | not of concern |
| | Loggerhead turtle | of potential concern | of potential concern | of less concern | of less concern | of concern | of potential concern | of concern | of potential concern | of less concern |
| | Sea snakes | not of concern | of potential concern | not of concern | not of concern | of potential concern | of potential concern | of less concern | not of concern | data deficient or not assessed |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishin*g is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6]: Sea level rise | Changes in sea temperature | Changes in oceanography | Ocean acidification | Changes in terrestrial sand temperatures | Chemical pollution/ contaminants | Nutrient pollution | Marine debris | Noise pollution |
|---|---|---|---|---|---|---|---|---|---|---|
| Seabirds | Black noddy | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Common noddy | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Crested tern | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Roseate tern | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Sooty tern | of less concern | of potential concern | of concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | White tern | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Grey ternlet | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Flesh-footed shearwater | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Little shearwater | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Short-tailed shearwater | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Sooty shearwater | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Wedge-tailed shearwater | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Black petrel | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Black-winged petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Gould's petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Great-winged petrel | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Kermadec petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Providence petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | White-bellied storm petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | White-faced storm petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | White-necked petrel | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6]: Light pollution | Physical habitat modification | Human presence at sensitive sites | Extraction of living resources | Bycatch | Oil pollution | Collision with vessels | Invasive species | Changes in hydrological regimes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seabirds** | Black noddy | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Common noddy | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Crested tern | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Roseate tern | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Sooty tern | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | White tern | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Grey ternlet | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Flesh-footed shearwater | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Little shearwater | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Short-tailed shearwater | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Sooty shearwater | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Wedge-tailed shearwater | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Black petrel | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Black-winged petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Gould’s petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Great-winged petrel | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Kermadec petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Providence petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | White-bellied storm petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | White-faced storm petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | White-necked petrel | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of concern | data deficient or not assessed |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6]: Sea level rise | Changes in sea temperature | Changes in oceanography | Ocean acidification | Changes in terrestrial sand temperatures | Chemical pollution/ contaminants | Nutrient pollution | Marine debris | Noise pollution |
|---|---|---|---|---|---|---|---|---|---|---|
| Seabirds | Wilson's storm petrel | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Northern giant-petrel | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Southern giant-petrel | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Antipodean (Gibson's) albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Black-browed albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Campbell albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Indian yellow-nosed albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Salvin's albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Wandering albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | White-capped albatross | not of concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Little penguin | of less concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Masked booby | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| | Red-tailed tropicbird | of potential concern | of potential concern | of potential concern | of potential concern | data deficient or not assessed | of potential concern | of less concern | of potential concern | of less concern |
| Sharks | Grey nurse shark | not of concern | of potential concern | of potential concern | of less concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | Porbeagle shark | not of concern | of potential concern | of potential concern | not of concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | Longfin mako shark | not of concern | of potential concern | of potential concern | not of concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | Shortfin mako | not of concern | of potential concern | of potential concern | not of concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | Whale shark | not of concern | of potential concern | of potential concern | not of concern | data deficient or not assessed | of less concern | not of concern | of less concern | not of concern |
| | White shark | not of concern | of potential concern | of potential concern | not of concern | data deficient or not assessed | of less concern | not of concern | of less concern | of less concern |

**Legend** of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

## Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

| Species group | Protected species | Pressure[6]: Light pollution | Physical habitat modification | Human presence at sensitive sites | Extraction of living resources | Bycatch | Oil pollution | Collision with vessels | Invasive species | Changes in hydrological regimes |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seabirds** | Wilson's storm petrel | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Northern giant-petrel | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Southern giant-petrel | of potential concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Antipodean (Gibson's) albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Black-browed albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Campbell albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Indian yellow-nosed albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Salvin's albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Wandering albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | White-capped albatross | of less concern | not of concern | of potential concern | of less concern | of potential concern | of potential concern | not of concern | of potential concern | data deficient or not assessed |
| | Little penguin | of potential concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Masked booby | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| | Red-tailed tropicbird | not of concern | not of concern | of potential concern | of less concern | not of concern | of potential concern | not of concern | of concern | data deficient or not assessed |
| **Sharks** | Grey nurse shark | not of concern | not of concern | of potential concern | of less concern | of concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Porbeagle shark | not of concern | not of concern | not of concern | not of concern | of less concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Longfin mako shark | not of concern | not of concern | not of concern | not of concern | of less concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Shortfin mako | not of concern | not of concern | not of concern | not of concern | of less concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | Whale shark | not of concern | not of concern | not of concern | of less concern | not of concern | of less concern | not of concern | not of concern | data deficient or not assessed |
| | White shark | not of concern | not of concern | not of concern | not of concern | of concern | of less concern | not of concern | not of concern | data deficient or not assessed |

**Legend** of concern · of potential concern · of less concern · not of concern · data deficient or not assessed

6 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

**Table S1.4: Pressures *of concern* to key ecological features of the Temperate East Marine Region**

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEF** | **Rationale** |
| **Changes in sea temperature (climate change)** | Elizabeth and Middleton reefs | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Elizabeth and Middleton reefs are valued for their aggregations of marine life and biodiversity. Ocean warming is expected to alter food web dynamics (Hoegh-Guldberg & Bruno 2010), potentially increase the frequency or severity of coral bleaching events and result in southerly distribution shifts of pelagic fish species (Hobday et al. 2006). The reefs are at risk from these expected impacts, however, the overall implications for ecosystem processes and responses are not known, and will be influenced by species tolerance and adaptive capacity. |
| **Ocean acidification (climate change)** | Elizabeth and Middleton reefs | Driven by increasing levels of atmospheric $CO_2$ and subsequent chemical changes in the ocean, ocean acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). Elizabeth and Middleton reefs are valued for their aggregations of marine life and biodiversity, and expected impacts of acidification include a reduction in coral growth rates and resilience, which may make the reef systems more vulnerable to erosion and disturbance from storms (Anthony & Marshall 2009) and affect the ability of molluscs, echinoderms and some planktonic organisms to form skeletal material (Doney et al. 2009). Corals provide structural habitat complexity for a range of invertebrates and fish (Althaus et al. 2009); therefore, any impact on coral reef habitat is likely to result in changes to the distribution and abundance of species that depend on the reefs for food and shelter. |

**Table S1.5: Pressures *of potential concern* to key ecological features of the Temperate East Marine Region**

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Sea level rise (climate change)** | Elizabeth and Middleton reefs | Global sea levels rose by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). Elizabeth and Middleton reefs are shallow water reefs valued for their aggregations of marine life and biodiversity. Over time, rising sea levels are expected to decrease the amount of light that reaches the corals, thereby reducing coral growth rates (Anthony & Marshall 2009). Any impact on coral reef habitat is likely to change the distribution and abundance of species that depend on the reefs for food and shelter (Chambers et al. 2009b). |
| **Changes in sea temperature (climate change)** | Shelf rocky reefs<br>Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Norfolk Ridge | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Ocean warming is *of potential concern* for all of the region's key ecological features, except the Elizabeth and Middleton reefs, where it is *of concern* **(see Table S1.4**). Expected impacts include changes to food web dynamics (Hoegh-Guldberg & Bruno 2010), potentially increasing the frequency or severity of coral bleaching events, and a southerly shift in the distribution of pelagic fish species (Hobday et al. 2006). For features located in the deeper waters of the region (such as the shelf rocky reefs, seamounts and ridges), the impacts of rising sea temperatures are more complex. Rising temperatures drive changes such as thermal expansion (Hoegh-Gulberg & Bruno 2010), resulting in greater stratification in the water column, reducing mixing in some parts of the ocean, and consequently affecting nutrient availability and primary production at depth (Hoegh-Gulberg & Bruno 2010). |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Changes in oceanography (climate change)** | Shelf rocky reefs<br>Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Elizabeth and Middleton reefs<br>Norfolk Ridge | Changes in oceanography include consideration of circulation patterns; current intensities; wind strength and direction; the location and strength of eddy and upwelling events; and climatic oscillations such as the El Niño–Southern Oscillation. In the region, changes in oceanography will be primarily influenced by the East Australian Current, which is one of the key drivers of the region's biological productivity, species distribution and abundance (Dambacher et al. 2011).<br>The East Australian Current has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km) (Ridgway & Hill 2009). Changes in the strength and extent of the current are likely to impact on productivity, shifting trophic webs, and changing migration patterns and reef and shelf habitats, all of which have implications for marine species (Chin et al. 2010). Offshore, the current is partly responsible for the unique mix of warm and cold water species associated with Elizabeth and Middleton reefs and the Tasmantid and Lord Howe seamount chains (Dambacher et al. 2011). |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Ocean acidification (climate change)** | Shelf rocky reefs<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Norfolk Ridge | Driven by increasing levels of atmospheric $CO_2$ and subsequent chemical changes in the ocean, ocean acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). The key ecological features listed here are particularly vulnerable to ocean acidification because they support a range of shallow and deepwater coral reef systems. The direct impacts of ocean acidification are expected to be most marked for organisms with calcareous skeletons, such as corals, plankton, molluscs and echinoderms (Doney et al. 2009). Increasing acidity reduces the ability of these organisms to form skeletal structures, which is likely to affect not only their ability to function within the ecosystem, but the functioning of the ecosystem as a whole (Kleypas & Yates 2009). For example, research on coral cores in the Great Barrier Reef identified a 14% decline in coral calcification rates between 1990 and 2005 (De'ath et al. 2009), which the authors attribute to excessive temperature increases, ocean acidification, or a combination of the two. For this region, increased ocean acidification and sea surface temperatures are predicted to have combined impacts, prompting reef conditions to shift from 'marginal' (Kleypas et al. 1999) to 'extremely marginal' by the middle of this century (Noreen 2010).<br>For the subtropical regions of the Tasmantid and Lord Howe seamount chains, it is likely that increased ocean acidity will reduce coral growth rates and resilience, making the reef systems more susceptible to erosion and disturbance from storms (Anthony & Marshall 2009). Predictive climate models indicate that the unique, deep, cold water reefs and sponge gardens of the Norfolk Ridge, shelf edge and seamount chains are also at risk from a similar range of impacts (Cohen & Holcomb 2009; Howard et al. 2009; Hyder Consulting 2008). Corals provide structural habitat complexity for a range of invertebrates and fish (Althaus et al. 2009). Consequently, any impact on coral reef habitat is likely to change the distribution and abundance of species that depend on them for food and shelter. |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Chemical pollution** | Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Elizabeth and Middleton reefs | Chemical pollution/contaminants is *of potential concern* for key ecological features with values that make them particularly vulnerable to the impacts of a chemical spill, such as important aggregations of marine life at or near the sea surface. Vulnerable key ecological features include the Tasman Front and eddy field; the Fraser upwelling; the Tasmantid and Lord Howe seamount chains; canyons on the eastern continental slope; and Elizabeth and Middleton reefs. As is the case with oil spills, chemical spills are unpredictable events and their likelihood is low in the context of the international and domestic regulatory mitigation measures that apply in Australia. The effects of a major chemical spill can be similar to those of oil spills (GBRMPA 2009), particularly in areas and at times of biological significance for important or threatened species. The impacts vary depending on the toxicity of chemicals, how the materials are packaged and transported, the quantity spilled, the site and ecological sensitivity. |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Marine debris** | Shelf rocky reefs<br>Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Elizabeth and Middleton reefs<br>Norfolk Ridge | Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of, or abandoned, in the marine and coastal environment (UNEP 2005). This includes a range of materials from plastics (e.g. bags, bottles, ropes, fibreglass and insulation) to derelict fishing gear, and ship-sourced, solid, non-biodegradable floating materials (DEWHA 2009a). Although region-specific marine debris data is limited, key sources for the introduction and spread of debris (such as shipping, commercial fishing and major current systems) are present across the region. This suggests that all key ecological features will experience a high degree of overlap with this pressure (Katsanevakis 2008). Marine debris has been listed as a key threatening process under the EPBC Act, in recognition of its negative impacts on substantial numbers of Australia's marine wildlife, including protected species of birds, turtles and marine mammals. Therefore, this pressure has implications for key ecological feature values such as biodiversity and aggregations of marine life. The Australian Government has developed a threat abatement plan that provides a coordinated national approach to prevent and mitigate the effects of harmful marine debris on marine life (DEWHA 2009a). |
| **Light pollution** | Elizabeth and Middleton reefs | Light pollution is *of potential concern* to Elizabeth and Middleton reefs as they are known to support important aggregations of marine life that are vulnerable to light (e.g. turtles). Light quality is important for turtles (Salmon 2003) and lighting from shipping and fishing vessels offshore can attract hatchlings to vessel hulls, exposing them to predation. Shipping traffic, including fishing vessels anchoring in close proximity to Elizabeth and Middleton reefs, have the potential to negatively impact turtles that forage in these areas. |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Physical habitat modification (fishing gear)** | Shelf rocky reefs<br>Canyons on the eastern continental slope | Physical habitat modification due to fishing gear can result in loss or significant degradation of key ecological features that are subject to bottom trawl activities or are inherently vulnerable to habitat modification, including the shelf rocky reefs and canyons on the eastern continental slope. Both of these features are characterised by complex communities of benthic species that are highly vulnerable to the impacts of demersal trawl fishing, which removes, modifies or disturbs seabed flora and fauna (Furlani et al. 2007). These communities, particularly the deepwater coral species, are highly fragile, long lived and therefore susceptible to disturbance (Williams et al. 2010). Potential impacts include declines in the richness, diversity and density of benthic species and the range of invertebrates and fish that depend on these habitats for prey opportunities and shelter (Althaus et al. 2009). |
| **Extraction of living resources (commercial fishing)** | Shelf rocky reefs<br>Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Norfolk Ridge | The ecosystem effects of fishing are not well understood. The key ecological features highlighted here are considered valuable for their aggregations of marine life and unique features which support ecological properties of regional significance. The rating *of potential concern* is primarily driven by the impact of the targeted take of commercial fisheries on top-order predators, which are considered to be a key functional species group within these features. The extraction of top predators by fishing activities has implications for ecological communities as it influences the abundance, recruitment, species composition, diversity and behaviour of prey species. Removal of top predators can have a 'cascading' effect on all the components of a food web (Baum & Worm 2009; Ceccarelli & Ayling 2010). Reef sharks, cod and groupers are important for coral reef communities, while tuna and billfish are important for pelagic systems (Ceccarelli & Ayling 2010). In the context of active fisheries management and the steady move towards ecosystem-based management of fisheries by all jurisdictions in Australia, the *of potential concern* rating is considered a conservative assessment. This rating highlights the limited understanding of both the ecosystem effects of individual fisheries and the cumulative effects of a number of fisheries on protected species, marine communities, habitats and ecosystems. |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Bycatch (commercial fishing—domestic)** | Shelf rocky reefs<br>Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Norfolk Ridge | Commercial fishing operations are a key activity in the region and overlap, to varying extents, with these ecological features (e.g. Eastern Tuna and Billfish Fishery, Southern and Eastern Scalefish and Shark Fishery). In the context of active fisheries management and the steady move towards ecosystem-based management of fisheries by all jurisdictions in Australia, the *of potential concern* rating is considered a conservative assessment. For example, a recent review of all Commonwealth fisheries found that the current numbers of independent observers are not sufficient to allow a cumulative assessment of the catch of non-target species (Phillips et al. 2010). The review stated that such assessment is important to understand the environmental performance of fisheries more broadly and to underpin a holistic approach to the management of ecosystem impacts (Phillips et al. 2010). Generally, there is also a need to increase our understanding of the effectiveness of bycatch mitigation measures (Bensley et al. 2010). |

| Key ecological features assessed = 8 | | |
|---|---|---|
| **Pressure** | **KEFs** | **Rationale** |
| **Oil Pollution** | Canyons on the eastern continental slope<br>Tasman Front and eddy field<br>Upwelling off Fraser Island<br>Tasmantid seamount chain<br>Lord Howe seamount chain<br>Elizabeth and Middleton reefs | Oil pollution is *of potential concern* for key ecological features with values that make them particularly vulnerable to the impacts of an oil spill, such as important aggregations of marine life at or near the sea surface. Vulnerable key ecological features include the Tasman Front and eddy field; upwelling off Fraser Island; Tasmantid and Lord Howe seamount chains; canyons on the eastern continental slope; and Elizabeth and Middleton reefs. These key ecological features are highlighted because of their characteristics that make their ecosystems and communities vulnerable to the effects of an oil spill; for example, features that include regions of high productivity that attract aggregations of marine life.<br>Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas can be severe. The level of impact that actually occurs depends on a number of factors including the concentration of oil; chemical and physical properties of the oil (or oil and dispersant mixture).<br>Also influencing the impact of an oil spill event are the timing of breeding cycles and seasonal migrations of species, the amount of contact, the susceptibility of particular species; and the health, age and reproductive status of the individuals (AMSA 2011a).<br>Particular ecological values associated with the KEFs that may be impacted by such an event include seasonal feeding aggregations of pelagic invertebrates, fish and mammals associated with the Tasman Front and eddy field and the upwelling off Fraser Island, seabirds and turtles that forage at Elizabeth and Middleton reef and the tropical and temperate demersal and pelagic fish assemblages supported by these reefs; fish that seek refuge on seamounts; and predatory fish and seabirds that forage in waters surrounding seamounts.<br>Both the intensity and distribution of activities that might lead to oil spills (such as transport) are expected to increase in the region. |

**Table S1.6: Pressures *of potential concern* to bony fishes of the Temperate East Marine Region**

| Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in sea temperature (climate change)** | Eastern gemfish<br>Orange roughy<br>Black cod<br>Seahorses, pipehorses and sea dragons | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Research from Europe suggests that the warming of deep waters may have negative consequences for ecosystem function and community distribution (Weaver et al. 2009). All species assessed are likely to experience shifts in distribution and abundance due to sea temperature rises, with impacts on their life cycle stages, prey availability and habitat. Adult black cod and syngnathids are particularly vulnerable given the species' tendency to have specific habitat preferences within a small home range, thus reducing their ability to find and adapt to new habitats (Malcolm 2011; McClatchie et al. 2006). |
| **Changes In oceanography (climate change)** | Eastern gemfish<br>Orange roughy<br>Black cod<br>Seahorses, pipehorses and sea dragons | Changes in oceanography include consideration of circulation patterns; current intensities; wind strength and direction; the location and strength of eddy and upwelling events and climatic oscillations such as the El Niño–Southern Oscillation. Although species-specific responses to oceanographic changes are limited, consequences are expected for the structure, function and dynamics of deep sea habitats. For example, there is likely to be an impact on the transport of matter and energy to depths (Entoyer 2010; Weaver et al. 2009), thereby impacting on food supplies reaching these systems. Evidence from Europe suggests that this change alone will alter the population dynamics of commercial deep sea species such as orange roughy (Weaver et al. 2009). In New South Wales ocean current changes resulting from climate change are predicted to cause a reduction in the flow of freshwater to estuaries, and an increase in nutrient laden waters in near coastal areas. These changes will alter species distribution and abundance and potentially decrease sources of prey for juvenile black cod which use these habitats (DTIRIS 2012).<br>Eastern gemfish are considered vulnerable to changes in productivity associated with changes in wind strength (Hobday et al. 2008), and the annual pre-spawning migration may also be impacted by changes in oceanography; however, it is unclear whether the impacts on migration will be positive or negative on the species (Prince & Griffin 2001; Rowling 2001). Black cod, seahorses, pipehorses and sea dragons have specific habitat preferences with small home ranges, and this may reduce their ability to find and adapt to new habitats (Malcolm 2011; McClatchie et al. 2006). |

| Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Chemical pollution/ contaminants**<br>**Nutrient pollution (agricultural activities, urban development)** | Black cod | Black cod's use of estuaries as juvenile development grounds makes them vulnerable to the effects of water pollution, in the form of pollutants contained within run-off from urban development and agricultural activities. These pollutants can degrade the quality of habitats, alter the water chemistry, encourage the growth of algae and smother benthic flora and fauna species. In particular, heavy metals and organochlorine pesticides pose high risks to estuarine biota, as they persist in the environment, magnify along food chains and reduce the relative abundance of top-order predators (ANZECC 2000; DECC 2009). Over time, changes in the water chemistry, food chain and turbidity caused by urban and agricultural run-off may significantly impact the long term viability of black cod within estuaries (DTIRIS 2012). |
| **Physical habitat modification (dredging)** | Seahorses, pipehorses and sea dragons | Physical habitat modification due to dredging activities is expected to increase adjacent to the Temperate East Marine Region due to the growth in recreational boating activity (Bay Journal 2008; MSQ 2011). Seahorses, pipehorses and sea dragons have a sedentary lifestyle and close affinity to sponge and reef habitats, which makes them vulnerable to impacts arising from this pressure. Impacts on habitat include a reduction in structural diversity and fewer opportunities for the settlement of new coral colonies, due to the removal of biogenic substratum (Althaus et al. 2009; Lack et al. 2003; Pogonoski et al. 2002). |
| **Physical habitat modification (fishing gear)** | Orange roughy<br>Seahorses, pipehorses and sea dragons | Physical habitat modification from fishing gear (e.g. trawling) has the potential to impact on seahorses, pipehorses and sea dragons due to their specific habitat requirements and limited geographic range (Foster & Vincent 2004; Kuiter 2009). These species are distributed across the fishing grounds of the Queensland East Coast Otter Trawl Fishery. As is the case with dredging, mobile fishing gear crushes, buries and exposes marine animals and their habitat (e.g. sponge gardens and rocky reefs), and reduces the structural diversity of preferred habitat (Althaus et al. 2009; Lack et al. 2003; Pitcher et al. 2009; Pogonoski et al. 2002).<br>Commercial bottom trawling on seamounts can cause physical damage to benthic environments affecting benthic fauna. Damage to seamounts could affect orange roughy recruitment due to the link between their spawning aggregations and this habitat feature. |
| **Physical habitat modification (urban/coastal development)** | Black cod | Estuaries provide a nursery, refuge and feeding opportunities for black cod in its juvenile development stages. Physical habitat modification of estuaries as a result of urban and coastal development can impact black cod prior to their migration to coastal rocky reefs. In particular, the ongoing building and repair of seawalls, designed to protect low-lying foreshore infrastructure from sea level rise associated with climate change (DTIRIS 2012) can have a detrimental effect on flows, vegetation and habitat, impacting juvenile black cod. |

| Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Extraction of living resources (illegal, unregulated and unreported fishing)** | Black cod | Isolated incidences of the illegal take of black cod by recreational spear fishers along the New South Wales coast are occasionally reported (DTIRIS 2012), and illegal fishing is *of potential concern* for black cod. The New South Wales Fisheries' 2003 draft recovery plan for black cod reported anecdotal evidence of large catches of black cod in the early 1980s from Elizabeth and Middleton Reefs, and in 1993 a commercial fishing boat crew was found to have taken 24 black cod from the same area (TSSC 2012). |
| **Bycatch (commercial fishing)** | Black cod<br>Seahorses, pipehorses and sea dragons | There is evidence that black cod, seahorses, pipehorses and sea dragons are caught in commercial fisheries in the region. Commercial take of black cod is prohibited, however, the species is still caught as bycatch in Commonwealth fisheries, with fish suffering mortality due to hooks from fishers and barotrauma (Baker 2009). Indiscriminate fishing methods such as bottom-set baited lines (e.g. setlining, trotlining, handlining) are the most widely used methods with the potential to have a significant negative impact on black cod numbers and distribution (DTRIS 2012). Commercial fisheries targeting estuarine species may also impact juvenile black cod numbers, in particular those fisheries trapping in the lower reaches of estuaries on the north coast of New South Wales (DTIRIS 2012).<br>Seahorses, pipehorses and sea dragons are considered vulnerable to Danish-seine operations, as these activities occur in relatively shallow waters and use nets with a small mesh size. They are also caught as bycatch in the Queensland East Coast Otter Trawl Fishery, particularly Duncker's and Hardwick's pipehorses, although numbers are low and considered to be declining (Coles et al. 2008). In New South Wales, bycatch of these species, particularly *Solegnathus* spp. (pipehorses) is a concern (Bowles & Martin-Smith 2003). |
| **Bycatch (recreational fishing)** | Black cod | As for commercial fishing, recreational fishing of black cod is prohibited; however recreational fishers are still known to occasionally catch black cod. Limited recognition or knowledge of the species has meant that it is not always released, or even when released does not survive due to barotrauma. New fishing technologies have improved recreational fishing effectiveness, particularly in deeper waters where adult black cod are found, which may increase the risk of recreational bycatch of the species (TSSC 2012). |

## Table S1.7: Pressures *of concern* to selected cetaceans of the Temperate East Marine Region

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Physical habitat modification (urban/coastal development)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Increased physical habitat modification associated with urban and coastal development is expected adjacent to the region, along the south-east Queensland and New South Wales coastline. Studies on coastal and riverine cetaceans worldwide indicate that habitat degradation is a serious threat that fragments populations and, in some cases, eliminates habitat (Reeves & Smith 1999). In the Temperate East, the overlap between coastal development and habitats used by inshore dolphins makes them vulnerable to this pressure. Indo-Pacific humpback dolphin populations are particularly susceptible because they are highly localised, occur in small subpopulations and are extremely sensitive to disturbance in their preferred habitats (Corkeron et al. 1997; Parra et al. 2006). |
| **Bycatch (commercial fishing)** | Killer whale<br>Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Bycatch of cetacean species predominantly results in drowning and may cause changes to species distribution and population health. Diet studies of inshore dolphins by Heinshohn (1979), Marsh et al. (1989) and Parra & Jendensjo (2009) indicate that coastal estuarine waters are important foraging habitats for these species and, as a result, they are at greater risk of directly or indirectly interacting with fisheries operating in coastal waters (Parra & Jendensjo 2009). For inshore dolphins, bycatch in gillnets has emerged as a key threat to their survival (D'Agrosa et al. 2000; Northridge 1991; Rojas-Bracho & Taylor 1999). Australian net fisheries' catch is taken close to the coast, at depths less than 50 m (Kearney et al. 1996) and there is evidence that coastal dolphin bycatch occurs in these fisheries (Corkeron et al. 1997). For example, the outcome of the ecological risk assessment process by AFMA for the Small Pelagic Fishery (purse seine) assessed both the coastal bottlenose and Indo-Pacific humpback dolphin as at high risk of capture. The Small Pelagic Fishery Bycatch Action Plan is intended to reduce bycatch in this fishery. The rating assigned for the killer whale has been led by the outcomes of the AFMA ecological risk assessment process, which assessed the species as at high risk of capture within the Eastern Skipjack Tuna Fishery. *Australia's tuna purse seine fisheries bycatch action plan* (AFMA 2005) is intended to reduce bycatch and associated impacts in the Commonwealth tuna purse-seine fisheries. |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch**<br>**(bather protection programs)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Bather protection (shark meshing) programs have been in operation for over 70 years, deploying nets and drumlines to protect swimmers from the risk of shark attacks in coastal waters adjacent to the Temperate East Marine Region (Queensland and New South Wales). However, these programs lead to the bycatch of other marine species, including inshore dolphins. Between 1995 and 2009, 257 dolphins were caught in nets and drumlines associated with the bather protection programs (228 were caught in nets and 29 on drumlines); of these, 47 were bottlenose dolphins and 26 were Indo-Pacific humpback dolphins (Nias 2011). |

**Table S1.8: Pressures *of potential concern* to selected cetaceans of the Temperate East Marine Region**

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Sea level rise (climate change)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Global sea levels rose by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). Inshore dolphins are vulnerable to rising sea levels because of the predicted impacts on their preferred foraging habitat (seagrass). In general, seagrass abundance and extent is predicted to decline as sea level rise decreases the light available for photosynthesis (Connolly 2009). A decrease in the extent of seagrass is expected to impact negatively on inshore dolphins. |
| **Changes in sea temperature (climate change)** | Blue whale<br>Dwarf minke whale<br>Humpback whale<br>Killer whale<br>Fin whale<br>Sei whale<br>Southern right whale<br>Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Inshore dolphins are vulnerable to rising sea temperatures because of the expected impacts on their preferred foraging habitat (seagrass) (Connolly 2009; Parra & Corkeron, 2001; Parra et al. 2002; Parra, 2006). Temperature is a key factor determining the distribution of seagrasses (Poloczanska et al. 2007) and shallow subtidal species are considered at risk from warming ocean and air temperatures (Seddon et al. 2000). Climate variability may also affect other cetaceans; for example, research on climate variability and reproduction in southern right whales suggests a detrimental impact on reproductive success with warming events (Pirzl et al. 2008). Environmental fluctuations may impact on reproduction by affecting body condition and health through changes in foraging conditions, with krill availability in the summer feeding grounds influencing reproductive success the following winter (Trathan & Murphy 2002; Trathan et al. 2003). |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in oceanography (climate change)** | Blue whale<br>Dwarf minke whale<br>Humpback whale<br>Killer whale<br>Fin whale<br>Sei whale<br>Southern right whale<br>Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Changes in oceanography include consideration of circulation patterns, current intensities, wind strength and direction, the location and strength of eddy and upwelling events and climatic oscillations such as the El Niño–Southern Oscillation. Oceanographic changes in the region will be primarily driven by the East Australian Current. Studies indicate this major boundary current has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km). Predictive climate models have medium confidence that this trend will increase (Ridgway & Hill 2009). There will also be associated circulation effects arising from expected changes to the El Niño–Southern Oscillation. Potential consequences of changes in ocean circulation patterns and the bifurcation point of the East Australian Current include shifts in upwelling events, increased thermal stratification, increased eddy activity and a shift in the thermocline depth (Chin et al. 2010). For cetaceans, these changes may influence the availability of prey, migration patterns and selection of calving sites (Chin et al. 2010). |
| **Ocean acidification (climate change)** | Blue whale<br>Dwarf minke whale<br>Humpback whale<br>Killer whale<br>Fin whale<br>Sei whale<br>Southern right whale<br>Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Driven by increasing levels of atmospheric $CO_2$ and subsequent chemical changes in the ocean, acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). Recent research indicates significant impacts of ocean acidification on Antarctic krill (Kawaguchi et al. 2011), which are a key food source for many whale species that visit Australian waters. While there are no observed impacts of climate change on zooplankton in Australian waters, based on knowledge of impacts elsewhere, Australia is likely to start losing calcifying zooplankton from its southern waters (Richardson et al. 2009). |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Chemical pollution/ contaminants (urban development, agricultural activities)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Cetaceans that frequent nearshore areas, such as the Indo-Pacific bottlenose dolphin and the Indo-Pacific humpback dolphin, may be exposed to higher levels of chemical pollutants than wholly offshore species (Jacob 2009). Shipping is a key activity in the region, with shipping routes servicing a number of ports that are adjacent to the region and inshore dolphin habitat. Higher levels of polychlorinated biphenyls (PCBs) have been found in dolphins from the Gold Coast compared to anywhere else in Australia; high levels of PCBs have been linked to impaired reproductive capacity in dolphins (Gaus et al. 2001). There is limited data on the likelihood of chemical spills in the region; however, like oil spills, they are unpredictable events that may have severe consequences for marine species. Inshore dolphins are particularly vulnerable because of their highly localised populations along the east coast. |
| **Nutrient pollution (urban development, agricultural activities)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Nutrient pollution, also known as eutrophication, refers to an increase in the rate of supply of organic matter into an ecosystem, particularly nitrogen, phosphorus and silica. Eutrophication is considered a threat to coastal marine environments, leading to an increased frequency of harmful algal blooms, loss of ecosystem integrity and changes to biodiversity. High rainfall and catchment run-off, particularly in south-east Queensland, increases the exposure of dolphins to bioaccumulated toxins (Lawler et al. 2007). For example, inshore dolphins can be directly exposed to toxins through algae outbreaks associated with increased nutrient loads, absorbing toxins from water or ingesting algal cells; or indirectly through eating prey that contain toxins (Carmago & Alonso 2006). |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Marine debris** | Blue whale<br>Dwarf minke whale<br>Humpback whale<br>Killer whale<br>Fin whale<br>Sei whale<br>Southern right whale<br>Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | *Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2009 as a key threatening process under the EPBC Act (DEWHA 2009a). Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of or abandoned in the marine and coastal environment (UNEP 2005). Cetaceans are considered vulnerable to entanglement in marine debris, and the threat abatement plan lists a number of cetaceans that are known to be adversely affected by marine debris, including the southern right whale, blue whale and humpback whale (DEWHA 2009a). The potential for marine debris to affect inshore dolphin habitat is high because of the high number of people living adjacent to the coast (ABS 2001), the popularity of recreational fishing, and the number of commercial fisheries operating in and adjacent to the region (DEWHA 2009b). The Australian Government has developed a threat abatement plan that provides a coordinated national approach to prevent and mitigate the effects of harmful marine debris on marine life (DEWHA 2009a). |
| **Noise pollution (shipping, urban development)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | There is growing concern that the impacts of human-made noise on marine life, particularly cetaceans, may result in physical or behavioural effects on these species (DEWHA 2008a). With pressures such as coastal development, a number of important ports and associated shipping activity, there is concern that noise may interfere with the ability of inshore dolphins to communicate, resulting in displacement from preferred habitat, or physical trauma and damage to sensory systems (Bejder & Samuels 2003; Mattson et al. 2005; Nowacek et al. 2007; Richardson et al. 1995). Evidence of changes in behaviour can be found in Moreton Bay, where the rate of whistling by humpback dolphins has increased in the presence of travelling boats, particularly in mother–calf pairs (van Parijs & Corkeron 2001). |
| **Physical habitat modification (dredging/ dredge spoil)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Physical habitat modification from dredging activities is expected adjacent to the Temperate East Marine Region due to the growth in recreational boating activity (Bay Journal 2008; MSQ 2011). Dredging can also occur in association with development projects for extractive purposes and for the installation of pipelines and cables. Dredging modifies nearshore habitats by removing or smothering benthic flora and fauna, and changing water flows (GBRMPA 2009). Studies on coastal and riverine cetaceans worldwide indicate that habitat degradation is a serious threat that fragments populations and, in some cases, eliminates habitat (Reeves & Smith 1999). In the region, the overlap between coastal development and habitats used by inshore dolphins makes them vulnerable to this pressure. The Indo-Pacific humpback dolphin populations are particularly susceptible because they are highly localised, occur in small subpopulations and are extremely sensitive to disturbance in their preferred habitats (Corkeron et al. 1997; Parra et al. 2006). |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch (bather protection programs)** | Humpback whale | Bather protection (shark meshing) programs have been in operation for over 70 years, deploying nets and drumlines to protect swimmers from the risk of shark attacks along the New South Wales and Queensland coasts. However, these programs lead to the bycatch of other marine species. The number of humpback whales caught in nets along the Queensland coast during migration has remained relatively constant over recent years (DERM 2009); however, as the population recovers, the interaction between humpback whales and shark meshing may increase. |
| **Oil pollution (shipping, vessels)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Oil spills are unpredictable events and their likelihood is low, particularly in the context of the international and domestic regulatory mitigation measures that apply in Australia. However, their consequences can be severe, particularly in biologically significant areas or times. Shipping is a key activity in the region, with shipping routes servicing a number of ports that are adjacent to the region and inshore dolphin habitat. In the event of an oil spill, dolphins have been known to detect oil and avoid it; however, at other times they have been exposed to floating oil (AMSA 2010). Inshore dolphin species are particularly vulnerable to oil spills because of their highly localised populations along the east coast. |
| **Collisions with vessels**<br>**(shipping, tourism, fishing)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Collisions between dolphins and vessels have been recorded in Australian waters, with records of dolphin mortality attributed to boat strike in Victoria (DSE 2011) and South Australia (News Limited 2010). The growth in recreational boating activity in the region (Bay Journal 2008; MSQ 2011), combined with a preference for nearshore habitats, makes inshore dolphins vulnerable to collisions with vessels. |
| **Changes in hydrological regimes**<br>**(climate change)** | Indo-Pacific (coastal) bottlenose dolphin<br>Indo-Pacific humpback dolphin | Changes in hydrological regimes through, for example, an increase in the frequency and intensity of storm and flooding events could impact on nearshore environments used by inshore dolphins. The predicted increase in intensity of storm events, combined with rising sea levels, is expected to cause shoreline erosion, thereby increasing turbidity of shallow coastal waters (Cabaco et al. 2008; Hennessy et al. 2007; Waycott et al. 2007) and reducing the amount of light available for photosynthesis in seagrasses (Connolly 2009), the preferred habitat of inshore dolphins. Increases in turbidity within mangrove environments may also reduce the efficiency of predators (Abrahams & Kattenfeld, 1997), including both species of inshore dolphin. |

**Table S1.9: Pressures *of concern* to selected marine reptiles of the Temperate East Marine Region**

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Sea level rise (climate change)** | Loggerhead turtle | Global sea levels rose by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). The implications of sea level rise for marine turtles include an increased risk of tidal inundation or destruction of nests, the selection of suboptimal nesting areas, and risk of nest destruction by other turtles associated with higher nesting densities (Hamann et al. 2007; Poloczanska et al. 2010). Collectively, these impacts may reduce breeding success. It is expected that the effects of sea level rise will be particularly marked in regions of extensive coastal development, such as eastern Australia, where development acts as a barrier to the landward movement of beaches or hinders natural accretion of beach material and the evolution of beach morphology (Poloczanska et al. 2010). |
| **Changes in sea temperatures (climate change)** | Loggerhead turtle | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Increasing sea temperatures have the potential to impact on marine turtles in a number of ways, including a shift in distribution, which may either increase or decrease the species range (Hawkes et al. 2009; Milton & Lutz 2003); alterations to life history characteristics such as growth rates and age at maturity (Balazs & Chaloupka 2004; Chaloupka & Limpus 2001; Hamann et al. 2007); and reduced prey availability (Chaloupka et al. 2008; Fuentes et al. 2009). For example, higher mean annual sea surface temperatures in core loggerhead foraging areas correlate with trends towards smaller annual nesting populations during the following summer in eastern Australia (Chaloupka et al. 2008). |
| **Changes in terrestrial sand temperatures (climate change)** | Loggerhead turtle | Changes in terrestrial sand temperature have implications for nesting marine turtles: higher sand temperatures increase the female bias in the sex ratio of turtle hatchlings, which may lead to a female bias in marine turtle populations (Fuentes et al. 2009). A rise in sand temperature may also compromise egg incubation, leading to lower hatchling success and reduced hatchling survival (Fuentes et al. 2009). Emerging research suggests that turtles are responding to these pressures in a highly adaptive manner; for example, by shifting nesting periods to correspond to lower temperatures (Poloczanska et al. 2010). |

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch (commercial fishing)** | Green turtle<br>Leatherback turtle<br>Loggerhead turtle | Bycatch associated with commercial fisheries operating in the region is *of concern* to marine turtles that are listed as threatened, including the green, leatherback and loggerhead turtle. Turtles are vulnerable to trawl, gillnet and longline fisheries gear, and bycatch interactions typically result in the death of individuals by drowning. All three gear types are used across the region and records indicate that all three species of turtle are caught (Limpus 2008a, 2008b, 2009). The population effects of bycatch mortality are unknown for some species; however, for others such as the loggerhead and green turtle, it has led to population declines. For example, mortality associated with otter trawl operations across eastern and northern Australia were identified as the cause of the 86% decline in loggerhead annual nesting numbers in eastern Australia from the mid-1970s to 2000. In the past decade, the introduction of turtle excluder devices (TEDs) in several key trawl fisheries such as the Queensland East Coast Otter Trawl Fishery has resulted in a significant reduction of bycatch. Despite their success, TEDs are not universally used. For example, New South Wales trawl fisheries (e.g. New South Wales Otter Trawl Fishery) do not use these devices and it is expected this will slow the recovery of threatened species across the Temperate East Marine Region and in the south-west Pacific. For other fisheries, such as longline operations, where TEDs cannot be used, bycatch levels continue to be considered a high risk. For example, in the Eastern Tuna and Billfish Fishery, green and leatherback turtles are the most frequently caught turtle species. |
| **Collision with vessels** | Green turtle<br>Hawksbill turtle<br>Loggerhead turtle | Boat strikes are a common cause of death and injury in marine turtles, with turtles' poor hearing and vision hampering their ability to avoid boats. Turtles are most vulnerable to boat strike when they are in shallow waters, or basking or breathing at the surface. Growing coastal development and the associated rise in recreational boating activities in the region are expected to exacerbate this issue (Limpus 2008a, b, 2009a). Adult turtles are particularly vulnerable, and this compounds the impact of this pressure on turtle populations by disproportionately reducing the numbers of breeding-age individuals (Limpus 2008a). Some very effective mitigation measures are in place, such as the 'Go slow' zones in the Moreton Bay Conservation Park; however, experts remain concerned about the impact of boat strikes on turtle populations within the region. |

**Table S1.10: Pressures *of potential concern* to selected marine reptiles of the Temperate East Marine Region**

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Sea level rise (climate change)** | Green turtle | Global sea levels have risen by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). The implications of sea level rise for marine turtles include an increased risk of tidal inundation or destruction of nests, the selection of suboptimal nesting areas, and risk of nest destruction by other turtles associated with higher nesting densities (Hamann et al. 2007; Poloczanska et al. 2010). Collectively, these impacts may reduce breeding success. It is expected that the effects of sea level rise will be particularly marked in regions of extensive coastal development, such as eastern Australia, where development acts as a barrier to the landward movement of beaches or hinders natural accretion of beach material and the evolution of beach morphology (Poloczanska et al. 2010). |
| **Changes in sea temperature (climate change)** | Green turtle<br>Hawksbill turtle<br>Leatherback turtle<br>Sea snakes | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Increasing sea temperatures have the potential to impact on marine turtles in a number of ways, including a shift in distribution that may either increase or decrease the species range (Hawkes et al. 2009; Milton & Lutz 2003), alterations to life history characteristics (e.g. growth rates, age at maturity and reproductive periodicity) (Balazs & Chaloupka 2004; Chaloupka & Limpus 2001; Fuentes et al. 2009; Hamann et al. 2007) and reduced prey availability (Chaloupka et al. 2008).<br><br>Sea snakes depend on water temperatures for their body heat while foraging (Guinea 1995; Heatwole 1981). Little is known about the thermal requirements and tolerances of sea snakes and how they will respond to increasing water temperatures (Hamann et al. 2007). Potential impacts from changes in sea temperatures include changes to the availability of prey species and seasonal movements for breeding or feeding (Fuentes et al. 2009; Hamann et al. 2007). |

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in oceanography (climate change)** | Green turtle<br>Hawksbill turtle<br>Leatherback turtle<br>Loggerhead turtle | Changes in oceanography broadly refer to changes in ocean circulation patterns, current intensities, wind strength and direction, the location and strength of eddy and upwelling events and climatic oscillations such as the El Niño–Southern Oscillation. For turtles, changes to these ocean characteristics may have implications for hatchling dispersal, migration and feeding. For example, dispersal of loggerhead and green turtle hatchlings from the Great Barrier Reef occurs via offshore currents (Boyle 2006; Hamann et al. 2007), and any changes in offshore current will influence this dispersal. |
| **Changes in terrestrial sand temperature (climate change)** | Green turtle | Changes in terrestrial sand temperature have implications for nesting marine turtles: higher sand temperatures increase the female bias in the sex ratio of turtle hatchlings, which may lead to a female bias in marine turtle populations (Fuentes et al. 2009). A rise in sand temperature may also compromise egg incubation, leading to lower hatchling success and reduced hatchling survival (Fuentes et al. 2009). Emerging research suggests that turtles are responding to these pressures in a highly adaptive manner; for example, by shifting nesting periods to correspond to lower temperatures (Poloczanska et al. 2010). |
| **Chemical pollution/ contaminants (shipping, vessels, urban development, agricultural activities)** | Green turtle<br>Hawksbill turtle<br>Leatherback turtle<br>Loggerhead turtle | The Temperate East Marine Region is highly exposed to possible vectors for chemical pollutants, including significant shipping, fishing and agricultural activities in and adjacent to the region. It is expected that the effects of a major chemical spill would be similar to, or possibly exceed, those of a major oil spill (GBRMPA 2009). The implications of small and gradual influxes of chemicals (e.g. agricultural run-off) are harder to ascertain, and the effects on turtle populations are unknown (Muusee et al. 2006). Studies indicate that turtles, as high-order predators, bioaccumulate and biomagnify chemicals, meaning that chemicals can reach high concentrations in individuals, with potentially negative consequences (Muusee et al. 2006). A number of management measures are in place to respond to this risk, including the National plan to combat pollution of the sea by oil and other noxious and hazardous substances and the International Convention for the Prevention of Pollution from Ships (MARPOL), both of which are implemented through the Australian Maritime Safety Authority. Although these measures mitigate the risk of a significant pollution event, the potential for such an event remains. |

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Nutrient pollution (urban development, agricultural activities)** | Green turtle<br>Hawksbill turtle<br>Loggerhead turtle | Nutrient pollution, also known as eutrophication, refers to an increase in the rate of supply of organic matter into an ecosystem, particularly nitrogen, phosphorus and silica. Eutrophication is considered a threat to coastal marine environments, leading to an increased frequency of harmful algal blooms, loss of ecosystem integrity and changes to biodiversity. Algal blooms have been associated with substandard diets in turtles, which may hamper growth and development and reduce reproduction (Arthur et al. 2006). It is also suggested that these blooms are associated with tumour-promoting toxins in turtles. Given the expected increase in nutrient pollution associated with the growth in coastal development, experts consider this pressure to be of increasing concern to turtle populations that are already compromised. |
| **Marine debris** | Green turtle<br>Loggerhead turtle | *Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of, or abandoned, in the marine and coastal environment (UNEP 2005). The green and loggerhead turtles are known to be adversely affected by marine debris. Ingestion of debris is common, particularly plastic bags, which can be mistaken for prey (i.e. jellyfish) (Derraik 2002). This can cause turtles to float, thereby affecting foraging and animal health. Young turtles are especially vulnerable, as they drift within convergence zones (e.g. rips, fronts and drift lines formed by ocean currents) where high densities of marine debris accumulate. In a recent study by Boyle & Limpus (2008), synthetic materials accounted for up to 46% of total stomach content in green turtle post-hatchlings. Hatchlings are not able to compensate for the intake of non-nutritional items, and this results in reduced energy uptake. Research also indicates that toxins within materials are absorbed by turtles (Bjorndal et al. 1994). |

**Species assessed = 24 (sea snakes assessed as a group)**

| Pressure | Species | Rationale |
|---|---|---|
| **Light pollution (onshore activities and offshore activities)** | Green turtle<br>Loggerhead turtle | The Temperate East Marine Region is adjacent to a highly populated coastline where lighting from coastal development, ports and associated shipping activity is considered *of potential concern* to marine turtles, particularly during the breeding season. Light pollution along, or adjacent to, nesting beaches may alter nocturnal turtle behaviours, particularly the selection of nesting sites and the passage of adult females and emerging hatchlings from the beach to the sea (Limpus 2008b). The impacts of these changes in behaviour include a decrease in nesting success, beach avoidance by nesting females and disorientation, leading to increased mortality through predation, road kill and dehydration (Limpus 2008b; Lorne & Salmon 2007; Witherington & Martin 2000). Managers have addressed the issue by applying management zones to the majority of nesting sites (Limpus 2008b); for example, at Mon Repos Conservation Park, a 1.5 km radius darkness zone has been applied to protect nesting turtles. However, lighting from nearby towns is extensive and thought to remain visible out to sea for distances greater than 3 km, thereby influencing hatchling behaviour at Mon Repos (Limpus 2008b). |
| **Physical habitat modification (dredging)** | Green turtle<br>Loggerhead turtle<br>Sea snakes | Physical habitat modification due to dredging activities is expected to increase in areas adjacent to the Temperate East Marine Region due to the growth in recreational boating activity (Bay Journal 2008; MSQ 2011). Dredging can also occur in association with development projects for extractive purposes and for the installation of pipelines and cables. Dredging modifies nearshore habitats by removing or smothering benthic flora and fauna, and changing water flows (GBRMPA 2009). Marine turtles and sea snakes are likely to use habitats that are affected by dredging and are therefore vulnerable to this pressure. |
| **Extraction of living resources (commercial fishing, non-domestic)** | Green turtle<br>Hawksbill turtle | Marine turtles are protected in Australian waters but, because they roam internationally, declines may be due to unsustainable fishing in other parts of the species' range. Evidence indicates that fishing occurs in neighbouring South Pacific countries (Meylan & Donnelly 1999), with green and hawksbill turtles preferentially taken for their meat and shells, respectively, and sold in markets (e.g. Daru and Koki markets in Papua New Guinea). Long life spans and late sexual maturity make these species vulnerable to continued harvesting and impacts on populations both within and beyond the region (Dethmers et al. 2010). |

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch (commercial fishing)** | Hawksbill turtle<br>Sea snakes | Turtles are vulnerable to trawl, gillnet and longline fisheries gear and bycatch interactions typically result in the death of individuals by drowning. All three gear types are used across the region, and records indicate that hawksbill turtles are caught as bycatch (Limpus 2008a; 2008b; 2009). In the past decade, the introduction of turtle excluder devices (TEDs) in several key trawl fisheries has significantly reduced bycatch levels. Despite their success, TEDs are not universally used; for example, New South Wales trawl fisheries (e.g. New South Wales Ocean Trawl Fishery) do not use these devices.<br>Bycatch from the Queensland trawl fishery is the main pressure impacting on sea snakes (Cogger 2000). In particular, the redspot king prawn fishery records significant sea snake bycatch (Courtney et al. 2010. This fishery has the potential to impact on all species, especially the spectacled and small-headed seasnakes. Very little is known about either of these species, other than that they are slow to mature, have few young and do not survive well in trawl nets. |
| **Bycatch (illegal, unregulated and unreported fishing)** | Green turtle<br>Hawksbill turtle<br>Leatherback turtle<br>Loggerhead turtle | Illegal, unregulated and unreported (IUU) fishing is considered *of potential concern* for all turtle species. IUU fishing encompasses a complex range of fisheries activities, but generally refers to fisheries operations that violate the governing laws and conventions of that fish stock. Although not explicitly targeting turtle species, IUU fisheries operations create significant collateral damage to ecosystems. By their nature, such operations do not respect national and international actions designed to reduce bycatch and mitigate the incidental mortality of marine animals such as marine turtles (Agnew et al. 2009). Although IUU fishing is not a significant issue within the region, it is widespread in adjacent waters and is thought to be contributing to declines in turtle populations within the Temperate East Marine Region. |

| Species assessed = 24 (sea snakes assessed as a group) | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Oil pollution (shipping, vessels)** | Green turtle<br>Hawksbill turtle<br>Leatherback turtle<br>Loggerhead turtle<br>Sea snakes | Oil spills are unpredictable events and their likelihood is low, particularly in the context of the international and domestic regulatory mitigation measures that apply in Australia. However, their consequences can be severe, particularly in biologically significant areas and times. Shipping is a key activity in the region, with shipping routes servicing a number of ports adjacent to the region, and adjacent to habitat for turtles and sea snakes. Marine reptiles are affected by oil pollution through exposure when surfacing to breath, contaminated food supplies, fouling of nesting beaches and absorption through the skin (Anon 2010; Gagnon 2009; Watson 2009). Physical contact may result in a range of impacts including burns, damage to internal organs, and toxicity resulting in reduced hatchling success and deformities in developing embryos (AMSA 2010). |
| **Invasive species** | Green turtle<br>Loggerhead turtle | Egg predation by invasive or introduced species is a significant issue for marine turtle populations. An invasive species is defined as one that occurs and thrives outside its normal geographical distribution as a result of human activities, and can include animals, weeds, diseases and parasites (Olsen et al. 2006). Of particular concern to turtle populations within the region are the European red fox and feral pig, both of which have had impacts on turtle populations, particularly the eastern loggerhead stocks (Limpus & Limpus 2003; Limpus & Parmeter 1985; Tisdell et al. 2004). Extensive monitoring of (index) nesting sites both within the region (e.g. Mon Repos) and beyond (e.g. Gulf of Carpentaria) indicate that a high proportion of nests are destroyed by foxes and pigs. In the case of Mon Repos, a key nesting site for the loggerhead, predation has seriously impacted on the recruitment of females to the population, reducing overall stocks (Limpus & Limpus 2003). A Queensland Government fox eradication program has reduced fox impacts to negligible levels at key sites (i.e. Mon Repos); however, uncontrolled predation remains an issue. Threat abatement plans have been prepared under the EPBC Act for foxes and pigs (DEWHA 2008c; DEH 2005a). |

**Table S1.11: Pressures *of concern* to selected seabirds of the Temperate East Marine Region**

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in oceanography (climate change)** | Sooty tern | Changes in oceanography broadly refer to changes in ocean circulation patterns; current intensities; wind strength and direction; the location and strength of eddy and upwelling events; and climatic oscillations such as the El Niño–Southern Oscillation. The sooty tern is considered especially vulnerable to changes in oceanography through impacts on the distribution and availability of prey species, and on its breeding success. In the region, changes in oceanography will be primarily driven by the East Australian Current, which has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km). Models suggest with medium confidence that this trend will increase (Ridgway & Hill 2009). For the sooty tern, El Niño events have also been linked to breeding failure. In 2002, following an El Niño–Southern Oscillation event, sooty terns at Lord Howe Island experienced almost complete breeding failure, with the majority of chicks dying of starvation (Congdon et al. 2007). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Invasive species** | Black noddy<br>Common noddy<br>Crested tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Invasive species impact on seabird populations by preying on adults and nest contents (eggs and chicks), destroying nests and modifying habitat (DEH 2005). Invasive species are considered to be the greatest threat to seabirds after habitat loss, contributing to the threatened status of many species breeding within the region (Olsen et al. 2006). An invasive species is defined as one that occurs and thrives outside its normal geographical distribution as a result of human activities, and can include animals, weeds, diseases and parasites (Olsen et al. 2006). European settlers are implicated in the introduction of Australia's most established invasive species—the rat, rabbit and fox—all of which are known to threaten seabirds. More recent invaders also known to threaten seabirds include the Argentine ant and kikuyu grass. Rat predation on Lord Howe Island have resulted in the localised extinction of the Kermadec petrel, little shearwater and white-bellied storm-petrel (Garnett et al. 2011); severe degradation by rabbits of nesting habitat for Gould's petrel on Cabbage Tree Island (NSW NPWS 2000); and kikuyu grass mats on Montague Island that entangle little penguin adults and chicks (DECC 2009). Threat abatement plans have been prepared under the EPBC Act for pigs, rabbits, foxes, and exotic rodents on small islands (DEH 2005b; DEWHA 2008b; DEWHA 2008c; DEWHA 2009c). |

### Table S1.12: Pressures *of potential concern* to selected seabirds of the Temperate East Marine Region

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Sea level rise (climate change)** | Black noddy<br>Common noddy<br>Crested tern<br>Masked booby<br>Red-tailed tropicbird | Global sea levels have risen by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 to 1 m by 2100, relative to 2000 levels (Climate Commission 2011).<br>Seabird species nesting on the lowland parts of the Lord Howe Island group are at risk from sea level rise (Congdon et al. 2007). The impacts of rising sea levels on seabirds include loss of habitat through inundation of breeding sites, greater effect from storms (compounded by the predicted increase in frequency and intensity of storms), and impacts from altered erosion and deposition patterns (Chambers et al. 2009a). Impacts are expected to vary with breeding habitat and location, and high rocky islands are at lower risk than low-lying, less stable islands. However, there are no known quantitative links between observed sea level rise and changes in the distribution and abundance of nesting Australian seabirds (Chambers et al. 2009b). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in sea temperature (climate change)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Seabirds are expected to be impacted by rising sea temperatures through changes in the availability and distribution of prey species (Feng et al. 2009), thereby shifting the distribution of seabirds in the region. Distributions are most likely to move southward, which may alter reproductive timing and success (Chambers et al. 2009a). Beyond the region, impacts have been observed in the Great Barrier Reef on populations of sooty tern, black noddy and wedge-tailed shearwater. These species have experienced decreased breeding success linked to reduced prey rates driven by increasing water temperatures (Congdon et al. 2007; Peck et al. 2004; Smithers et al. 2003). Data from across the central and eastern Pacific, Indian and Southern oceans also indicate similar impacts in a number of seabird species (Chambers et al. 2009a). For species such as those breeding on the Lord Howe Island group that are already at the extremity of their breeding range and travel long distances to obtain food, any southward shifts in prey distribution are likely to greatly impact breeding success. |

**Species assessed = 34**

| Pressure | Species | Rationale |
| --- | --- | --- |
| **Changes in oceanography (climate change)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Changes in oceanography broadly refer to changes in ocean circulation patterns; current intensities; wind strength and direction; the location and strength of eddy and upwelling events; and climatic oscillations such as the El Niño–Southern Oscillation. In the region, changes in oceanography will be primarily driven by the East Australian Current, which has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km). Models suggest with medium confidence that this trend will increase (Ridgway & Hill 2009). At sea, seabirds commonly seek out regions of enhanced productivity (e.g. eddies or fronts) for foraging opportunities (BirdLife International 2010; Hyrenbach et al. 2000), and the breeding success of seabirds in the region is linked to the stability of a small number of highly productive nutrient hotspots along the edge of the continental shelf (Chambers et al. 2009a; Congdon et al. 2007). Temporal or spatial shifts in areas of upwelling are expected to influence the distribution, migration, foraging and breeding habits of seabirds (Chambers et al. 2009a). For example, El Niño events have been linked to breeding failure in seabirds (particularly temperate species) due to changes in ocean stratification and associated impacts on prey species. The southward movement of the East Australian Current is also expected to bring subtropical species into temperate waters, thereby increasing competition in foraging and nesting habitats (Chambers et al. 2009a). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Ocean acidification (climate change)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Driven by increasing levels of atmospheric $CO_2$ and subsequent chemical changes in the ocean, ocean acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). The impacts of ocean acidification on seabirds are expected to be indirect, through changes in the abundance, availability and distribution of prey species. For example, research indicates potentially significant impacts on Antarctic krill (Kawaguchi et al. 2011) and squid (Frisch 2006), which are important food sources for seabirds that visit the Temperate East Marine Region. |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Chemical pollution/ contaminants (shipping, vessel)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | The Temperate East Marine Region is highly exposed to possible vectors for chemical pollutants, including significant shipping and fishing activities in and adjacent to the region. It is expected that the effects of a major chemical spill would be similar to, or possibly exceed, those of a major oil spill (GBRMPA 2009). As top-order predators, seabirds are vulnerable to persistent chemical pollutants such as organochlorines, which accumulate through the food chain. Data in other regions show that chemical bioaccumulation results in seabird mortality and breeding failure (Becker 1989). A number of management measures are in place to respond to the risk of chemical spills, including the National plan to combat pollution of the sea by oil and other noxious and hazardous substances and the International Convention for the Prevention of Pollution from Ships (MARPOL), both of which are implemented through the Australian Maritime Safety Authority. |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Marine debris** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | *Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of or abandoned in the marine and coastal environment (UNEP 2005). Impacts of marine debris on seabirds include death through drowning, injury through entanglement, or starvation following ingestion (Baker et al. 2002). Seabirds are particularly prone to ingesting polystyrene balls and plastic buoys (which they confuse with fish eggs) and entanglement (which can kill individuals or slow them down, reducing their ability to catch prey and avoid predators) (Ceccarelli 2009). A regional study analysing 205 known interactions between seabirds and plastic debris across 29 species found approximately 70 per cent of birds perished (C&R Consulting 2009). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Light pollution (land-based activities)** | Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Little penguin | Light pollution from onshore sources is *of potential concern* for shearwaters, petrels and the little penguin because it can attract and disorientate seabirds. Petrels, shearwaters and penguins are vulnerable to this pressure as they commonly return to their breeding colonies at night (Aubrecht et al. 2010). Juvenile seabirds are thought to be particularly vulnerable to disorientation from artificial lighting because they are less familiar with visual cues (e.g. moon and stars) (Aubrecht et al. 2010). Although research on the impact of light pollution on seabird populations is limited, preliminary studies in Hawaii, the Reunion Islands and the Canary Islands indicate that light-induced mortality rates are an issue for petrels and small shearwaters (Aubrecht et al. 2010). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Human presence at sensitive sites (tourism, recreational and charter fishing, research)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Disturbance to seabirds during the breeding season may result in decreased the breeding success and fitness of adult birds, particularly when adult birds are distracted from foraging, roosting or resting (WMB Oceanics & Claridge 1997). For example, if adult birds are disturbed from a nest, the unattended eggs and chicks become vulnerable to predation. The extent of the impact at a breeding site is influenced by visitor frequency, approach distances and the sensitivity of particular species to disturbance. In general, ground nesting species (e.g. tern and booby species) are more vulnerable to disturbance; highly sensitive species include the roseate tern, little tern and crested tern (Langham & Hulsman 1986; Surman & Nicholson 2006; WMB Oceanics & Claridge 1997). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch (commercial fishing)** | Flesh-footed shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Great-winged petrel<br>White-necked petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross | Bycatch associated with commercial fisheries operating in the region is *of concern* for 16 species of seabird. Direct interactions with commercial fishing operations can lead to seabird death by drowning (e.g. on longline hooks), death by collision (e.g. warp strike) and more broadly, decreased fecundity. Bycatch generally affects larger species of seabird because they can swallow baited hooks and habitually follow ships (Baker et al. 2002). Seabirds are known to be particularly vulnerable to longline operations, and these fisheries (e.g. the Eastern Tuna and Billfish Fishery) implement bycatch mitigation measures guided by the threat abatement plan for the incidental catch of seabirds in longline fishing operations (DEWR 2006). However, further efforts are required to reduce the impacts of bycatch on seabirds and this pressure remains *of concern* (Bensley et al. 2010; DEWR 2006; Phillips et al. 2010; Wilcox & Donlan 2007). |
| **Bycatch (recreational and charter fishing)** | Flesh-footed shearwater | Bycatch associated with the domestic recreational and charter fishing sector is considered *of potential concern* for the flesh-footed shearwater. Recreational and charter fishing activities are widespread along Australia's east coast, and recreational boating activity is growing (Bay Journal 2008; MSQ 2011). The likelihood of seabird–fisher interactions is high, and these interactions can result in seabird injury and death from the ingestion of baited hooks and fishing line, and entanglement (McPhee et al. 2002). Trolling in particular is known to affect flesh-footed shearwaters (Australian Bird and Bat Banding Scheme, unpublished data). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Oil pollution (shipping, vessels)** | Black noddy<br>Common noddy<br>Crested tern<br>Roseate tern<br>Sooty tern<br>White tern<br>Grey ternlet<br>Flesh-footed shearwater<br>Little shearwater<br>Short-tailed shearwater<br>Sooty shearwater<br>Wedge-tailed shearwater<br>Black petrel<br>Black-winged petrel<br>Gould's petrel<br>Great-winged petrel<br>Kermadec petrel<br>Providence petrel<br>White-bellied storm-petrel<br>White-faced storm-petrel<br>White-necked petrel<br>Wilson's storm-petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross<br>Little penguin<br>Masked booby<br>Red-tailed tropicbird | Oil spills are unpredictable events and their likelihood is low, particularly in the context of the international and domestic regulatory mitigation measures that apply in Australia. However, their consequences can be severe, particularly in biologically significant areas and times. Shipping is a key activity in the region, with shipping routes servicing a number of ports adjacent to the region, and adjacent to seabird habitat. Seabirds are vulnerable to oil pollution because oil sticks to feathers, affecting their insulation and waterproofing properties, rendering some birds flightless or vulnerable to predation. Oil may also indirectly impact seabirds through effects on prey species such as damage to fish eggs, larvae and young fish (AMSA 2010). Chemicals used to disperse oil can themselves be toxic to marine life (AMSA 2010). Adjacent to the region, a study on the effects of oil spills on birds at Moreton and Bribie islands found that sites affected by the spill contained 50% fewer species than unaffected sites. Seabirds such as terns and gulls were considered among those most at risk (Birds Australia 2010). |

| Species assessed = 34 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Invasive species** | Roseate tern<br>Great-winged petrel<br>Wilson's storm petrel<br>Northern giant petrel<br>Southern giant petrel<br>Antipodean albatross<br>Black-browed albatross<br>Campbell albatross<br>Indian yellow-nosed albatross<br>Salvin's albatross<br>Wandering albatross<br>White-capped albatross | Invasive species impact on seabird populations by preying on adults and nest contents (eggs and chicks), destroying nests and modifying habitat (DEH 2005b). Invasive species are considered to be the greatest threat to seabirds after habitat loss, contributing to the threatened status of many species within the region (Olsen et al. 2006). An invasive species is defined as one that occurs and thrives outside its normal geographical distribution as a result of human activities, and can include animals, weeds, diseases and parasites (Olsen et al. 2006). European settlers are implicated in the introduction of Australia's most established invasive species—the rat, rabbit and fox—all of which are known to threaten seabirds. More recent invaders also known to threaten seabirds include the Argentine ant and kikuyu grass. Threat abatement plans have been prepared under the EPBC Act for exotic rodents on islands and rabbits (DEWHA 2009c, 2008a). |

**Table S1.13: Pressures *of concern* to selected sharks of the Temperate East Marine Region**

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Bycatch (commercial fishing)** | Grey nurse shark | The grey nurse shark is listed as threatened under the EPBC Act and is protected in Australian waters. The species interacts with a range of commercial fisheries, and there are reports of sharks with fishing gear trailing from their mouths (Bansemer & Bennett 2010). The effectiveness of management measures is not fully understood and bycatch mortality will continue to be *of concern* for this species until evidence of management effectiveness is conclusive. |
| **Bycatch (recreational and charter fishing)** | Grey nurse shark<br>White shark | The grey nurse shark is listed as threatened under the EPBC Act and is protected in Australian waters. The species interacts with the recreational and charter fishing sector, and there are reports of individuals with recreational fishing gear (e.g. trolling lures) trailing from their mouths (Bansemer & Bennett 2010). Due to the small population size and conservation status, any fishing-related mortality is *of concern* to the species.<br>The white shark is listed as threatened under the EPBC Act and is protected in Australian waters. Evidence suggests there is a partial failure to report captures of individuals and interactions within the recreational fishing sector (DEWHA 2009b). Data from the Great Barrier Reef Marine Park suggests post-release mortality could account for the majority of recreational fishing mortality. Mortality can occur as a result of capture and subsequent handling or, as seen in grey nurse shark populations, attached fishing gear (Lynch et al. 2009). |

**Table S1.14: Pressures *of potential concern* to selected sharks of the Temperate East Marine Region**

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Changes in sea temperature (climate change)** | Grey nurse shark<br>Porbeagle shark<br>Longfin mako shark<br>Shortfin mako shark<br>Whale shark<br>White shark | Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Increasing sea temperatures may result in changes in the metabolism, behaviour and movement patterns of sharks (Chin & Kyne 2007). Climate change vulnerability assessments for the grey nurse shark and white shark in the Great Barrier Reef assessed both species as moderately vulnerable to rising sea temperatures (Chin et al. 2010). Indirect effects on sharks in general relate to potential changes in abundance and distribution of prey species. For example, studies predict that ocean warming will cause a large southward shift in the distribution of many tropical and subtropical zooplankton (Hobday et al. 2006), which may influence the distribution of whale sharks both within the region and beyond. |
| **Change in oceanography (climate change)** | Grey nurse shark<br>Porbeagle shark<br>Longfin mako shark<br>Shortfin mako shark<br>Whale shark<br>White shark | Changes in oceanography broadly refer to changes in ocean circulation patterns; current intensities; wind strength and direction; the location and strength of eddy and upwelling events; and climatic oscillations such as the El Niño–Southern Oscillation. In the region, changes in oceanography will be primarily driven by the East Australian Current, which has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km). Models suggest with medium confidence that this trend will increase (Ridgway & Hill 2009). These changes are likely to impact on productivity, resulting in subsequent shifts in trophic webs and migration patterns, and changes to reef and shelf habitats, all of which have implications for shark species (Chin et al. 2010). For example, a climate change vulnerability assessment of sharks in the Great Barrier Reef region suggested that white sharks would have high exposure and vulnerability to oceanographic change (Chin et al. 2010). As a specialist plankton feeder, whale sharks are also considered to have high exposure and vulnerability to oceanographic change due to expected impacts on the abundance and distribution of plankton populations (Chin et al. 2010). Other migratory species (e.g. mako and porbeagle sharks) are expected to be similarly impacted. |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Human presence at sensitive sites (tourism, recreational and charter fishing, research)** | Grey nurse shark | Aggregation sites for grey nurse sharks off New South Wales and Queensland are popular recreational diving locations, and this threatened species is considered a major drawcard for recreational divers (Pollard et al. 1996). Interactions between divers and grey nurse sharks are common, and studies have found that sharks milled less in the presence of six or more divers, and the frequency of behaviours such as jaw gaping, rapid withdrawal and stiff or jerky movements correlated with the distance between divers and sharks (Pollard et al. 1996). Diving regulations are in place to limit the adverse effects of divers on sharks, particularly diver harassment of sharks (Smith et al. 2010). As recreational diving continues to grow in popularity, however, so does the potential for negative impacts at sensitive grey nurse shark sites. |
| **Extraction of living resources (commercial fishing)** | Shortfin mako shark | The shortfin mako is listed as migratory under the EPBC Act and the targeted commercial take of shortfin mako is prohibited in Commonwealth waters; however, individuals can be retained (as byproduct) if they are dead upon capture. Since their migratory listing in 2010, there has been a 30% reduction in the level of byproduct take and a number of management arrangements are in place; however, they remain vulnerable to capture in commercial fishing operations and this pressure remains *of potential concern*. |
| **Extraction of living resources (commercial fishing—non-domestic)** | Porbeagle shark<br>Longfin mako shark<br>Shortfin mako shark<br>White shark | The white shark is listed as both threatened and migratory under the EPBC Act and is protected in Australian waters; the shortfin and longfin mako sharks and porbeagle shark are listed as migratory under the EPBC Act. All are highly migratory, and it is expected that these species will cross over the region's exclusive economic zone boundary and thus be exposed to international commercial fisheries targeting sharks for their meat and fins. This pressure is devastating northern Australian shark populations and although temperate east populations are not expected to interact with this pressure to the same extent, it nonetheless has the potentially to significantly impact them (Lack & Sant 2008). |

| Species assessed = 9 | | |
|---|---|---|
| **Pressure** | **Species** | **Rationale** |
| **Extraction of living resources (illegal, unregulated and unreported fishing—non-domestic)** | Longfin mako shark<br>Shortfin mako shark | The shortfin and longfin mako sharks are listed as migratory under the EPBC Act and the targeted commercial take of both species is prohibited in Commonwealth waters; however, individuals can be retained (as byproduct) if they are dead upon capture. Mako sharks are an important component of the international shark fin trade (Clarke et al. 2006) and are vulnerable to capture in longline operations. It is likely that all non-domestic illegal, unregulated and unreported take, both within and beyond Australian waters, will impact on populations of mako sharks within the region. |
| **Extraction of living resources (illegal, unregulated and unreported fishing—domestic)** | White shark | The white shark is listed as threatened under the EPBC Act and is protected in Australian waters. Although fishing of white shark is prohibited, the illegal capture of white sharks by the commercial and recreational fishing sector and the illegal trade in white shark products threaten populations in Australian waters (DEWHA 2010). Demand for white shark products as trophies (e.g. jaws and teeth), as well as fins for the fin trade, has increased their value and there is evidence that these items support both international and national illegal trade (EA 2002). Despite strict regulations in both sectors, the high prices obtained for white shark products continue to provide incentive for this illegal trade (DEWHA 2010). |
| **Bycatch (commercial fishing)** | White shark | The white shark is listed as threatened under the EPBC Act and is protected in Australian waters. Individuals have been recorded hooked on longlines and caught in the nets of commercial fishing operations and aquaculture cages (e.g. tuna farms) (DEWHA 2010). Given the lack of data on white shark populations, it is unknown whether the species is recovering. Consequently, the effectiveness of management measures is not fully understood and bycatch mortality continues to be *of potential concern* for this species until conclusive evidence of management effectiveness is provided. |

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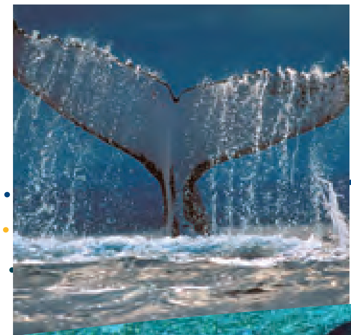

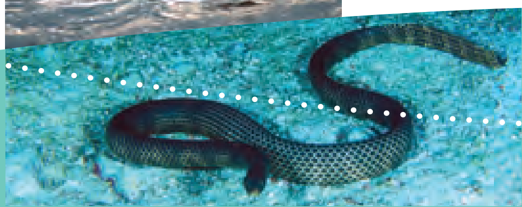


# SCHEDULE 2

## Regional advice on matters of national environmental significance

# SCHEDULE 2
# REGIONAL ADVICE ON MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

# Introduction

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an action requires approval from the environment minister if it has, will have or is likely to have a significant impact (refer to glossary **www.environment.gov.au/marineplans**) on a matter of national environmental significance. A person proposing to take an action that they think is, or may be, such an action must refer it to the minister for a decision as to whether further assessment and approval are required under the EPBC Act. Substantial penalties apply for taking such an action without approval.

There are currently eight matters of national environmental significance protected under the EPBC Act:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species (except those listed as extinct or conservation dependent) and ecological communities (except those listed as vulnerable)
- migratory species protected under international agreements
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- nuclear actions, including uranium mines.

This schedule to the Temperate East Marine Bioregional Plan has been prepared under the EPBC Act. It contains information about matters of national environmental significance within the Temperate East Marine Region and should be considered when deciding whether a proposed action needs to be referred to the environment minister for a decision.

Under section 176 of the EPBC Act, once a bioregional plan has been made, the environment minister must have regard to it when making any decision under the Act to which the plan is relevant. The minister will have regard to the information provided in Schedule 2 when making decisions about referrals, assessments and approvals, as well as other relevant decisions under the EPBC Act. However, this does not limit the information the minister may consider when making decisions.

The advice contained in this schedule is not comprehensive (i.e. it does not cover all matters of national environmental significance occurring in the Temperate East Marine Region) and should not be regarded as definitive in relation to those matters for which advice is provided.

The regional advice should be read as supplementary to, and not as replacing, EPBC Act policy statements. In particular, the following policy statement is the key guidance document for determining whether a referral is required:

- *EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance.*

Depending on the type of action proposed, industry policy statements also provide important information:

- *EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales*
- *EPBC Act Policy Statement 2.2: Industry—offshore aquaculture*
- *EPBC Act Policy Statement 2.3: Wind farm industry.*

Other policy statements and guidelines may also be developed and provide important information. Further information and assistance can be obtained by contacting the referral business entry point through the department's community information unit on 1800 803 772 or by sending an email to **epbc.referrals@environment.gov.au**.

Schedule 2 does not provide advice for the assessment of the environmental performance of fisheries managed under Commonwealth legislation and state export fisheries. Guidelines for the strategic assessment of fisheries under Part 10 of the EPBC Act; assessments relating to impacts on protected marine species under Part 13; and assessments for the purpose of export approval under Part 13A are contained within the document Guidelines for the Ecologically Sustainable Management of Fisheries (**www.environment.gov.au/coasts/fisheries/publications/guidelines.html**).

## Using the regional advice

This schedule is a guide and is not definitive. The regional advice provided in this schedule is augmented by information provided in the conservation value report cards, which are available on the website of the Department of Sustainability, Environment, Water, Population and Communities at **www.environment.gov.au/marineplans/temperate-east**.

The rating of risks in this schedule was developed to provide practical information on the kinds of actions which should be referred to determine if approval under the EPBC Act is needed. The ratings here are not designed to prioritise environmental risks. They relate to the risk of a proposed action needing to be referred under the EPBC Act. The highlighted advice provide further assistance in identifying types of activities that are at low risk of needing to be referred and those that are at higher risk of needing to be referred.

Considerations underpinning the rating of a risk include:

- pressure rating (of key ecological features and species, see Tables S1.2 and S1.3)
- conservation status (of species)
- presence of a biologically important area (for species; see Conservation Values Atlas **www.environment.gov.au/cva**)
- trends in pressures.

**Commonwealth marine environment:** Section 24 of the EPBC Act defines a Commonwealth marine area (see glossary for further details). It is the area that extends beyond the outer edge of State and Territory waters, generally 3 nautical miles (or 5.5 kilometres) from the coast, to the boundary of Australia's exclusive economic zone generally 200 nautical miles (370 kilometres) from shore. Under the EPBC Act, the environment within the Commonwealth marine area is a matter of national significance.

Where sufficient information exists to aid decision-making, this schedule presents regional advice on the Commonwealth marine environment in relation to:

- key ecological features of the Temperate East Marine Region and protected places
- protected species that occur in the Temperate East Marine Region that are not otherwise matters of national environmental significance.

Some advice provided in this schedule refers to **biologically important areas**. These are areas that are particularly important for the conservation of protected species and where aggregations of individual species display biologically important behaviour, such as breeding, foraging, resting or migration. The presence of the observed behaviour is assumed to indicate that habitat required for the behaviour is also present. Regional advice has been developed for biologically important areas due to their relevance to a protected species. The advice focused on these areas should not be construed to mean that legislative obligations do not apply outside these areas. Biologically important areas are not protected matters and should not be confused with 'critical habitat' as defined in the EPBC Act.

A register of **critical habitat** is maintained under the EPBC Act. The register lists habitats considered critical to the survival of a listed threatened species or listed threatened ecological community. If a habitat occurs in or on a Commonwealth area and is listed in the register, it is an offence under the EPBC Act to take an action when it is known that the action significantly damages the critical habitat.

Species protected under the EPBC Act may be listed as threatened, migratory or marine species. Those protected species that are matters of national environmental significance are:

- threatened species (other than those categorised as extinct or conservation dependent)
- migratory species.

Species that are listed under the EPBC Act but are *not* matters of national environmental significance include those species that are listed as:

- marine (s. 248 of the EPBC Act)
- cetaceans (whales, dolphins and porpoises)
- threatened species listed as extinct or conservation dependent.

However, it is possible for listed marine species and cetaceans to also be matters of national environmental significance; that is, where they have been listed as a threatened species (other than in the conservation dependent category) or as migratory. For example, the humpback whale is listed as a cetacean but it is also a matter of national environmental significance because it is listed as vulnerable and migratory under the EPBC Act.

A number of terms related to protected species that are matters of national environmental significance have specific meaning under the EPBC Act, namely:

- **Population:** A population of a species is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to species that are categorised as critically endangered, endangered or vulnerable occurrences include but are not limited to:
  - a geographically distinct regional population or collection of local populations
  - a population or collection of local populations that occurs within a particular bioregion.
- **Important population:** This term relates to populations of threatened species that are categorised as vulnerable under the EPBC Act. An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or populations that are:
  - key source populations either for breeding or dispersal
  - necessary for maintaining genetic diversity
  - near the limit of the species' range.

This definition is consistent with that provided in EPBC Act *Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance*. In accordance with these guidelines, in determining the significance of an impact on a vulnerable species, consideration should be given to whether an important population is found in the area.

- **Ecologically significant proportion of a population:** This term applies to species listed as migratory. In accordance with Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance, for migratory listed species, consideration should be given to whether an ecologically significant proportion of a population is found in an area. Whether the species in an area represents an ecologically significant proportion of a population needs to be determined on a case-by-case basis, as different species have different life histories and populations. Some key factors that should be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).

## Schedule 2.1
## The Commonwealth marine environment of the Temperate East Marine Region

The Commonwealth marine environment, including the Temperate East Marine Region, is a matter of national environmental significance under the EPBC Act. An action requires approval if it is taken:

- in a Commonwealth marine area (refer to glossary **www.environment.gov.au/marineplans**), and the action has, will have, or is likely to have a significant impact on the environment, or
- outside a Commonwealth marine area but within Australian jurisdiction and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area.[7]

7 Actions taken outside the Commonwealth marine area may impact on its environment through downstream effects—for example, by resulting in water quality changes that can spread offshore beyond 3 nautical miles or by adversely affecting species that are an important component of the Commonwealth marine environment, either throughout, or at specific stages of, their lifecycle. For example, seagrass beds are an important nursery habitat for a number of species, some of which move offshore in their adult stages. Reductions in seagrass beds—for example, as a result of dredging—depending on their extent, have the potential to impact on the population dynamics of a number of species that inhabit the Commonwealth marine area

The Temperate East Marine Region covers Commonwealth waters extending from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, as well as the waters surrounding Lord Howe and Norfolk islands. The marine environment is made up of numerous habitats, biological communities and ecosystems. Determining whether a proposed action has the potential to cause a significant impact on the marine environment requires consideration of its individual and combined components at a scale relevant to the action.

The EPBC Act Policy Statement 1.1 outlines criteria to assist in determining the significance of impacts on the Commonwealth marine environment. Specifically, an action is likely to have a significant impact on the Commonwealth marine environment if there is a real chance or possibility that the action will:

- result in a known or potential pest species becoming established in the Commonwealth marine area
- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that there will be an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area
- have a substantial adverse effect on a population of a marine species or cetacean, including its lifecycle (e.g. breeding, feeding, migration behaviour or life expectancy) and spatial distribution
- result in a substantial change in air quality or water quality (including temperature) that may adversely impact on biodiversity, ecological integrity, social amenity or human health
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected
- have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

The regional advice in this schedule has been developed to assist the interpretation of some of these criteria within the context of the Temperate East Marine Region. The regional advice addresses:

- S2.1.1: establishment of marine pest species
- S2.1.2: adverse impacts on marine ecosystem functioning and integrity
- S2.1.3: adverse effects on populations of a marine species or cetacean (excluding those listed as threatened or migratory)
- S2.1.4: adverse impacts on heritage values
- S2.1.5: actions in Commonwealth marine reserves.

## S2.1.1 Establishment of marine pest species

Although the Commonwealth waters of the Temperate East Marine Region contain introduced marine species, no pest species[8] has been recorded yet in this region. Adjacent to the region, Queensland has no recorded established invasive marine pests; however, 26 invasive marine pests are listed as posing a potential threat to the state (Hayes et al. 2004). In New South Wales waters, six listed marine pest species occur (Table S2.1) (NSW Industry & Investment 2011).

The invasive strain of the green alga Caulerpa which occurs in State waters adjacent to the region, is capable of invading benthic communities in depths up to 100 metres. Other species in State waters capable of spreading into deeper water environments include the European/green shore crab, European fan worm, Japanese goby, and the New Zealand screw shell. The National System for the Prevention and Management of Marine Pest Incursions maintains a ‘trigger list’ of species that may become invasive if introduced as part of its Emergency Marine Pest Plan.[9]

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8 Introduced marine pests are marine plants or animals that are not native to Australia but have been introduced by human activities such as shipping and have become aggressive pests.

9 **www.marinepests.gov.au**

**Table S2.1: Marine pests known to be established in State waters, adjacent to the Temperate East Marine Region**

| Pest name | Location | Impact | Habitat |
|---|---|---|---|
| Caulerpa<br>*(Caulerpa taxifolia)* | Batemans Bay<br>Botany Bay<br>Brisbane Waters<br>Burril Lake<br>Durras Lake<br>Lake Conjola<br>Narrawallee Inlet<br>Hawkesbury River<br>Pittwater<br>Port Hacking<br>Port Jackson<br>St Georges Basin<br>Wallagoot Lake | Overgrows native habitat and can establish vast beds on soft sediment, degrading fish habitat<br>Tangles in nets and anchors | Depths up to 100 m<br>Exposed and sheltered estuaries, coastal lagoons and bays<br>Rock, sand, mud and seagrass beds |

| Pest name | Location | Impact | Habitat |
|---|---|---|---|
| European or green shore crab *(Carcinus maenas)* | Clyde River Batemans Bay<br>Tomaga River/ Barlings Beach<br>Candlagan Creek<br>Coila Lake<br>Wagonga Inlet<br>Nangudga Lake<br>Corunna Lake<br>Tilba Tilba Lake<br>Bermagui River<br>Cuttagee Lake<br>Wapengo Lake<br>Nelson Lagoon<br>Merimbula Lake<br>Pambula Lake<br>Twofold Bay<br>Towamba River<br>Kiah Creek<br>Wonboyn River<br>Nadgee Lake | Aggressive predator, outcompetes native species for food and habitat | Prefers bays and estuaries but found on all types of shores at depths up to 60 m<br>Tolerates temperatures up to 30 °C |

| Pest name | Location | Impact | Habitat |
|---|---|---|---|
| European fan worm (*Sabella spallanzanii)* | Twofold Bay (near Eden) | Forms dense colonies that consume vast amounts of food<br><br>No known predators in Australia | Tubes attached to hard surfaces, artificial structures, rocks, shells and seagrass on soft sediments<br><br>Sheltered waters, depths up to 30 m |
| Japanese goby *(Tridentiger trigonocephalus)* | Sydney Harbour Port Kembla | Competes with native species | Prefers estuaries and rocky reef areas |
| New Zealand screw shell *(Maoricolpus roseus)* | Continental shelf off Merimbula and Bermagui | Forms a dense covering on the sea floor and competes with native shellfish for food | Depths up to 130 m<br><br>Prefers sand, mud or gravel in intertidal to subtidal areas |
| Pacific oyster *(Crassostrea gigas)* | Most New South Wales estuaries south of the Macleay River and some offshore areas | Establish dense populations in some areas, displacing native intertidal species, with the potential to modify habitat for non-oyster species | Depths up to 3 m<br><br>On hard substrate in intertidal and shallow subtidal areas<br><br>Favours brackish waters in sheltered estuaries but tolerates a range of salinity and water quality<br><br>Can also occur offshore |

Marine pests can be introduced through ballast water exchange or via biofouling. High-risk vessels for the introduction of species include those that are slow moving, have space where marine species can settle, come in close contact with the sea bottom or remain in a single area for extended periods. These characteristics increase the likelihood that a species can establish on a vessel, from where it can be introduced to new regions. Vessels in this category include dredges, supply boats, drilling rigs and some fishing boats. Other high-risk ships include some of the flag-of-convenience carriers that are low-cost operators with poorly maintained vessels, as well as small private recreational vessels from other parts of the world.

Shallow and inshore areas, particularly port areas and sites where infrastructure development and maintenance take place, have the highest risk of marine pests becoming established. Some introduced species have the potential to settle or expand into deeper waters, including in the offshore Commonwealth marine environment.

The introduction of marine pests is a particularly important issue for the Temperate East Marine Region given the high levels of sea transport to and through the region, and fishing activity in the region.

The following types of actions have a real chance or possibility of resulting in marine pests becoming established in the Commonwealth marine environment, thereby affecting the biodiversity values and/or ecological integrity of the Commonwealth marine environment:

- development of new ports or upgrades of existing port facilities that substantially increase shipping traffic
- construction of infrastructure or any other action involving the translocation into the region of marine equipment (e.g. dredges or platforms), from within or outside Australia.

There is a low risk of marine pests becoming established in the Commonwealth marine environment or affecting its biodiversity values and/or ecological integrity as a result of these actions when appropriate mitigation measures are adopted. Mitigation measures consistent with the National System for the Prevention and Management of Marine Pest Incursions, the Australian Ballast Water Management Requirements and the *National biofouling management guidelines for commercial vessels*[10] and the *National biofouling management guidelines for recreational vessels*[11] aim to reduce the risk that actions will result in the introduction of marine pests, which may significantly impact on the Commonwealth marine environment, in port and inshore environments. Further information on responsibilities regarding the management of marine pest incursions is provided at **www.marinepests.gov.au**.

## S2.1.2 Adverse impacts on marine ecosystem functioning and integrity

The Temperate East Commonwealth marine environment report card provides an overview of key ecological features defined for the region and their relevance to ecosystem processes and structure. While the report card provides useful context, determining potential impacts of specific activities on the Commonwealth marine environment requires consideration of habitats and biodiversity at an appropriate subregional and local scale.

10 **www.marinepests.gov.au/_data/pdf_file/001/1109594/Bifouling_guidelines_commercial_vessels.pdf**.
11 **www.marinepests.gov.au/_data/pdf_file/001/1109594/Bifouling_guidelines_rec.pdf**.

The regional advice below provides further guidance for considering impacts on areas and habitats that are defined as key ecological features in the Temperate East Marine Region by virtue of their regional importance for biodiversity and/or ecosystem functioning and integrity. The Temperate East Commonwealth marine environment report card provides further information, including references to relevant scientific literature, on the region's key ecological features.

The advice here provides information of relevance to people considering impacts on the Commonwealth marine environment. It is essential to note that provision of advice in relation to the key ecological features does not imply that they are the only habitats, areas, species or species groups that should be considered when determining the significance of potential impacts on the Commonwealth marine environment. It remains the responsibility of a person proposing to take an action to determine whether there is a real chance or possibility that the action is likely to result in a significant impact on the Commonwealth marine environment.

The Temperate East Marine Region has eight areas and/or types of habitats that are key ecological features (see Figure S1). Further information on these key ecological features is provided in the Temperate East Commonwealth marine environment report card (**www.environment.gov.au/marineplans/temperate-east**).

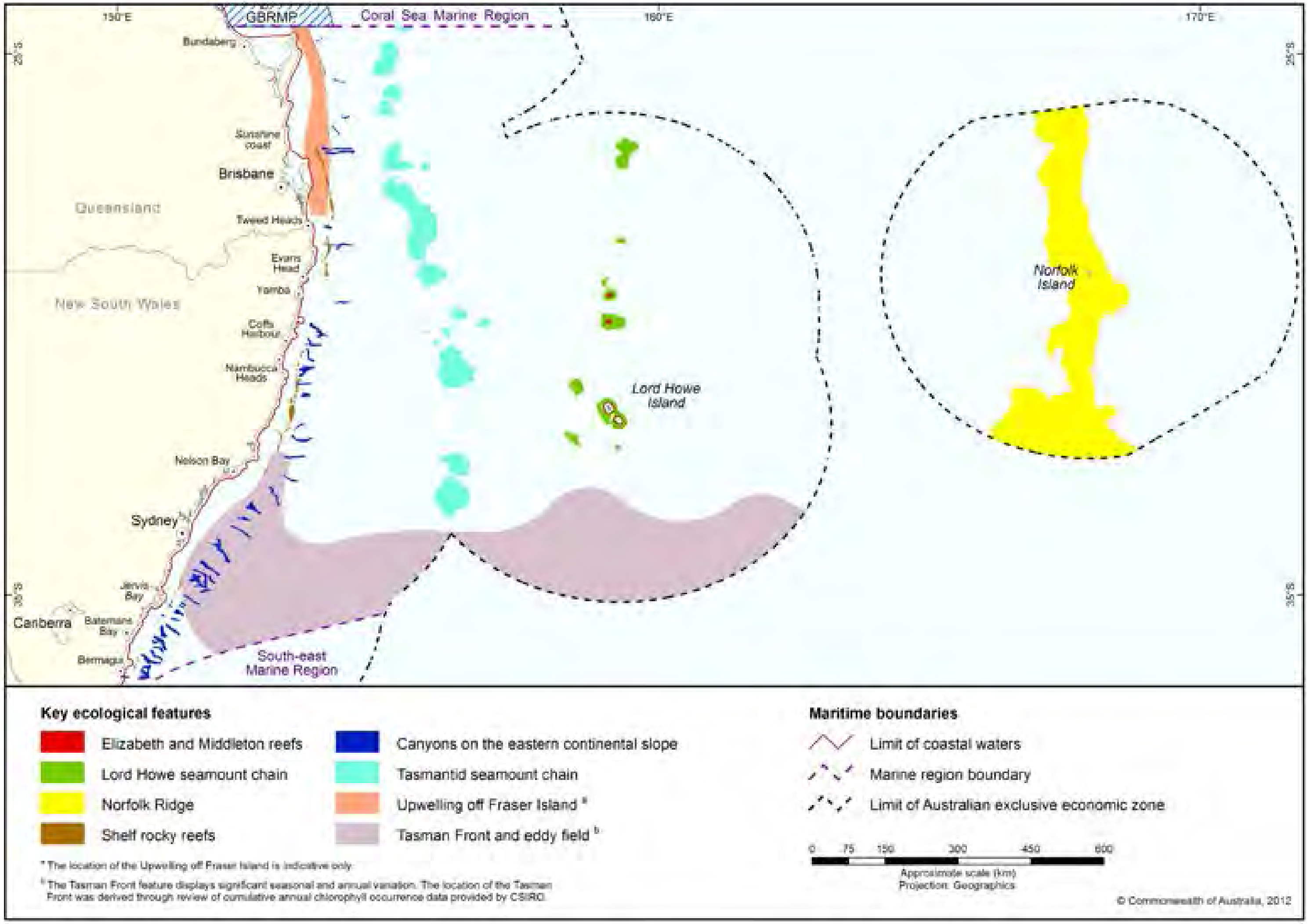


**Figure S2.1: Key ecological features in the Temperate East Marine Region**

In assessing the impacts of a proposed action on the Commonwealth marine environment and their significance, the relevance of the proposed action to the regional importance and vulnerabilities of the key ecological features described below should be considered.

**Shelf rocky reefs:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to its benthic habitats.

Along the continental shelf south of the Great Barrier Reef, benthic communities on rock outcrops and boulder substrates shift from algae-dominated communities to those dominated by attached invertebrates. This shift generally occurs at a depth of 45 metres, and these habitats are densely populated by large sponges, with a mixed assemblage of moss animals and soft corals. Below wave-influenced areas, massive and branched forms of sponges are more prevalent, and sponge species richness and density generally increases with depth along the New South Wales coast. Collectively, these invertebrates create a complex habitat–forming community that supports a multitude of microorganisms and invertebrates, such as crustaceans, molluscs, annelids and echinoderms. These habitats also provide refuge from predation for juvenile fishes, thereby increasing their survival. Rocky reef habitats on Australia's east coast support a diverse assemblage of demersal fish, which show distinct patterns of association with shelf reef habitats. For example, jackass morwong, barracouta, orange-spotted catshark, eastern orange perch, butterfly perch and warehou are species that distinguish rocky reef habitats at depths greater than 45 metres from those of soft sediments.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes, and causing ocean acidification. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- marine debris from vessel based sources
- physical habitat modification from fishing gear
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Generally, most actions in or adjacent to the Temperate East Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Shelf rocky reefs.

**Canyons on the eastern continental slope:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats.

Submarine canyons are widespread features around the Australian continent and island margins, and a large number of these features are present on the eastern continental slope. Canyon systems have a marked influence on the diversity and abundance of species, driven by the combined effects of steep and rugged topography, ocean currents, varied sea-floor types and nutrient availability. Large benthic species such as attached sponges and feather stars are abundant, with high diversity at upper-slope canyon depths of 150–700 metres. Canyons also provide critical feeding grounds for a wide range of species, including many which are commercially important (e.g. tuna) and threatened (e.g. marine turtles). Canyons contribute to habitat diversity by providing a hard surface that offers anchoring points and vertical relief for filter feeder benthic species (e.g. sponges and bryozoans). A range of higher trophic level species, including crustaceans, echinoderms, bivalves, cephalopods and fish are then attracted to these regions.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of the canyons on the eastern continental slope
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters surrounding the canyons on the eastern continental slope

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) in the canyons on the eastern continental slope have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Tasman Front and eddy field:** This key ecological feature is recognised for its significant ecological functioning and integrity, and biodiversity, which apply to its pelagic habitats.

The Tasman Front is described as a region of intermediate productivity that separates the nutrient-poor waters of the Coral Sea from the nutrient-rich waters of the Tasman Sea. The front is formed by a meandering current located between 27° S and 33° S, which moves northward in winter months and southward in summer months. Across the southern portion of the Temperate East Marine Region, the Tasman Front creates a complex oceanographic environment where waters mix vertically. Patches of productivity are important for mid-level consumers including turtles and top fish predators, as well as catch in the Eastern Tuna and Billfish Fishery. Fishery oceanography studies describe a positive relationship between catch rates and proximity to frontal features, and a predominance of bigeye tuna and swordfish associated with the Tasman Front. The feature is also important for providing connectivity of tropical species to the Lord Howe seamount chain and Norfolk Ridge.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of the Tasman Front and eddy field
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters in the area of the Tasman Front and eddy field

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) in the area around the Tasman Front and eddy field have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Upwelling off Fraser Island:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to its pelagic habitats.

In the vicinity of Fraser Island, two areas of upwelled waters mix with surface waters and are drawn onto the shelf through a number of processes, including tidal currents, wind and eddy influence. The upwelled waters support blooms of large diatoms that are important to food chains for commercially valuable species in the area. Examples of food chains include diatoms → macrozooplankton → laternfish → squid → tuna and billfish (long-chain), and diatoms→ crustaceans → tuna (short-chain). However, the entire food web for this system is complex and includes small pelagic fishes, mid-sized fish predators and top predators. The feature also appears to be an important node of connectivity in migrations of small pelagic fishes and top predators. The subtropical waters are an important spawning area for temperate small pelagic fishes (e.g. tailor, sardine, round herring and Australian anchovy), the adults of which appear to migrate from the south, and their larvae are subsequently transported back into temperate nursery areas by the East Australian Current.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes. These changes alter localised productivity and/or community structures through shifts in marine species distribution

- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of the upwelling off Fraser Island
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters in the area of the Fraser upwelling

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising (e.g. port developments that increase shipping and drilling) in the area of the upwelling off Fraser Island have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Tasmantid seamount chain:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats.

The Tasmantid seamount chain is a prominent chain of submarine guyots, plateaux and terraces, running north–south at approximately 155° E, and extending down into the Tasman Basin. At its deepest, features rise from 1400–900 metres below sea level; at its northern extent, features rise to from 400–150 metres below sea level, with some breaking the surface to form islands. The Tasmantid seamount chain supports a diverse range of habitats, including deep sea sponge gardens and near-pristine tropical coral reef systems. Collectively, these are known to be biological hotspots, supporting significant demersal and pelagic diversity, and feeding grounds and reproduction sites for a number of open ocean species (e.g. billfish, marine turtles, marine mammals). There is limited information regarding pelagic species composition around these seamounts, but little information on benthic species. High species diversity and endemicity has been reported from the neighbouring Lord Howe seamount chain, however, which may be used as an indicator for biodiversity levels for the Tasmantid chain.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes, and causing ocean acidification. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of the Tasmantid seamount chain
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters surrounding the Tasmantid seamount chain (i.e. waters adjacent to areas of the seamount chain that break the surface and those above areas that do not break the surface)

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) over the Tasmantid seamount chain have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Lord Howe seamount chain:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats.

The Lord Howe seamount chain runs for approximately 1000 kilometres along the western margin of the Lord Howe Rise, extending from Lord Howe Island in the south to Nova Bank in the north. The chain includes Lord Howe Island, Balls Pyramid, Elizabeth Reef, Middleton Reef and Gifford Guyot within the Temperate East Marine Region, and to the north of the Region are Capel, Kelso, Argo and Nova banks. The seamount chain supports tropical shallow coral reefs and deep cold water corals (depths greater than 40 metres). The fringing coral reefs around Lord Howe Island, and Elizabeth and Middleton reefs to the north, are the southernmost tropical coral reefs in the Pacific Ocean. The seamount chain lies in the path of the Tasman Front, which brings a mix of warm tropical waters and colder, nutrient-rich waters from the south, depending on the season. In general, waters surrounding this feature are nutrient-deficient and relatively unproductive. However, significantly higher catch rates of a range of tuna species along the seamounts suggest periodic bursts of productivity, presumably from subantarctic waters to the south. Deep-water, large, benthic animals occur on the Lord Howe Rise and southern portion of the Norfolk Ridge, with distributions influenced by the Tasman Front. The distribution of benthic invertebrates does extend from the Lord Howe Rise across to the northern part of the Norfolk Ridge as these features lack a hydrographic connection.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes, and causing ocean acidification. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature’s ecosystem functioning and integrity
- bycatch.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of the Lord Howe seamount chain
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters surrounding the Lord Howe seamount chain (i.e. waters adjacent to areas of the seamount chain that break the surface and those above areas that do not break the surface)

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) over the Lord Howe seamount chain have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Elizabeth and Middleton temperate and tropical reefs:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats.

The Elizabeth and Middleton reefs are small, isolated, oceanic platform-reefs on volcanic seamounts of the Lord Howe seamount chain. The reefs are within the present filaments of the East Australian Current and represent an overlapping area of tropical, reef-building corals and cool-water, non-reef-building corals, which provide habitat for both tropical and temperate species of fish and invertebrates. The lagoons of both reefs are strongholds for populations of the black cod and Galapagos shark. A recent study of the genetic diversity of the reefs and their connectivity suggests that their gene pools are periodically supplemented by long-distance migrants and they are likely to have population sizes that are large enough to avoid inbreeding and maintain genetic diversity. For example, 48 per cent of the coral species of the southern Great Barrier Reef are also found on Elizabeth and Middleton reefs.

A pressure *of concern* on this key ecological feature is climate change, which has the potential to alter the ecological values of this feature through changes to sea temperature and ocean acidification. These changes alter localised productivity and/or community structures through shifts in marine species distribution.

Pressures *of potential concern* on the ecosystem functioning and integrity of this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea levels and oceanographic processes. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- oil pollution and chemical pollution/contaminants from shipping traffic which can impact on water quality and ecosystem functioning and integrity
- marine debris from vessel based sources
- light pollution from offshore activities such as shipping traffic.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- a substantial change in water quality that may adversely impact on biodiversity or ecological integrity in the area of Elizabeth and Middleton reefs
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the waters surrounding Elizabeth and Middleton reefs
- the introduction of a new source from which light pollution may modify, destruct, fragment, isolate or disturb an important or substantial area of habitat within the Elizabeth and Middleton reef ecosystems

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping) at Elizabeth and Middleton reefs have a **risk** of significant impact on the Commonwealth marine environment of the Temperate East Marine Region.

**Norfolk Ridge:** This key ecological feature is recognised for its enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats.

The Norfolk Ridge is set within a region of remnant volcanic arcs, plateaux, troughs and basins. The ridge runs southward from New Caledonia to New Zealand, and lies between the New Caledonia Trough to the west and the Norfolk Basin to the east. The high level of diversity in seamount benthos in this area is likely to be caused by relatively productive benthic habitats that support far higher population densities than surrounding regions. The Tasman Front conveys tropical species to the southern portion of the ridge within the Temperate East Marine Region, supporting a diverse assemblage of tropical and temperate species, with evidence of connectivity to the benthic fauna of Lord Howe Rise. The semipermanent Norfolk Eddy may create a closed system that limits connectivity and increases endemism within the South Norfolk Basin.

Pressures *of potential concern* on this key ecological feature include:

- climate change, which has the potential to alter ecological values through changes to sea temperatures and oceanographic processes, and causing ocean acidification. These changes alter localised productivity and/or community structures through shifts in marine species distribution
- marine debris from vessel based sources
- extraction of living resources by commercial fishing impacting on the feature's ecosystem functioning and integrity
- bycatch.

Generally, most actions in or adjacent to the Temperate East Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Norfolk Ridge.

## S2.1.3 Adverse impacts on populations of a marine species or cetacean (excluding those listed threatened or migratory)[12]

An impact on the Commonwealth marine environment might be significant if there is a real chance or possibility that it will result in a substantial adverse effect on a population of a marine species, including its lifecycle and spatial distribution. The regional advice below provides further guidance that might assist in considering impacts on the Commonwealth marine environment of the Temperate East Marine Region and their significance, with respect to:

- protected marine species, which are not considered matters of national environmental significance, including
  - cetaceans of known regional importance (that are not listed as threatened or migratory species under the EPBC Act)
  - listed marine species of known regional importance (that are not listed as threatened or migratory species under the EPBC Act)
  - threatened species listed as conservation dependent that are of known regional importance
- species and/or communities that have been defined as key ecological features, as they are believed to play an important role in the Temperate East Marine Region's ecosystem structure and functioning and/or to have particular relevance to its biodiversity and conservation.

It is essential to note that the provision of advice in relation to these species does not imply that they are the only species that should be considered in determining the significance of potential impacts on the Commonwealth marine environment. It remains the responsibility of a person proposing to take an action to determine whether the action will adversely and substantially affect any other marine species in a way that results in a significant impact on the Commonwealth marine environment.

12 Advice on the significance of actions for species listed as threatened and/or migratory that are matters of national environmental significance is provided in Schedules 2.2 to 2.5. (Listed threatened species that are conservation dependent and are not, of themselves, matters of national environmental significance are discussed here.)

### *Protected species of known regional importance (not listed as threatened or migratory)*

Sixty-eight species protected under Part 13 of the EPBC Act (but not listed as threatened or migratory) are currently known to occur in the Temperate East Marine Region (see Table A appended to this schedule). The information currently available on many of these species is insufficient to provide separate regional advice. Six species are of known importance in the context of the region's biodiversity and/or ecological functioning. These species are described below to assist in the interpretation of the significant impacts criteria of EPBC Act Policy Statement 1.1.

The **Indo-Pacific (coastal) bottlenose dolphin** *(Tursiops aduncus)* is listed as cetacean and protected under the EPBC Act. Biologically important areas are defined for this species within the Temperate East Marine Conservation Values Atlas (**www.environment.gov.au/cva**). The Indo-Pacific bottlenose dolphin was only recently recognised and is considered taxonomically distinct from the common bottlenose dolphin. The common bottlenose dolphin is found throughout offshore waters of the region (including Norfolk and Lord Howe islands), but Indo-Pacific bottlenose dolphins occur in riverine and coastal waters, over shallow coastal waters on the continental shelf and around oceanic islands.

Pressures *of concern* to this species include:

- physical habitat modification associated with urban/coastal development
- bycatch associated with commercial fishing and bather protection programs.

Pressures *of potential concern* include:

- climate change (sea level rise, changes in sea temperature, oceanography and storm events and ocean acidification)
- chemical pollution/contaminants and nutrient pollution associated with urban development and agricultural activities
- marine debris
- noise pollution associated with shipping and urban development
- physical habitat modification associated with dredging activities
- oil pollution associated with shipping
- collision with vessels
- changes in hydrological regimes.

Actions that have a real chance or possibility of increasing the likelihood of chemical contamination, oil pollution and sediments in biologically important areas for the Indo-Pacific (coastal) bottlenose dolphin have a **risk** of resulting in substantial adverse effects on populations of these species.

Actions that have a real chance or possibility of increasing localised vessel traffic, including small crafts, in areas where Indo-Pacific (coastal) bottlenose dolphins reside, have a **risk** of substantial adverse impact on populations of these species.

Actions that have a real chance or possibility of increasing noise levels above ambient levels (e.g. dredging, pile-driving or blasting) have a **risk** of substantial adverse impact on populations of both bottlenose dolphin species.

Actions that have a real chance or possibility of modifying, destroying or isolating habitat (e.g. dredging or changes to hydrological regimes) have a **risk** of substantial adverse impact on populations of both bottlenose dolphin species.

Actions that have a real chance or possibility of introducing marine debris to the biologically important areas of the Indo-Pacific (coastal) bottlenose dolphins have a risk of resulting in substantial adverse effects on populations of these species.

The **little shearwater** *(Puffinus assimilis)* breeds on islands of the Lord Howe and Norfolk Island groups and, after breeding, disperses over the Tasman Sea and possibly the Coral Sea. Lord Howe Island has one of the larger breeding colonies of little shearwater in the Australian region. Biologically important areas are defined for this species within the Temperate East Marine Conservation Values Atlas. The little shearwater is vulnerable to a range of impacts from a number of invasive species. Other potential pressures include climate change (changes in sea temperature and oceanography, ocean acidification), oil pollution and chemical pollution/contaminants associated with shipping, light pollution associated with land-based activities, marine debris and human presence at sensitive sites associated with tourism, recreational and charter fishing and research activities.

The **white-necked petrel's** *(Pterodroma cervicalis)* only known breeding location in Australia is Phillip Island, off Norfolk Island. However, no breeding pairs were recorded during a recent survey of Phillip Island. Globally, the species has a very small range, breeding on two to three small islands (BirdLife International 2011). Biologically important areas are defined for this species within the Temperate East Marine Conservation Values Atlas. This species is vulnerable to a range of impacts from a number of sources. Other potential pressures include bycatch associated with commercial fishing activities, climate change (changes in sea temperatures and oceanography, ocean acidification), oil pollution and chemical pollution/contaminants associated with shipping, light pollution associated with land-based activities shortfin and longfin, marine debris and human presence at sensitive sites associated with tourism, recreational and charter fishing and research activities.

The **eastern gemfish** *(Rexea solandri)* is listed as conservation dependent under the EPBC Act. The species is distributed from southern Queensland to the central western Australian coast, including Tasmania. Genetic studies have indicated two distinct populations in Australia, one in eastern Australian waters (referred to as the eastern gemfish) and another west of Bass Strait. Gemfish are meso-pelagic, inhabiting oceanic waters around the continental shelf and upper slope, and are known to feed near the ocean floor at 100–800 metres. The only confirmed spawning area for eastern gemfish in Australian waters is off the central New South Wales coast, and fish migrate there during the spawning season. Potential pressures on this species include climate change (changes in sea temperatures and oceanography). Biologically important areas have not been identified for this species.

**Orange roughy** *(Hoplostethus atlanticus)* is listed as conservation dependent under the EPBC Act. A high-value commercial species, it is highly vulnerable to depletion because of its long-lived and late maturing nature. It is a deep water species associated with pinnacles, seamounts (e.g. Lord Howe Rise) and other features where its prey aggregates. In Australia, the species is widely distributed in temperate waters between southern Western Australia and central New South Wales, including Tasmania, and is most commonly found on the continental slope at depths of 500–1400 metres. Potential pressures on this species include climate change (changes in sea temperature and oceanography) and physical habitat modification. Biologically important areas have not been identified for this species.

### S2.1.4 Adverse impacts on heritage values

#### *Historic shipwrecks*

There are likely to be hundreds of historic shipwrecks in the Temperate East Marine Region, but the precise location in Commonwealth waters of many of these shipwrecks in unknown (Figure S2.2). The protected places report card provides further information (**www.environment.gov.au/marineplans/temperate-east**). It is an offence under the Historic Shipwreck Act 1976 to damage, destroy or interfere with a historic shipwreck without a permit.

> Actions that have a real chance or possibility of resulting in substantial adverse impacts on the heritage values of the Commonwealth marine area, including damage to or destruction of a historic shipwreck, have a **high risk** of a significant impact on the Commonwealth marine environment.

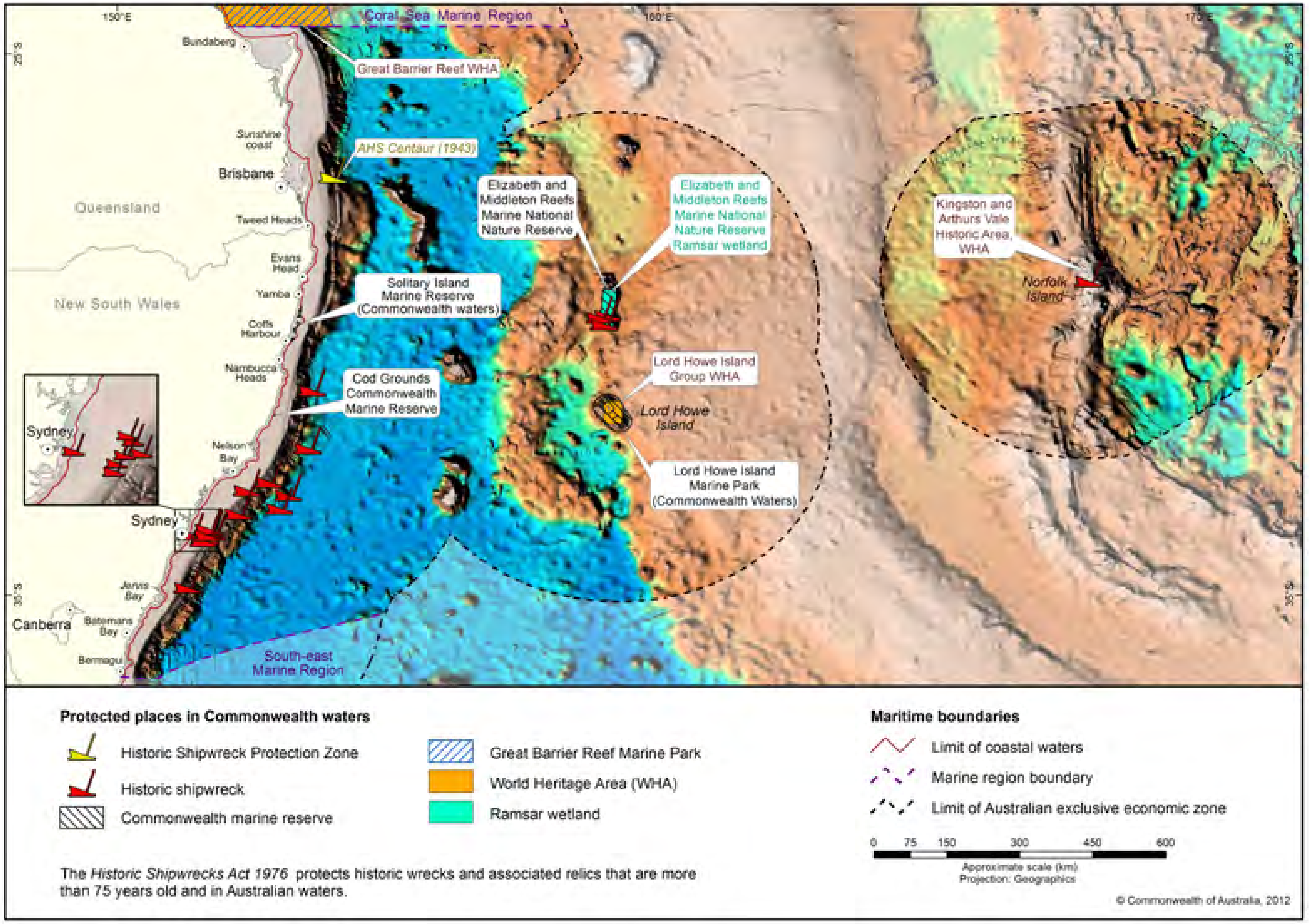


**Figure S2.2: Heritage places in the Temperate East Marine Region**

### *Other heritage places*

The Lord Howe Island group is listed within several heritage categories under the EPBC Act (Table S2.2).

**Table S2.2: Heritage places in the Temperate East Marine Region as of May 2012**

| Heritage place | Commonwealth marine reserve | World Heritage List | Commonwealth Heritage List | National Heritage List | Ramsar site | Relevant key ecological feature |
|---|---|---|---|---|---|---|
| Lord Howe Island group | ✓ | ✓ | ✗ | ✓ | ✗ | Lord Howe seamount chain |

* The Lord Howe Island group World Heritage place and National Heritage place sits partly within the Lord Howe Island Marine Park (Commonwealth waters).

Heritage places adjacent to the region include the Great Barrier Reef and Kingston and Arthurs Vale Historic Area on Norfolk Island. These sites, along with the Lord Howe Island group, are listed on both the World Heritage and National Heritage lists therefore they are protected under the EPBC Act. The Act requires approval to be obtained before any action takes place that could have a significant impact on the world heritage or national heritage values of a listed place. For information on the specific world heritage and national heritage values of the three sites, visit the Australian Heritage Database at **www.environment.gov.au/heritage**.

Actions that have a real chance or possibility of causing one or more of the world heritage and/or national heritage values to be lost, degraded, damaged, or notably altered, modified, obscured or diminished, have a **high risk** of significant impact on the Lord Howe Island Group.

### S2.1.5 Actions in Commonwealth marine reserves

Commonwealth marine reserves (also called marine protected areas) in the Temperate East Marine Region are areas recognised as having high conservation value. Marine protected areas in the region (Figure S2.2) for which information is provided in this plan include:

- Elizabeth and Middleton Reefs Marine National Nature Reserve
- Solitary Islands Marine Reserve (Commonwealth Waters)
- Cod Grounds Commonwealth Marine Reserve
- Lord Howe Island Marine Park (Commonwealth Waters).

The Director of National Parks is the statutory authority responsible for managing all Commonwealth reserves (including marine protected areas) as specified by the EPBC Act. The Act also requires all Commonwealth reserves (terrestrial and marine) to have a management plan. The Act prohibits some activities being carried out on or in a Commonwealth reserve unless they are expressly provided for by a management plan for the reserve or are approved in writing by the Director of National Parks when a management plan is not in operation. This includes actions that affect native species, commercial activities and mining operations.

People considering actions in or adjacent to the Temperate East Marine Region should check the Commonwealth environment department's web site (**www.environment.gov.au/marinereserves**) for the current list and location of Commonwealth marine reserves in the Temperate East Marine Region.

#### *Elizabeth and Middleton Reefs Marine National Nature Reserve*

Elizabeth and Middleton Reefs Marine National Nature Reserve is located in the Tasman Sea, approximately 600 kilometres east of Coffs Harbour and to the north of Lord Howe Island. The reserve includes two separate reefs, Elizabeth Reef and Middleton Reef. The reserve was proclaimed in 1987 and has two zones: Habitat Protection Zone (IUCN Category II) and Sanctuary Zone (IUCN Category Ia). Activities undertaken in the reserve are regulated under the management plan for the Elizabeth and Middleton Reefs Marine National Nature Reserve. This management plan is due to expire in 2013. People intending to undertake activities in Elizabeth and Middleton Reefs Marine National Nature Reserve must apply for approval from the Director of National Parks. For more information on Elizabeth and Middleton Reefs Marine National Nature Reserve, please visit **www.environment.gov.au/coasts/mpa/elizabeth/index.html**.

### *Solitary Islands Marine Reserve (Commonwealth Waters)*

Solitary Islands Marine Reserve (Commonwealth Waters) (SIMR) is located off the coast of northern New South Wales, 600 kilometres north of Sydney, between Coffs Harbour and Plover Island. It is adjacent to the Solitary Islands Marine Park (New South Wales waters) and extends from the 3-nautical mile state limit seaward to the 50-metre depth contour. The Solitary Islands Marine Reserve encompasses the waters, seabed and subsoil beneath the seabed to a depth of 1000 metres. The Solitary Islands Marine Park covers 710 square kilometres; the Solitary Islands Marine Reserve covers a further 160 square kilometres. The reserve was proclaimed in 1993 and has three zones: General Use Zone (IUCN Category VI); Sanctuary Zone (IUCN Category Ia) and Habitat Protection Zone (IUCN Category IV). Activities undertaken in the reserve are regulated under management arrangements. People intending to undertake activities in the Solitary Islands Marine Reserve (Commonwealth waters) must apply for approval from the Director of National Parks. For more information on the Solitary Islands Marine Reserve, please visit **www.environment.gov.au/coasts/mpa/solitary/index.html**.

### *Cod Grounds Commonwealth Marine Reserve*

The Cod Grounds Reserve comprises a 1000-metre radius from a point at 152°54’37”E 31°40’52”S, offshore of Laurieton, New South Wales. The reserve was proclaimed in 2007 as an IUCN Category 1a strict nature reserve (Sanctuary Zone) to protect important habitat of the critically endangered east coast population of grey nurse shark. Activities undertaken in the reserve are regulated under interim management arrangements. People intending to undertake activities in the Cod Grounds Commonwealth Marine Reserve must apply for approval from the Director of National Parks. For more information on the Cod Grounds Commonwealth Marine Reserve, please visit **www.environment.gov.au/coasts/mpa/cod-grounds/index.html**.

### *Lord Howe Island Marine Park*

The Lord Howe Island Marine Park is approximately 700 kilometres north-east of Sydney. The park comprises State waters around Lord Howe Island and Ball’s Pyramid and the Commonwealth waters between 3 nautical miles and 12 nautical miles around Lord Howe Island and Ball’s Pyramid form the Lord Howe Island Marine Park (Commonwealth Waters). The perimeter of the Lord Howe Island Marine Park (Commonwealth Waters) roughly corresponds to the 1800-metre depth contour, which follows the base of the seamounts that underlie Lord Howe Island and Ball’s Pyramid. The sea area of the Commonwealth Marine Park is estimated to be 3005 square kilometres and includes the seabed to a depth of 100 metres. The reserve was proclaimed in 2000 and has two zones: Sanctuary Zone (IUCN Category 1a) and Habitat Protection Zone (IUCN Category IV). Activities undertaken in the reserve are regulated under management arrangements. People intending to undertake activities in the Lord Howe Island Marine Park (Commonwealth Waters) must apply for approval from the Director of National Parks. For more information on the Lord Howe Island Marine Park (Commonwealth Waters), please visit **www.environment.gov.au/coasts/mpa/lordhowe/index.html**.

Actions in or near Commonwealth marine reserves have a **greater risk** of significant impacts on the Commonwealth marine environment.

## Advice for preparing a referral with respect to impacts on the Commonwealth marine environment of the Temperate East Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on the Commonwealth marine environment of the Temperate East Marine Region, consideration of the following matters is recommended:

- For actions associated with physical habitat modification, for example dredging, independent dredge plume modelling undertaken to predict suspended sediment levels and the extent of sediment dispersal as a result of the proposed action would assist in assessing the action.
- For actions involving physical habitat modification, for example the dumping of dredge spoils or other materials into the Commonwealth marine environment, requirements under the Environment Protection (Sea Dumping) Act 1981 and the National assessment guidelines for dredging 2009 (DEWHA 2009) apply. An application for a sea dumping permit should be submitted. Further information on sea dumping is available at **www.environment.gov.au/coasts/pollution/dumping/index.html**.
- For actions likely to release nutrients or pollutants into the Commonwealth marine environment, modelling of nutrient or pollutant dispersal and accumulation undertaken to determine potential impacts on marine ecosystems would assist in assessing the action.
- To mitigate the effects of an accidental hydrocarbon spill from a vessel, an approved shipboard oil pollution emergency plan should be in place. For actions relating to petroleum facilities and pipelines, an approved environment plan containing an oil spill contingency plan should be in place. Further information on responsibilities regarding the protection of the marine environment from oil spills is available on the National Offshore Petroleum Safety and Environmental Management Authority's website: **www.nopsema.gov.au**.

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# Schedule 2.2
# Cetaceans of the Temperate East Marine Region

All cetaceans are protected under the EPBC Act in the Australian Whale Sanctuary[13] (and, to some extent, beyond its outer limits). Of the 45 cetacean species (whales, dolphins and porpoises) recorded in Australian waters, 11 are known to occur in the Temperate East Marine Region, and one other species may occur infrequently in the region. Please refer to the conservation values report card—cetaceans, for a complete list of cetaceans and additional information (**www.environment.gov.au/marineplans/temperate-east**).

The Temperate East Marine Region supports diverse and abundant cetacean populations, whose use of the region's marine habitats and resources varies markedly. Toothed whales found in the region include killer whales, the Indo-Pacific humpback and Indo-Pacific (coastal) bottlenose dolphins, known to feed on a wide range of prey including fish and squid, are also found in the region, and the area is used as a migration pathway for humpback whales between their feeding and breeding areas.

The following advice relates only to those species listed above for which it has been possible to identify biologically important areas (Table S2.3). The Indo-Pacific bottlenose dolphin is listed as cetacean and is considered in Schedule 2.1.

**Table S2.3: Cetaceans listed as threatened and/or migratory with known biologically important areas in or adjacent to the Temperate East Marine Region**

| Species | Listing status |
|---|---|
| Humpback whale (*Megaptera novaeangliae*) | Vulnerable, migratory |
| Indo-Pacific humpback dolphin (*Sousa chinensis*) | Migratory |

13 The Australian Whale Sanctuary was established under the EPBC Act to protect all whales and dolphins in Australian waters. The Australian Whale Sanctuary comprises the Commonwealth marine area and covers all of Australia's Exclusive Economic Zone which generally extends out to 200 nautical miles from the coast and includes the waters surrounding Australia's external territories such as Christmas, Cocos (Keeling), Norfolk, Heard and Macdonald Islands. Within the Australian Whale Sanctuary it is an offence to kill, injure or interfere with a cetacean. Severe penalties apply to anyone convicted of such offences. More information about the Australian Whale Sanctuary can be found at **www.environment.gov.au/coasts/species/cetaceans/conservation/sanctuary.html**.

## Key considerations in relation to significant impacts on cetacean species in the Temperate East Marine Region

### *Population status and ecological significance*

The **humpback whale** is listed as vulnerable and migratory. The population is estimated to be growing consistently at about 10 per cent per year (Bannister & Hedley 2001; Bryden, Kirkwood & Slade 1990; Chaloupka & Osmond 1999; Paterson, Paterson & Cato 2001; Paterson, Paterson & Cato 2004). The Australian east coast population is estimated to be 10 000 individuals (Noad et al. 2008).

The **Indo-Pacific humpback dolphin** is listed as migratory. The total Australian population size of this species is unknown, but it is likely that the Indo-Pacific humpback dolphin occurs as one genetic population within Australia (DSEWPaC 2011). Regional population levels are likely to be in the low thousands on the east coast of Queensland, with populations in particular bays in the region varying between approximately 50 and 100 individuals. Populations of this inshore dolphin are highly localised, occur in small subgroups, and have low gene flow between groups (Cagnazzi 2010; Corkeron et al. 1997; Parra, Corkeron & Marsh 2006).

Top-order predators—such as dolphins—are a key functional species group, influencing abundance, recruitment, species composition, diversity and behaviour of prey species. Their removal can have a cascading effect on all the components of a food web (Heithaus 2001; Baum & Worm 2009; Ings et al. 2009, cited in Ceccarelli & Ayling 2010).

For the purposes of determining the significance of impacts of proposed actions on the two species listed above, note that:

- the humpback whale is listed as vulnerable under the EPBC Act. It should be assumed that populations of this species in and adjacent to the Temperate East Marine Region are important populations[14] of the species
- the Indo-Pacific humpback dolphin is listed as migratory under the EPBC Act. There is insufficient information to determine whether an ecologically significant proportion of the population occurs in the Temperate East Marine Region. However, it should be taken into consideration that this species generally exhibits small group sizes (less than 100 individuals), high site fidelity and geographic isolation with low gene flow between populations. As such, the loss (i.e. anthropogenic mortality) of even a very small percentage of mature animals may cause population decline or local extinction.

### *Species distribution and biologically important areas*

**Humpback whales** migrate annually between their summer feeding grounds in Antarctica and their winter tropical and subtropical breeding grounds. In general, the species is sighted in southern Australian waters in May, and migrates slowly up the east and west coasts. By October, most whales have started their southward migration, and sightings are less frequent after November. During migration, individuals travel alone or in temporary aggregations of generally non-related individuals (cow–calf pairs being the exception) (Valsecchi et al. 2002).

14 Definitions of 'important population' and 'ecologically significant population' are provided in Section 1 of this schedule and are consistent with EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance. In accordance with Policy Statement 1.1 for threatened species listed as vulnerable, such as the humpback whale, consideration should be given to whether an important population

Biologically important areas have been identified for the **humpback whale** in the Temperate East Marine Region and include (from north to south):

- the Hervey Bay area for migration/resting during migration, including resting during northbound migration (June–July) and as a resting area for females and calves on southbound migration (August–mid-October)
- Fraser Island to Moreton Bay, between the coast and 15 km offshore as a migration pathway (northbound migration peaking in June–July and southbound migration peaking in August–mid-October)
- the Moreton Bay area, for migration/resting during migration, including resting during northbound migration (peaking June–July), and as a resting area for females and calves on southbound migration (peaking August–mid-October)
- from the Queensland/New South Wales border to the Eden area for migration/resting during migration. Resting during migration between May and November, northbound (peaking June–July) and southbound (peaking August–mid-October). Feeding has been observed just to the south of the region, off Eden.

Actions undertaken offshore from the continental shelf and not affecting waters over the continental shelf have a **low risk** of significant impact on the humpback whale.

The **Indo-Pacific humpback dolphin** is found in coastal and estuarine areas of Queensland and New South Wales (Parra & Ross 2009). It occurs in a variety of inshore shallow water habitats at depths less than 20 metres, including inshore reefs, tidal and dredged channels, mangroves and river mouths (Karczmarski, Cockroft & McLachlan 2000; Parra 2006). The Indo-Pacific humpback dolphin is a generalist feeder, preying on bottom-dwelling and pelagic fish and cephalopods associated with coastal and estuarine waters (Parra & Jendensjo 2009).

Biologically important areas have been identified for the **Indo-Pacific humpback dolphin** in and adjacent to the Temperate East Marine Region and include (from north to south):

- from Hervey Bay north-east to Commonwealth waters, within the 20-metre depth contour (Queensland), for foraging
- from Hervey Bay south to Tin Can Bay, within the 20-metre depth contour (Queensland), for foraging/feeding and breeding year-round
- the southern tip of Fraser Island in coastal waters adjacent to Rainbow Beach, within the 20-metre depth contour (Queensland), for foraging
- from the north-eastern tip of Cooloola National Park south to the Queensland/New South Wales border (including Moreton Bay), within the 20-metre depth contour (Queensland), for foraging/feeding and breeding year-round
- coastal waters south of the Queensland—New South Wales border to Cabarita Beach, within the 20-metre depth contour (New South Wales), for foraging.

Further information on these areas is found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

Table S2.4 should be considered in assessing the risk of significant impact on each of the three species within and outside known biologically important areas.

### Table S2.4: Advice on the risk of significant impact on humpback whale and Indo-Pacific humpback dolphin[15]

| Species | Action in biologically important areas | Action outside biologically important areas | Temporal considerations[18] |
|---|---|---|---|
| **Humpback whale** | **High risk** of significant impact, depending on the type of action[16] | Actions undertaken outside of, and not affecting[17], biologically important areas for the humpback whale and, in the case of seismic activities, undertaken in accordance with EPBC Act Policy Statement 2.1, have a **low risk** of significant impact on this species | In the Temperate East Marine Region from early December to April[18], there is a low likelihood of encounter with humpback whales. Generally, actions undertaken anywhere in the region during this period have a **low risk** of significant impact on the species |
| **Indo-Pacific humpback dolphin** | **High risk** of significant impact, depending on the type of action[16] | Actions undertaken outside of, and not affecting[17], biologically important areas for the Indo-Pacific humpback dolphin have a **low risk** of significant impact on this species | Indo-Pacific humpback dolphins use biologically important areas all year |

Further information on biologically important areas can be found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

15 This advice does not apply to actions that inherently result in prolonged or enduring changes to the biologically important areas or the marine environment in general. Actions should also be conducted in accordance with EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales, where relevant.
16 see 'Nature of proposed action', following page
17 Actions that might affect a biologically important area, even when undertaken outside the area, include sound transmission that may result in behavioural reactions of whale species and/or prey, such that a physical impact is likely.
18 This time period reflects a precautionary approach and includes a buffer of one month on either end of the known periods during which humpback whales are found in these areas. The buffer has been used as there is a limited understanding of the migratory movements of humpback whales or the seasonality of their occurrence in the region before or after they are sighted in known biologically important areas.

### *Nature of the proposed action*

The conservation values report card—cetaceans, provides an overview of the vulnerabilities and pressures on protected cetaceans in the Temperate East Marine Region. Inshore dolphins and humpback whale are particularly vulnerable to impacts from human activities because their nearshore coastal distribution overlaps with the areas of highest human use in the marine environment. Anthropogenic activities in coastal environments have the potential to significantly impact on inshore dolphins and humpback whales.

The Indo-Pacific humpback dolphin is vulnerable to physical habitat modification associated with urban/coastal development, and bycatch associated with commercial fishing activities and bather protection programs.

Pressures *of potential concern* on humpback whales include:

- climate change (changes in sea temperature, oceanography and ocean acidification)
- marine debris from a range of sources
- bycatch associated with bather protection programs.

Pressures *of potential concern* on the Indo-Pacific humpback dolphin include:

- climate change (sea level rise, changes in sea temperature and oceanography and ocean acidification)
- chemical pollution/contaminants and nutrient pollution associated with urban development and agricultural activities
- marine debris from a range of sources
- noise pollution associated with shipping and urban development
- physical habitat modification associated with dredging
- oil pollution associated with shipping
- collision with vessels
- changes in hydrological regimes.

People planning to undertake actions in biologically important areas for cetaceans should carefully consider the potential for their actions to have a significant impact on the species. For actions proposed outside biologically important areas for cetaceans, the risk of significant impact on the species is likely to be lower.

In addition to this general advice, the following actions have a **high risk** of a significant impact on humpback whales:

- actions that have a real chance or possibility of increasing rates of entanglement that potentially result in a long-term decrease in population size.

The following actions have a **risk** of a significant impact on Indo-Pacific humpback dolphins:

- actions that have a real chance or possibility of introducing a new source from which a severe chemical spill or nutrient pollution has a reasonable potential of arising (e.g. construction of ports or expansion in port facilities, development of residential, industrial or agricultural areas) within biologically important areas when the species is present
- actions that have a real chance or possibility of increasing relevant noise[19] above the ambient levels (e.g. actions resulting in a substantial increase in underwater acoustic noise from construction or ship noise) within any of the biologically important areas for this species when the species is present
- actions that have a real chance or possibility of substantially modifying, destroying or isolating habitat (e.g. dredging, changes to hydrological regimes, urban/coastal development) in a biologically important area
- actions that have a real chance or possibility increasing the rate of ship strike (e.g. increased shipping traffic associated with new or expanding port construction) within biologically important areas for this species when the species is present.

Actions that have a real chance or possibility of introducing marine debris to the biologically important areas of the Indo-Pacific humpback dolphin have a **risk** of significant impact on the Indo-Pacific humpback dolphin.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) in biologically important areas have a **risk** of significant impact on the Indo-Pacific humpback dolphin.

19 Relevant noise is defined here as low-frequency sounds (below 200Hz) that are within the same range of frequencies used by some whales.

For the Indo-Pacific humpback dolphin, given the currently incomplete knowledge of their population distribution, there is a risk of a significant impact from the actions described above outside known biologically important areas which are, however, still within the species' distribution and seasonal range in the region.

Ecotourism operations in biologically important areas for the Indo-Pacific humpback dolphin undertaken in accordance with the *Australian national guidelines for whale and dolphin watching 2005* (DEH 2005b) have a low risk of significant impact on the species. The national guidelines require strict management measures to be applied in areas where dolphin watching operations might be *of concern* (e.g. locations with a high number of operators). In an instance where these operations may be *of concern*, early advice should be sought from the Australian Government department responsible for the environment.

## Advice for preparing a referral with respect to impacts on humpback whales and Indo-Pacific humpback dolphins in the Temperate East Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/indedex.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on the humpback whale or Indo-Pacific humpback dolphin, consideration of the following matters is also recommended:

- If the action proposed is within a biologically important area, information should be considered about any alternative locations for the proposed action that would be outside the area, why the action is unlikely to have a significant impact or why any significant impact can be reduced to an acceptable level.
- If planning recreational or tourism operations, the *Australian national guidelines for whale and dolphin watching* (DEH 2005b) provides standards on approach distances and operating procedures.
- Referrals should be supported by scientifically credible information that places the proposal in the context of existing pressures on cetaceans and the life history characteristics of the species. The conservation values report card—cetaceans provides additional information on the range of pressures on cetaceans.
- For areas marked for long-term development involving noise-generating activities, passive acoustic monitoring programs (e.g. installation of sonobuoys) might assist in gaining the necessary understanding of the finer scale spatial and temporal patterns of some cetaceans and improve the ability to assess and mitigate impacts. It is recommended that early advice be sought from the Australian Government department responsible for the environment.

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## Schedule 2.3
## Marine turtles of the Temperate East Marine Region

Four species of marine turtle listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are known to occur in the Temperate East Marine Region, and all are listed as threatened and migratory under the EPBC Act.

Green and loggerhead turtles are the most common marine turtles found in the Temperate East Marine Region, with nesting sites dotted along the New South Wales and south-east Queensland coasts. Hawksbill and leatherback turtles are likely to be found foraging in the region.

The following advice relates to the marine turtles for which it has been possible to identify biologically important areas, listed in Table S2.5. Please refer to the conservation values report card—marine reptiles for a complete list of reptiles in the region and additional information (**www.environment.gov.au/marineplans/temperate-east**).

**Table S2.5: Marine turtles listed as threatened and/or migratory in or adjacent to the Temperate East Marine Region for which biologically important areas have been identified**

| Species | Listing status |
|---|---|
| Green turtle<br>*(Chelonia mydas)* | Vulnerable, migratory, marine |
| Loggerhead turtle<br>*(Caretta caretta)* | Endangered,<br>migratory, marine |

## Key considerations in relation to significant impacts on green and loggerhead turtles in the Temperate East Marine Region

### *Population status and ecological significance*

The **green turtle** is listed as vulnerable and migratory under the EPBC Act. Three breeding aggregations (considered to be separate stock) exist in and adjacent to the region: the northern and southern Great Barrier Reef stock and the Coral Sea stock. The Temperate East Marine Region is most important for the southern Great Barrier Reef stock. This population is estimated to include 36 500 breeding females (Dethmers et al. 2010). This stock was thought to be in decline, but recent studies indicate it is now increasing (Chaloupka et al. 2007). The northern Great Barrier Reef and Coral Sea populations have an estimated 133 500 and 15 500 breeding females, respectively (Dethmers et al. 2010).

The **loggerhead turtle** is listed as endangered and migratory under the EPBC Act. The eastern Australian stock, the most important within the Temperate East Marine Region, has undergone a sharp decline since the 1970s, with estimates from the 1999–2000 breeding season of less than 500 breeding females (Limpus 2008).

For the purposes of determining the significance of impacts of proposed actions on the four species[20] listed above, note that:

- the loggerhead turtle is endangered under the EPBC Act. It is known that populations of this species occur in and adjacent to the Temperate East Marine Region
- the green turtle is listed as vulnerable under the EPBC Act. It is known that populations of this species occur in and adjacent to the Temperate East Marine Region.

### *Species distribution and biologically important areas*

**Green turtles** are a global species that generally live in tropical environments within the 20 °C isotherm, but they are occasionally known to enter temperate waters. Adults forage mainly on seagrass and algae, and occasionally eat mangroves (Forbes 1994; Limpus & Limpus 2000; Pendoley & Fitzpatrick 1999), fish egg cases (Forbes 1994), jellyfish (Limpus, Couper & Read 1994) and sponges (Whiting, Guinea & Pike 2000). The species is common throughout north-eastern Australia and there are seven distinct genetic stocks within the Australian region (Dethmers et al. 2006; FitzSimmons et al. 1997). The northern Great Barrier Reef supports the largest population of nesting green turtles in Australia, with smaller breeding areas in the south (DEWHA 2009). Beyond the boundaries of the Great Barrier Reef, the islets that make up the Coringa-Herald National Nature Reserve in the Coral Sea, to the east of Cairns and Townsville, support the most significant nesting sites in the region.

20 Definitions of 'important population' and 'ecologically significant population' are provided in Section 1 of this schedule and are consistent with EPBC Act Policy Statement 1.1: Significant Impact Guidelines—Matters of National Environmental Significance. In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as the green turtle, consideration should be given to whether an important population occurs in the area where the action is proposed; for listed migratory species, consideration should be given to whether an ecologically significant proportion of a population may be impacted.

In their post-hatchling and juvenile stages, green turtles drift on ocean currents (Carr & Meylan 1980). They travel south along the east coast of Australia on the East Australian Current, leaving the region as they move east to northern New Zealand, then continuing on the South Pacific Gyre to re-enter the region via the Coral Sea (DEWHA 2009). In their next phase, they move to shallow waters to forage on seagrass and algae, living in coral and rocky reefs, inshore seagrass beds and algal mats (Musick & Limpus 1997; Poiner & Harris 1996; Robins, Bache & Kalish 2002; Whiting, Guinea & Pike 2000). Green turtles are much smaller than other marine turtles when they leave their open ocean phase, and it is presumed that they do not travel as extensively as some other species within the south Pacific (Limpus et al. 2005, DEWHA 2009).

Biologically important areas have been identified for **green turtles** in the Temperate East Marine Region and include (from north to south):

- Mon Repos Conservation Park, for nesting, with an internesting buffer of 20 kilometres (November to February)
- Moreton Bay for foraging (year round).

The **loggerhead turtle** breeds in eastern Australia and forages throughout Queensland and New South Wales. Females predominantly nest on beaches near Bundaberg and the islands of the southern Great Barrier Reef. The largest nesting sites are Mon Repos on the mainland and Wreck Island in the Great Barrier Reef, where several hundred females lay their eggs every year. Some isolated nesting occurs south of Bundaberg and as far south as Ballina in northern New South Wales (Limpus 1985; DEWHA 2009). In their early life they are carried south by the East Australian Current to around 30° S (Limpus, Couper & Read 1994; Walker 1994), leaving the region as they move east to northern New Zealand, then travelling on the South Pacific Gyre and re-entering the region via the Coral Sea (DEWHA 2009). As large, immature turtles, their oceanic, pelagic, post-hatchling phase moves to a benthic feeding phase (Bjorndal 1997; Lanyon, Limpus & Marsh 1989; Limpus & Limpus 2000; Limpus et al. 2005). Adults and large juveniles inhabit environments with both hard and soft substrata, including rocky and coral reefs (Limpus, Fleay & Guinea 1984), muddy bays (Conway 1994), sand flats, estuaries and seagrass meadows (Limpus, Couper & Read 1994; Preen 1996; McCauley & Bjorndal 1999). Large concentrations of foraging loggerhead turtles have been found in the lagoons of the southern Great Barrier Reef islands (e.g. Heron and Wistari), as well as the Hervey Bay and Moreton Bay areas (DEWHA 2009).

Biologically important areas have been identified for **loggerhead turtles** in the Temperate East Marine Region and include (from north to south):

- the coastline between Bustard Head, Queensland, and Ballina, New South Wales for nesting, with an internesting buffer of 20 kilometres (November to February)
- Mon Repos Conservation Park–Woongara Coast for nesting, with an internesting buffer of 20 kilometres (November to February).

Further information on these areas is found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

### *Nature of the proposed action*

The life history patterns of marine turtles, including long life spans and late sexual maturity, make them vulnerable to a range of pressures in the marine environment. Marine turtles spend their life at sea other than when adult females return to beaches in their natal region to nest (FitzSimmons et al. 1997; Chaloupka & Limpus 2001). They are highly migratory and occupy different habitats at different stages of their life.

The conservation values report card—reptiles provides a summary of the existing environment and pressures in the Temperate East Marine Region. Proposals for new actions should consider the existing environment, vulnerabilities and pressures acting on marine turtles in the region.

The green turtle is vulnerable to extraction of living resources associated with (non-domestic) commercial fishing activities; bycatch from commercial fishing activities; climate change (sea level rise); marine debris from a range of sources; and collision with vessels. Potential pressures include physical habitat modification from dredging activities; extraction of living resources from illegal, unregulated and unreported fishing activities; climate change (changes in sea and sand temperatures and oceanography); oil and chemical pollution/contaminants associated with shipping; chemical pollution/contaminants and nutrient pollution associated with urban development and agricultural activities; and light pollution from land-based and offshore activities.

The loggerhead turtle is vulnerable to bycatch from commercial fishing activities; climate change (sea level rise, changes in sea and sand temperatures); marine debris from a range of sources; and collision with vessels. Potential pressures include invasive species; physical habitat modification from dredging activities; extraction of living resources from illegal, unregulated and unreported fishing activities; climate change (changes in oceanography); oil and chemical pollution/contaminants associated with shipping; chemical pollution/contaminants and nutrient pollution associated with urban development and agricultural activities; and light pollution from land-based and offshore activities.

Growing urban and industrial development in the region is leading to an increase in recreational vessels and shipping in areas frequented by marine turtles, increasing the potential of vessel collisions for both species.

Pressures *of concern* and *of potential concern* on the loggerhead and green turtles in the Temperate East Marine Region are as follows:

- increases in sea temperature, changes in sea level and changes in terrestrial sand temperature are *of concern* for the loggerhead turtle and *of potential concern* for the green turtle
- bycatch as a result of commercial fishing activities is a pressure *of concern* while bycatch as a result of illegal, unregulated and unreported fishing is *of potential concern* for both turtle species
- vessel collision is a pressure *of concern* for both turtle species
- changes in oceanography is *of potential concern* for both species
- chemical and nutrient pollution as a result of industrial and coastal development and agricultural activities is a pressure *of potential concern* for both turtle species
- marine debris from a range of sources is a pressure *of potential concern* for both turtle species
- light pollution from onshore activities (e.g. petroleum facilities, ports and urban development) is a pressure *of potential concern* for both turtle species
- physical habitat modification through dredging is a pressure *of potential concern* for both turtle species
- oil pollution is *of potential concern* for both species
- invasive species (e.g. foxes and feral pigs) is a pressure *of potential concern* for both turtle species
- non-domestic commercial fishing is *of potential concern* for green turtles.

People planning to undertake actions in biologically important areas for marine turtles should carefully consider the potential for their action to have a significant impact on the species. For actions proposed outside biologically important areas for marine turtles, the risk of significant impact on the species is likely to be lower.

The following actions have a **very high risk** of a significant impact on the loggerhead turtle:

- actions that have a real chance or possibility of resulting in an increase in collision with vessels.

The following actions have a **high risk** of a significant impact on both the loggerhead and the green turtle:

- actions that have a real chance or possibility of resulting in an increase in lighting at important nesting sites during breeding seasons. Examples of such actions include onshore sources of lighting (e.g. petroleum processing facilities, ports)
- actions, such as dredging, that have a real chance or possibility of modifying, destroying or decreasing the availability of habitat for the species
- actions that have a real chance or possibility of changing the water quality of; increasing nutrient pollution of; or introducing contaminants into, biologically important areas
- actions that have a real chance or possibility of leading to the introduction of invasive species into biologically important areas.

Actions with a real chance or possibility of resulting in an increase in collision with vessels have a **high risk** of a significant impact on the green turtle.

Actions that have a real chance or possibility of introducing marine debris to the biologically important areas of the loggerhead and green turtle have a **risk** of significant impact on these species.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. increased shipping and drilling) have a **risk** of significant impact on the loggerhead and green turtles.

## Advice for preparing a referral with respect to impacts on green and loggerhead turtles in the Temperate East Marine Region

The ‘referral of proposed action’ form is available electronically at **www.environment.gov.au/epbc/indedex.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on either of the two species of marine turtle considered here, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area classified in a nesting, internesting or foraging area, information should be considered about alternative locations for the proposed action that would be outside the area, why the action is unlikely to have a significant impact or why any significant impact can be reduced to an acceptable level.
- Referrals should include information on how the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to any marine turtles. Independent scientific assessments of any intended mitigation measures should be sought before submitting a referral and these assessments should be included in the referral.
- Referrals should be supported by scientifically credible information that places the proposal in the context of existing pressures on marine turtles and the life history characteristics of the species. The conservation values report card—reptiles provides information on the range of pressures on marine turtles addressed in this regional advice.

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## Schedule 2.4
## Seabirds of the Temperate East Marine Region

Twenty species of seabird listed as threatened and/or migratory are known to have biologically important areas in the Temperate East Marine Region (Table S2.6), and a further 21 species may occur infrequently in the region.[21] Seabirds listed as threatened and/or migratory are matters of national environmental significance and protected under the EPBC Act. Regional advice for some seabird species in the region that are not listed as threatened or migratory is included in Schedule 2.1.

**Table S2.6: Seabird species listed as threatened and/or migratory with biologically important areas in and adjacent to the Temperate East Marine Region**

| Species | Listing status | Breeding season and habits |
|---|---|---|
| **Terns and noddies** | | |
| Common noddy<br>*(Anous stolidus)* | Migratory, marine | Breeds in the region from October to January (Lord Howe and Norfolk Island groups) |
| **Shearwaters** | | |
| Flesh-footed shearwater<br>*(Ardenna carneipes)* | Migratory, marine | Breeds in the region from August to May<br>Forages in the region from September to November and January to February |
| Short-tailed shearwater<br>*(Ardenna tenuirostris)* | Migratory, marine | Breeds in the region from November to April |
| Sooty shearwater<br>*(Ardenna grisea)* | Migratory, marine | Breeds in the region from September to April |
| Wedge-tailed shearwater<br>*(Ardenna pacifica)* | Migratory, marine | Breeds in the region from November to April (Coral Sea, Great Barrier Reef, Montague Island, Muttonbird Island, Broughton Island)<br>Breeds in the region from September to April (Lord Howe Island group)<br>Breeds in the region from October to May (Norfolk Island group) |

21 All birds that occur naturally in the region (including the airspace) are protected under the EPBC Act as listed marine species. Seabirds are those birds that rely on and have an ecological association with the marine environment. Not all the birds that occur in the Temperate East Marine Region are seabirds (a complete list of all the birds known to occur in the region is provided in the report card on seabirds).

| Species | Listing status | Breeding season and habits |
|---|---|---|
| **Petrels and storm-petrels** | | |
| Gould's petrel *(Pterodroma leucoptera)* | Endangered, migratory | Breeds in the region from August to May |
| Southern giant-petrel *(Macronectes giganteus)* | Endangered, migratory, marine | Forages in the region from June to October |
| Northern giant-petrel *(Macronectes halli)* | Vulnerable, migratory, marine | Forages in the region from June to October |
| Kermadec petrel *(Pterodroma neglecta)* | Vulnerable, marine | Breeds in the region from November to June |
| White-bellied storm-petrel *(Fregetta grallaria)* | Vulnerable, marine | Breeds in the region from February to May |
| Black petrel *(Procellaria parkinsoni)* | Migratory, marine | Forages in the region year-round |
| Providence petrel *(Pterodroma solandri)* | Migratory, marine | Breeds in the region from March to November |
| Wilson's storm-petrel *(Oceanites oceanicus)* | Migratory, marine | Migrates through the region<br>North migration from April to June<br>South migration from September to November |
| **Albatrosses** | | |
| Antipodean albatross *(Diomedea antipodensis)* | Vulnerable, migratory, marine | Forages in the region year-round |
| Black-browed albatross *(Thalassarche melanophris)* | Vulnerable, migratory, marine | Forages in the region from May to November |
| Campbell albatross *(Thalassarche impavida)* | Vulnerable, migratory, marine | Forages in the region from June to August |
| Indian yellow-nosed albatross *(Thalassarche carteri)* | Vulnerable, migratory, marine | Forages in the region from May to November |
| Wandering albatross *(Diomedea exulans)* | Vulnerable, migratory, marine | Forages in the region from July to November |

| Species | Listing status | Breeding season and habits |
|---|---|---|
| White-capped albatross *(Thalassarche steadi)* | Vulnerable, migratory, marine | Forages in the region May to November |
| **Boobies** | | |
| Masked booby *(Sula dactylatra)* | Migratory, marine | Breeds in the region year-round |

The Temperate East Marine Region supports diverse seabird species, with areas such as the Lord Howe and Norfolk Island groups recognised both nationally and internationally as significant breeding sites (Dutson et al. 2009). The East Australian Current and the Tasman Front drive biological productivity, which offers key foraging opportunities for both resident and migratory species (DEWHA 2009).

The following advice relates only to those species listed in Table S2.6 which have known biologically important areas in the region. There is limited information on those species that may infrequently occur in the region. Please refer to the conservation values report card—seabirds for a complete list of seabirds and additional information (**www.environment.gov.au/marineplans/temperate-east**).

No specific advice is provided for birds that fly over but do not breed or feed within the Commonwealth marine area of the Temperate East Marine Region. A complete list of birds that are known to overfly the Temperate East Marine Region is provided in the conservation values report card—seabirds and migratory shorebirds.

Most actions would have low risk of significant impact on those birds listed as threatened and/or migratory which only fly over the region.

## Key considerations in relation to significant impacts on 20 species of seabird in the Temperate East Marine Region

### *Population status and ecological significance*

The **common noddy** is listed as migratory and marine. The species breeds on Lord Howe and Norfolk Islands, as well as beyond the region (e.g. Great Barrier Reef and Coral Sea) (Higgins & Davies 1996). There are estimated to be 2000 breeding pairs on islands adjacent to the Temperate East Marine Region (Higgins & Davies 1996).

The **flesh-footed shearwater** is listed as migratory and marine. The species breeds on Lord Howe Island and, in 2002–2003, there were an estimated 17 462 breeding pairs on the island (DSEWPaC 2011c). The species forages in the Tasman Sea, extending west from Lord Howe Island to waters in south-eastern Queensland (McKean & Hindwood 1965) and south-eastern Tasmania (Marchant & Higgins 1990).

The **short-tailed shearwater** is listed as migratory and marine. The species breeds on islands off the New South Wales coast, including Montague, Tollgate, Lion, Cabbage, Broughton, Little Broughton, Muttonbird, Boondelbah, Martin, Big, Bowen, Brush and Grasshopper islands. This species migrates to the northern hemisphere during the austral winter (Marchant & Higgins 1990). The global population of short-tailed shearwater is estimated to be 23 million individuals (Birdlife International 2011c).

The **sooty shearwater** is listed as migratory and marine. The species breeds on islands off the New South Wales Coast, including Montague, Tollgate, Lion, Cabbage, Broughton, Little Broughton, Muttonbird, Boondelbah, Martin, Big, Bowen, Brush and Grasshopper islands (Marchant & Higgins 1990). There were estimated to be 250 breeding pairs in New South Wales in 1979 (Lane & White 1983). This species migrates to the northern Pacific Ocean during the non-breeding (austral winter) season (BirdLife International 2011d; Brooke 2004).

The **wedge-tailed shearwater** is listed as migratory and marine. The species breeds on islands in the Lord Howe Island group, Norfolk Island group, off the New South Wales and Queensland coasts, and beyond the region (e.g. the Coral Sea) (Marchant & Higgins 1990). There is no information on breeding populations in the region.

The **black petrel** is listed as migratory and marine. The species breeds in New Zealand and there are estimated to be 1750 breeding pairs. The species forages in the Tasman Sea (ACAP 2009e).

**Gould's petrel** is listed as endangered and migratory. The species breeds at four locations in New South Wales: Cabbage Tree Island (1000 breeding pairs), Boodelbah Island (35 breeding pairs), Broughton Island and Little Broughton Island (Garnett, Szabo & Dutson 2011; DSEWPaC 2011a). The Australian birds are considered to be an endemic subspecies, *Pterodroma leucoptera leucoptera* (Garnett, Szabo & Dutson 2011). The species disperses throughout the Tasman Sea and eastern Pacific Ocean (BirdLife International 2011a).

The **Kermadec petrel** is listed as vulnerable and marine. The species breeds on Balls Pyramid and Phillip Island and there are estimated to be 40 breeding birds on these islands (Garnett & Crowley 2000). The species forages in the Tasman Sea.

The **providence petrel** is listed as migratory and marine. The species breeds on Lord Howe Island (32 000 breeding pairs) and Phillip Island (20 individuals). The species forages in the western Tasman Sea (Birdlife International 2011b).

The **white-bellied storm-petrel** is listed as vulnerable and marine. The species breeds on Roach Island (around 1000 breeding pairs), Ball's Pyramid, Muttonbird Island and possibly Blackburn Island in the Lord Howe Island group (Garnett, Szabo & Dutson 2011; DSEWPaC 2011b). The Australian birds are considered to be a subspecies, *Fregetta grallaria grallaria* (Garnett, Szabo & Dutson 2011). The species is highly pelagic, foraging in the Tasman and Coral Seas, and rarely approaches land except near breeding colonies (Garnett, Szabo & Dutson 2011; Marchant & Higgins 1990).

**Wilson's storm-petrel** is listed as migratory and marine. The species breeds in Australian territory (Macquarie Island, Heard Island) and there are estimated to be 10 000 breeding birds on Australia's subantarctic islands (Garnett & Crowley 2000). The species migration path appears to follow the edge of the continental shelf until approximately the New South Wales–Queensland border and then turns eastwards (Marchant & Higgins 1990).

The **northern giant-petrel** is listed as vulnerable, migratory and marine. The species breeds in Australian territory (Macquarie Island) and there are estimated to be 1793 breeding pairs on Macquarie Island (ACAP 2010c). The species forages in the Tasman Sea.

The **southern giant-petrel** is listed as endangered, migratory and marine. The species breeds in Australian territory (Heard Island and McDonald Island, Macquarie Island) and there are estimated to be 5625 breeding pairs on Australia's subantarctic islands (ACAP 2010b). The species forages in the Tasman Sea.

The **antipodean albatross** is listed as vulnerable, migratory and marine. The species breeds in New Zealand and there are estimated to be 11 557 breeding pairs. The antipodean albatross forages in the Tasman Sea (ACAP 2009a).

The **black-browed albatross** is listed as vulnerable, migratory and marine. The species breeds in Australian territory (Heard Island and McDonald Island, Macquarie Island) and there are estimated to be 787 breeding pairs on Australia's subantarctic islands (ACAP 2010a). The black-browed albatross forages over the New South Wales shelf and generally not north of the New South Wales–Queensland border.

The **Campbell albatross** is listed as vulnerable, migratory and marine. The species breeds in New Zealand and there are estimated to be 21 000 breeding pairs. During winter, adults can be found widely dispersed in the Tasman Sea (ACAP 2009b).

The **Indian yellow-nosed albatross** is listed as vulnerable, migratory and marine. The species breeds in France, South Africa and New Zealand (a single pair has been recorded on Chatham Island), and there are estimated to be 36 500 breeding pairs globally. The species forages in the Tasman Sea (ACAP 2009c).

The **wandering albatross** is listed as vulnerable, migratory and marine. The species breeds in Australian territory (Macquarie Island) and there are estimated to be 5–10 breeding pairs on Macquarie Island (ACAP 2009d). The wandering albatross forages in the Tasman Sea.

The **white-capped albatross** is listed as vulnerable, migratory and marine. The species breeds in New Zealand and there are estimated to be 97 111 breeding pairs. The species forages in the Tasman Sea (ACAP 2011).

The **masked booby** is listed as migratory and marine. The species breeds on islands in the Lord Howe Island and Norfolk Island groups, as well as beyond the region (e.g. Great Barrier Reef and Coral Sea) (Marchant & Higgins 1990). There are estimated to be 400 breeding pairs on islands adjacent to the Temperate East Marine Region (Marchant & Higgins 1990).

As a group, seabirds consume large amounts of marine resources and therefore play an important functional role in marine ecosystems. Examples of their role include nutrient transfer from pelagic and offshore regions to islands, reefs and coasts, dispersal of seeds and movement of organic matter through the soil layers, particularly by burrow-nesting species (Congdon et al. 2007).

For the purpose of determining the significance of impacts of proposed actions on the 20 species[22] listed above, note that:

- Gould's petrel and the southern giant-petrel are listed as endangered under the EPBC Act. It is known that populations of these species occur in and adjacent to the region.

The following species are listed as vulnerable under the EPBC Act: Kermadec petrel, white-bellied storm-petrel, northern giant-petrel, Antipodean albatross, black-browed albatross, Campbell albatross, Indian yellow-nosed albatross, wandering albatross and white-capped albatross. It should be assumed that populations of these species in and adjacent to the Temperate East Marine Region are important populations of the species.

The following species are listed as migratory under the EPBC Act: common noddy, flesh-footed shearwater, short-tailed shearwater, sooty shearwater, wedge-tailed shearwater, black petrel, providence petrel, Wilson's storm-petrel and masked booby. It should be assumed that important habitat for these species occurs in the Temperate East Marine Region.

### *Species distribution and biologically important areas*

The 20 species listed in Table S2.6 are known to either breed and/or forage in the region. In general, the albatross and petrel species only forage, feeding in offshore waters, mainly along the edge of the continental shelf. The shearwaters, boobies, terns, noddies and some smaller petrels breed on islands in and adjacent to the region, including islands in the Great Barrier Reef, Lord Howe and Norfolk Island groups and smaller islands off New South Wales.

22 Definitions of 'important population' and 'ecologically significant population' are provided in Section 1 of this schedule and are consistent with EPBC Act Policy Statement 1.1: Significant Impact Guidelines—Matters of National Environmental Significance. In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as the antipodean albatross, consideration should be given to whether an important population occurs in the area where the action is proposed; for listed migratory species, consideration should be given to whether an ecologically significant proportion of a population may be impacted.

Biologically important areas have been identified for all 20 species and include:

- breeding areas (encompasses breeding sites and areas where the species is likely to forage to provision young)
- foraging areas
- migration pathways.

Further information on these areas is found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

### *Nature of the proposed action*

The conservation values report card—seabirds provides an overview of the vulnerabilities and pressures on protected seabirds in the Temperate East Marine Region. Anthropogenic activities in coastal environments and offshore have the potential to significantly impact on seabirds.

Disturbance of colonies by invasive species, particularly during the breeding season, can reduce breeding success or cause direct mortality. **All seabird species** that breed in the region (see Table S2.6) are vulnerable to pest species, such as rats, rabbits and ants (e.g. Argentine ant, African big-headed ant).

Pressures *of potential concern* on **all seabird species** in the region include:

- climate change (changes in sea temperature and oceanography, ocean acidification)
- oil and chemical pollution/contaminants associated with shipping
- marine debris from a range of sources
- human presence at sensitive sites (e.g. breeding colonies).

Pressures *of potential concern* on specific species occurring in the region include:

- light pollution associated with land-based activities (shearwater and petrel species)
- bycatch from commercial fishing activities (foraging seabirds, particularly the larger species, such as the flesh-footed shearwater, short-tailed shearwater, sooty shearwater, wedge-tailed shearwater, black petrel, northern giant-petrel, southern giant-petrel, Antipodean albatross, black-browed albatross, Campbell albatross, Indian yellow-nosed albatross, wandering albatross and white-capped albatross)
- bycatch associated with recreational and charter fishing (flesh-footed shearwater)

People planning to undertake actions in biologically important areas for seabirds used for breeding, during breeding season, should carefully consider the potential for their actions to have a significant impact on the species. The risk of actions proposed outside 'breeding area' biologically important areas to have a significant impact on the species is likely to be significantly lower. For biologically important areas used for foraging, the potential for significant impact is not as high however actions undertaken within these areas during times when the species are present do carry a higher risk than actions undertaken outside these areas.

In addition to this general advice, actions with a real chance or possibility of resulting in the establishment of harmful invasive species into the biologically important areas of Gould's petrel (e.g. tourism development) have a **very high risk** of a significant impact on that species.

Actions with a real chance or possibility of resulting in the establishment of harmful invasive species in biologically important areas for all other seabird species in the region have a **high risk** of a significant impact on those species (e.g. tourism development).

The following actions have a **high risk** of a significant impact on all seabird species in the region:

- actions with a real chance or possibility of introducing a new source from which chemical contamination has a reasonable potential of arising in biologically important areas (e.g. construction of ports or expansion in port facilities leading to greater shipping traffic)
- actions with a real chance or possibility of increasing disturbances at breeding colonies (e.g. tourism, research), potentially disrupting the breeding cycle of an important population (of a threatened species) or ecologically significant proportion of the population (such as a non-breeding aggregation of a migratory species).

The following actions have a **high risk** of a significant impact on shearwaters (flesh-footed shearwater, short-tailed shearwater, sooty shearwater, wedge-tailed shearwater) and petrels (black petrel, Gould's petrel, Kermadec petrel, providence petrel, white-bellied storm-petrel, Wilson's storm-petrel, northern giant-petrel and southern giant-petrel):

- actions with a real chance or possibility of increasing lighting from land-based activities (e.g. construction of ports or expansion in port facilities; lighthouses and buildings at or around breeding colonies).

Actions that have a real chance or possibility of introducing marine debris within biologically important areas of the 20 species of seabirds have a **risk** of significant impact on these species.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in biologically important areas have a **risk** of significant impact on all seabird species (e.g. increased shipping).

## Advice for preparing a referral with respect to impacts on 20 species of seabirds of national environmental significance in the Temperate East Marine Region

A referral of proposed action form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on any of the 20 species of seabird discussed in this schedule, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area classified as a breeding area (including breeding colonies and/or foraging areas that are likely to incorporate chick provisioning), information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- Referrals should include information on how it is proposed that the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to any seabirds. It is recommended that independent scientific assessments of any intended mitigation measures be sought before submitting a referral and that any such assessment is included in the referral.
- Referrals should be supported by scientifically credible information that places the proposal in the context of the advice on existing pressures on seabirds and the particular life history characteristics of the species. The conservation values report card—seabirds provides information on the current understanding of the range of pressures on seabirds addressed in this regional advice.

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# Schedule 2.5
# Sharks of the Temperate East Marine Region

Six species of shark listed under the EPBC Act are known to occur in the Temperate East Marine Region. In addition to these listed species, two sharks occurring in the region have been nominated for listing under the EPBC Act, Harrison's dogfish and the southern dogfish.

Important breeding, feeding and aggregation areas for sharks are found throughout and adjacent to the Temperate East Marine Region. Grey nurse sharks are found on the continental shelf, occasionally venturing off the shelf to aggregate around inshore rocky reefs, islands or in rocky caves. Pelagic species such as the white, whale, mako (shortfin and longfin) and porbeagle sharks are wide ranging and diverse in their ecological niches. In general, sharks in the region predominantly feed on bony fishes and cephalopods, although some species feed on other sharks, rays, crustaceans, birds and marine mammals. Whale sharks are plankton feeders.

The following advice relates only to the grey nurse shark and the white shark for which biologically important area information is available (Table S2.7). Please refer to the conservation values report card—sharks for a complete list of sharks and additional information (**www.environment.gov.au/marineplans/temperate-east**).

**Table S2.7: Sharks listed as threatened and/or migratory with biologically important areas identified within the Temperate East Marine Region**

| Species | Listing status |
|---|---|
| Grey nurse shark [east coast population] (*Carcharias taurus*) | Critically endangered |
| White shark (*Carcharodon carcharias*) | Vulnerable, migratory |

## Key considerations in relation to significant impacts on sharks species in the Temperate East Marine Region

### *Population status and ecological significance*

The **grey nurse shark** is listed as two separate populations under the EPBC Act. The west coast population is listed as vulnerable, while the east coast population is listed as critically endangered. The east coast population is estimated at 1365 individuals, with 95 per cent confidence that the population is between 1146 and 1662 individuals (Cardno Ecology Lab 2010).

The **white shark** is listed as vulnerable and migratory under the EPBC Act. There are currently no estimates of the white shark population in Australian waters and no reliable measures with which to compare changes in population status over time. This is partly due to the scarcity of white sharks, but also the difficulty in distinguishing population changes from the high rates of variability in numbers observed in any one site or region between years (Bruce 2008).

Top-order predators—such as grey nurse and white sharks—are a key functional species group, influencing abundance, recruitment, species composition, diversity and behaviour of prey species. Their removal can have a cascading effect on all components of a food web (Baum & Worm 2009; Heithaus 2001; Ings et al. 2009, cited in Ceccarelli & Ayling 2010).

For the purposes of determining the significance of impacts of proposed actions on the two species[23] listed above, note that:

- the grey nurse shark (east coast population) is critically endangered under the EPBC Act. It is known that populations of this species occur in and adjacent to the Temperate East Marine Region
- the white shark is listed as vulnerable under the EPBC Act. It should be assumed that populations of this species in and adjacent to the Temperate East Marine Region are important populations of the species.

23 Definitions of 'important population' and 'ecologically significant population' are provided in Section 1 of this schedule and are consistent with EPBC Act Policy Statement 1.1: Significant Impact Guidelines—Matters of National Environmental Significance. In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as the antipodean albatross, consideration should be given to whether an important population occurs in the area where the action is proposed; for listed migratory species, consideration should be given to whether an ecologically significant proportion of a population may be impacted.

### *Species distribution and biologically important areas*

The **grey nurse shark** has a broad distribution within Australian waters, from subtropical to cool temperate waters. The east coast population, estimated at 1146–1662 individuals (Cardno Ecology Lab 2010) is found between the Capricornia coast of central Queensland and Narooma in southern New South Wales, although records from locations further north and south also exist. The species is found primarily in subtropical to cool temperate inshore waters around rocky reefs and islands, and is occasionally found in the surf zone and shallow bays. Grey nurse sharks have been recorded at varying depths to 230 metres, but are most commonly found at depths of 15–40 metres (Otway & Parker 2000). Critical habitats and key aggregation sites are adjacent to the region in New South Wales and southern Queensland state waters and there are also several sites in Commonwealth waters at the Cod Grounds and Solitary Islands. These regular aggregation sites may play an important role in pupping or mating activities.

Biologically important areas have been identified for the **grey nurse shark** in the Temperate East Marine Region and include:

- foraging areas
- aggregation areas
- seasonal breeding areas (mating or pupping).

Further information on these areas is found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

The **white shark** is widely distributed throughout temperate and subtropical regions and most frequently observed in inshore cool to warm temperate continental waters. Off eastern Australia, white sharks regularly range from central–southern Queensland southwards (Bruce et al. 2006; Last & Stevens 2009), from inshore rocky reefs, surf beaches and shallow coastal bays, to outer continental shelf and slope areas. They also make open ocean excursions and can cross ocean basins. Both adults and juveniles have been recorded diving to depths of 1000 metres, but most white shark movements and activities in Australian waters occur between the coast and the 100-metre depth contour (Bruce & Bradford 2008; Bruce et al. 2006). White sharks are often found in regions with high prey density and in sites where prey species aggregate. They do not live in one specific area or territory, but travel great distances between sites of temporary residency. There is also mounting evidence that they have common migratory routes between some areas of temporary residency in Australian waters (Bruce & Bradford 2008; Bruce et al. 2006). White shark movement data suggest a northerly movement along the east coast during autumn and winter, and a return to southern Australia by early summer (Bruce et al. 2006).

Biologically important areas have been identified for the **white shark** in the Temperate East Marine Region and include:

- a juvenile aggregation area off Port Stephens between September and mid-January (extending from the shoreline to the 120-metre depth contour and approximately 10–15 kilometres offshore) (Bruce & Bradford 2008)
- the distribution generally between the 120 and 1000-metre depth contours during autumn, winter and spring.

The location of pupping grounds is not known (Bruce 2008). Further information on these areas is found in the Temperate East Conservation Values Atlas (**www.environment.gov.au/cva**).

> Actions undertaken offshore of the continental shelf and not affecting waters over the continental shelf in the Temperate East Marine Region have a **low risk** of significant impact on the grey nurse shark and white shark.

### *Nature of the proposed action*

The conservation values report card—sharks provides an overview of the vulnerabilities and pressures on protected sharks in the Temperate East Marine Region.

Like most sharks, **grey nurse and white sharks** are characterised by a life history (late age at maturity, slow growth rate, low fecundity, longevity, low rate of natural mortality), which restricts productivity. They therefore have a limited capacity to withstand human-induced pressures and to recover from population depletion as a result of these pressures.

As coastal environments appear to be a preferred habitat for the grey nurse and white sharks, both species could be adversely affected by anthropogenic activities in these habitats, particularly by types of actions that have the potential to result in habitat degradation.

Pressures *of concern* for the grey nurse shark include bycatch from commercial, recreational and charter fishing activities. Pressures *of potential concern* include human presence at sensitive sites and changes in sea temperature and oceanography associated with climate change.

Pressures *of concern* for the white shark include bycatch from recreational and charter fishing activities. Pressures *of potential concern* include bycatch associated with commercial fishing activities and illegal, unregulated and unreported fishing, extraction of living resources associated with non-domestic commercial fisheries and climate change (changes in sea temperature and oceanography).

People planning to undertake actions in biologically important areas for grey nurse and white sharks should carefully consider the potential for their action to have a significant impact on these species. For actions proposed outside biologically important areas the risk of significant impact on these species is likely to be lower.

Actions which have a real chance or possibility of increasing human disturbance in biologically important areas of the grey nurse shark and have a **high risk** of significant impact on this species.

## Advice for preparing a referral with respect to impacts on grey nurse and white sharks in the Temperate East Marine Region

A referral of proposed action form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on either of the two species of shark considered here, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area classified as a breeding area (including mating, pupping and aggregation areas), information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- Referrals should include information on how it is proposed that the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to sharks. It is recommended that independent scientific assessments of any intended mitigation measures be sought before submitting a referral and that any such assessment is included in the referral.
- Referrals should be supported by scientifically credible information that places the proposal in the context of the advice on existing pressures on sharks and the particular life history characteristics of the species. The conservation values report card—sharks provides information on the current understanding of the range of pressures on sharks addressed in this regional advice.

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**Table A: Listed marine and cetacean species known to occur in the Temperate East Marine Region**

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| **Bony fishes** | |
| Big-bellied or pot-bellied seahorse *(Hippocampus abdominalis)* | Marine |
| Bullneck seahorse *(Hippocampus minotaur)* | Marine |
| Duncker's pipehorse *(Solegnathus dunckeri)* | Marine |
| Hardwick's pipehorse *(Solegnathus hardwickii)* | Marine |
| Kellogg's seahorse *(Hippocampus kelloggi)* | Marine |
| Sad seahorse *(Hippocampus tristis)* | Marine |
| Weedy seadragon *(Phyllopteryx taeniolatus)* | Marine |
| **Cetaceans** | |
| **Dolphins** | |
| Bottlenose dolphin *(Tursiops truncatus)* | Cetacean |
| Common dolphin *(Delphinus delphis)* | Cetacean |
| Fraser's dolphin *(Lagenodelphis hosei)* | Cetacean |
| Indian Ocean bottlenose dolphin *(Tursiops aduncus)* | Cetacean |
| Pantropical spotted dolphin *(Stenella attenuate)* | Cetacean |

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| Risso's dolphin *(Grampus griseus)* | Cetacean |
| Rough-toothed dolphin *(Steno bredanensis)* | Cetacean |
| Southern right whale dolphin *(Lissodelphis peronii)* | Cetacean |
| Spinner dolphin *(Stenella longirostris)* | Cetacean |
| Striped dolphin *(Stenella coeruleoalba)* | Cetacean |
| **Other cetaceans** | |
| Andrew's beaked whale *(Mesoplodon bowdoini)* | Cetacean |
| Arnoux's beaked whale *(Berardius arnuxii)* | Cetacean |
| Blainville's beaked whale *(Mesoplodon densirostris)* | Cetacean |
| Cuvier's beaked whale *(Ziphius cavirostris)* | Cetacean |
| Dwarf minke whale *(Balaenoptera acutorostrata)* | Cetacean |
| Dwarf sperm whale *(Kogia simus)* | Cetacean |
| False killer whale *(Pseudorca crassidens)* | Cetacean |
| Ginkgo-toothed beaked whale *(Mesoplodon ginkgodens)* | Cetacean |
| Gray's beaked whale, scamperdown whale *(Mesoplodon grayi)* | Cetacean |

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| Hector's beaked whale<br>*(Mesoplodon hectori)* | Cetacean |
| Long-finned pilot whale<br>*(Globicephala melas)* | Cetacean |
| Melon-headed whale<br>*(Peponocephala electra)* | Cetacean |
| Pygmy killer whale<br>*(Feresa attenuate)* | Cetacean |
| Pygmy sperm whale<br>*(Kogia breviceps)* | Cetacean |
| Shepherd's beaked whale or Tasman beaked whale<br>*(Tasmacetus shepherdi)* | Cetacean |
| Short-finned pilot whale<br>*(Globicephala macrorhynchus)* | Cetacean |
| Southern bottlenose whale<br>*(Hyperoodon planifrons)* | Cetacean |
| Strap-toothed beaked whale, strap-toothed whale, Layard's beaked whale<br>*(Mesoplodon layardii)* | Cetacean |
| True's beaked whale<br>*(Mesoplodon mirus)* | Cetacean |
| **Marine Reptiles** | |
| **Sea snakes** | |
| Beaked seasnake<br>*(Enhydrina schistosa)* | Marine |
| Blue-lipped sea krait<br>*(Laticauda laticaudata)* | Marine |
| Colubrine sea krait, banded sea krait or yellow-lipped sea krait<br>*(Laticauda colubrine)* | Marine |

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| Dubois' seasnake<br>*(Aipysurus duboisii)* | Marine |
| Elegant seasnake<br>*(Hydrophis elegans)* | Marine |
| Horned seasnake<br>*(Acalyptophis peronii)* | Marine |
| Laboute's seasnake<br>*(Hydrophis laboutei)* | Marine |
| Little file snake<br>*(Acrochordus granulatus)* | Marine |
| Marbled or spine-tailed seasnake<br>*(Aipysurus eydouxii)* | Marine |
| Olive-headed seasnake<br>*(Hydrophis major)* | Marine |
| Olive seasnake<br>*(Aipysurus laevis)* | Marine |
| Plain-banded seasnake<br>*(Hydrophis vorisi)* | Marine |
| Small-headed seasnake<br>*(Hydrophis macdowelli)* | Marine |
| Spectacled seasnake<br>*(Hydrophis kingii)* | Marine |
| Spotted seasnake<br>*(Hydrophis ornatus)* | Marine |
| Stokes' seasnake<br>*(Astrotia stokesii)* | Marine |
| Turtle-headed seasnake<br>*(Emydocephalus annulatus)* | Marine |
| White-bellied mangrove snake<br>*(Fordonia leucobalia)* | Marine |

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| Yellow seasnake *(Hydrophis spiralis)* | Marine |
| Yellow-bellied seasnake *(Pelamis platurus)* | Marine |
| **Seabirds** | |
| **Terns and noddies** | |
| White tern *(Gygis alba)* | Marine |
| Crested tern *(Thalasseus bergii)* | Marine |
| Sooty tern *(Onychoprion fuscata)* | Marine |
| Grey ternlet *(Procelsterna cerulea)* | Marine |
| Black noddy *(Anous minutus)* | Marine |
| **Shearwaters** | |
| Little shearwater *(Puffinus assimilis)* | Marine |
| **Petrels and storm-petrels** | |
| Black-winged petrel *(Pterodroma nigripennis)* | Marine |
| Great-winged petrel *(Pterodroma macroptera)* | Marine |
| White-faced storm-petrel *(Pelagodroma marina)* | Marine |
| White-necked petrel *(Pterodroma cervicalis)* | Marine |

| Species (common/scientific name) | Conservation status[24] |
|---|---|
| **Penguins** | |
| Little penguin<br>*(Eudyptula minor)* | Marine |
| **Tropicbirds** | |
| Red-tailed tropicbird<br>*(Phaethon rubricauda)* | Marine |

24 Species listed as threatened and/or migratory under the EPBC Act are not listed in this table

# MAP DATA SOURCES

DSEWPaC (2011): Australia, World Heritage Areas

DSEWPaC (2011): Key Ecological Features in the Temperate East Marine Planning Region

DSEWPaC (2011): Ramsar Wetlands of Australia

DSEWPaC (2010): Historic Shipwrecks Register

DSEWPaC (2010): Collaborative Australian Protected Areas Database (CAPAD)

DSEWPaC (2007): Commonwealth Marine Protected Areas Managed by DSEWPaC

DSEWPaC (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0

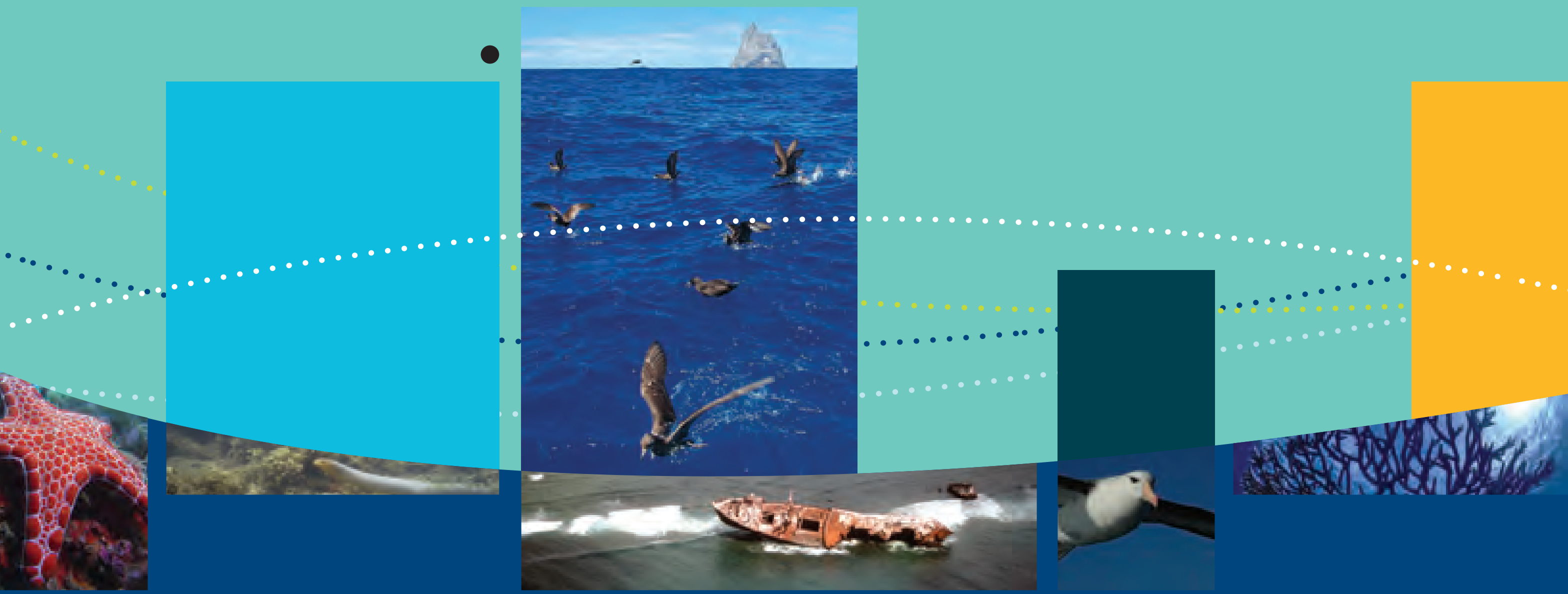
DSEWPaC (2006): Commonwealth Marine Planning Regions

Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0

Geoscience Australia (2009): Australian Bathymetry and Topography

Geoscience Australia (2004): Gazetteer of Australia

Geoscience Australia (2003): Australia, TOPO-2.5M Topographic Data



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Document 14q

Attachment L

**Summary of public submissions**
**All submissions provided on USB**

173 individual submissions- opposed
1238 campaign submissions - opposed
8 individual submissions – support

| From | Support / Oppose | Key Issues |
|---|---|---|
| Australian Marine Conservation Society | Oppose | ▪ The values of the Moreton Bay Ramsar Wetland will be significantly negatively impacted<br>▪ Species protected by the EPBC Act will be negatively impacted by the duration of the activity and increased boat activity and pollution<br>▪ The development will impact a large number of feeding and roosting sites for migratory species protected under international agreements<br>▪ The proposal will impact a significant population of koalas<br>▪ The project will destroy seagrass habitats upon which EPBC listed species are dependent<br>▪ Ongoing light, noise and physical pollution impacts to the Ramsar wetland post construction<br>▪ The proposed action is not critical infrastructure as the housing and shopping developments can be built on less sensitive and already disturbed areas |
| Birdlife Australia | Oppose | ▪ The project is expected to have clearly unacceptable impacts on Matters of National Environmental Significant protected under the EPBC Act<br>▪ The Australian Government's *Wildlife Conservation Plan for Migratory Shorebirds (2016)* identifies the need to protect migratory shorebird habitat across the flyway, including important habitat in Australia<br>▪ Conservation advice for the Eastern Curlew identifies Australia's obligation to maintain and improve protection of all feeding and roosting sites for the species, for which there is no evidence to suggest that habitat can be successfully recreated<br>▪ Australia is obligated to protect migratory shorebird habitat under several international agreements |

| **From** | **Support / Oppose** | **Key Issues** |
|---|---|---|
| Birds Queensland<br>(Queensland Ornithological Society Inc) | Oppose | ▪ The proposal does not support a key strategy in the Federal Department of Environment "Conservation Plan for Migratory Shorebirds"<br>▪ Australia should take its obligations under the Ramsar treaty seriously<br>▪ Any reclamation of the Moreton Bay Marine Park would be unacceptable under the EPBC Act |
| Brisbane Marketing<br>(Brisbane City Council) | Support | ▪ The development will enable the region to showcase natural assets |
| Brisbane Residents United | Oppose | ▪ The proposal shows a lack of response to the known climate change impacts on this region<br>▪ Mangroves and wetlands protect shorelines and will be beneficial in the future against increased storm surges and sea invasion<br>▪ The development is outside of what was the agreed urban footprint<br>▪ The development will have negative impacts on three matters protected by the EPBC Act<br>o A wetland of international significance<br>o Listed Threatened Species<br>o Migratory Species<br>▪ Australia has an international obligation to protect Ramsar-listed wetlands |
| s47F [redacted] – Global Flyway Network | Oppose | ▪ The development is in a Ramsar site<br>▪ The development is in habitat for critically endangered fauna |
| Community Alliance for Responsible Planning (C.A.R.P) | Oppose | ▪ The proposed project would adversely impact an area which uniquely combines the internationally significant wetlands, habitat for migratory shorebirds and a healthy koala population<br>▪ Dredging activity would destroy many hectares of seagrass beds and harm corals<br>▪ The proposed project will destroy feeding grounds for migratory shorebirds, including the Eastern Curlew (critically endangered) |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | ▪ All that is wanted and needed at Toondah Harbour is an upgrade of the harbour facilities |
| s47F<br>PhD Candidate \| Centre for Biodiversity and Conservation Science<br>School of Biological Sciences<br>University of Queensland | Oppose | ▪ The proposed development site contains wildlife species that of significant conservation concern<br>▪ The federal government has a responsibility to see the conservation of species listed under the Act<br>▪ Australia has an obligation to protect Ramsar Wetlands and species that rely on the area<br>▪ Australia is a party to the United Nation's Convention on Biological Diversity. The 20 Aichi Biodiversity Targets were adopted in 2010.<br>o Australia must, by 2020, prevent the extinction of known threatened species and improve their conservation status<br>o Australia must, by 2020, drastically reduce the loss of natural habitats and must reduce pollution.<br>▪ The approval of Toondah Harbour directly contravenes the targets and would set a dangerous precedent for other coastal development |
| s47F<br>State Council<br>Wildlife Preservation Society of Queensland | Oppose | ▪ The referral lacks a real understanding of the migratory wader birds that frequent the area, their roost sites and their feeding grounds<br>▪ There is great concern for how the fauna will be protected, including marine life |
| s47F<br>Adjunct Research Fellow<br>Environmental Futures Research Institute<br>Griffith University | Oppose | ▪ Developments like Toondah Harbour with up to 10,000 people concentrated in a small area will have a large impact on the viability of ecosystems in the bay<br>▪ These types of over-developments chip away at the environment undermining its health and capacity to recover |
| East Asian-Australasian Flyway Partnership (EAAFP) Shorebird Working Group | Oppose | ▪ The Moreton Bay Ramsar site is an internationally significant site for the Eastern Curlew<br>▪ The development footprint includes high quality feeding habitat for this species<br>▪ The Australian Government led the International Single Species Action Plan for the |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | Conservation of Far Eastern Curlew with key priorities such as ensuring all important non-breeding habitat is protected and adequately managed<br>▪ The Australian Government should uphold its obligations under the plan, as well as other international agreements<br>▪ The development of this site would set a dangerous precedent to develop other Ramsar-listed wetlands |
| s47F – Former Redland Shire Councillor | Oppose | ▪ The barge and ferry terminal need a makeover, not an enormous development as there is no need for thousands of apartments in Moreton Bay<br>▪ This proposal was deemed unsuitable for environmental impacts because of the acid sulphate soils |
| Friends of Stradbroke Island Association Inc. | Oppose | ▪ The project should be declared clearly unacceptable due to the proposed destruction of Ramsar protected wetlands<br>▪ The proposed action will destroy the feeding grounds of different species of migratory birds, including critically endangered birds<br>▪ The foreshore area included in the proposal holds a significant population of koalas<br>▪ The referral states that approximately 50% of the area proposed to be destroyed is covered in seagrass – an important source of food for EPBC listed species<br>▪ The high risk of pollution from the construction and ongoing operation which will impact on the values of the Ramsar site |
| Infrastructure Association of Queensland | Support | ▪ Provide an upgrade to ageing infrastructure<br>▪ Boost the amenity of the area and the capacity of the marine facilities<br>▪ Positive economic impact |
| Koala Action Group Qld Inc | Oppose | ▪ The Assessment of Federal Environmental issues should not be given to the Queensland State Government as the state has proclaimed its support and is likely to be biased. |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | ▪ The Project has been established under the Economic Development Act 2012 which is not covered by the bilateral agreement with the Federal Government<br>▪ The proposal is likely to have a significant impact on matters protected by the EPBC Act<br>▪ Dredging will cause silt plumes and they will destroy corals of Moreton Bay before they are able to be studied<br>▪ The area hosts an important koala population<br>▪ The koala population has declined by 80% in the last 20 years, however the area still has a colony of healthy breeding koalas that should be protected under the act<br>▪ 10,000 people participated in the most recent koala survey – indicating far more support for the population to remain protected and not threatened by this proposal |
| s47F – Freelance Writer | Oppose | ▪ Moreton Bay is known to provide shelter to migrating whales, often with calves<br>▪ The area has an important population of koalas that would be negatively impacted by the increased traffic in the area<br>▪ There are turtle nesting beaches in Moreton Bay, and important feeding grounds for multiple species of turtles, including green and loggerhead<br>▪ Moreton Bay is home to approximately 800 dugongs that feed on the seagrasses that will be destroyed by the development<br>▪ New corals have been discovered in Moreton Bay<br>▪ A newer safer harbour is needed, but not at Toondah where the ecology of the bay and the islands is too valuable. |
| National Parks Association of Queensland | Oppose | ▪ NPAQ support an upgrade to the current ferry terminal, however the scale and extent of the Toondah Harbour Project is inappropriate given its location within and adjacent to the Moreton Bay Ramsar site<br>▪ Direct and permanent damage to over 40 ha of the Moreton Bay Ramsar wetland through |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | dredging, sedimentation, litter and runoff<br>▪ Significant impacts on EPBC Act listed migratory bird species<br>▪ Significant impacts on the local koala population<br>▪ Significant loss of seagrass – important food source for dugongs and turtles, and also for fish and prawn spawning<br>▪ The protection of the wetlands should be upheld according to Australia's commitment nationally and internationally |
| s47F [redacted]<br>Centre for Biodiversity and Conservation Science<br>Centre for Marine Science<br>University of Queensland | Oppose | ▪ The dredging and reclamation of over 40ha of protected wetlands should be sufficient to refuse approval<br>▪ Dredging will have cascading impacts on water quality within Moreton Bay, leading to declines of coral reef and seagrass habitat, as well as the species that depend on these habitats<br>▪ Key Australian objectives for migratory species include: Maintain and enhance important habitat<br>▪ Declines in wetland habitats can have impacts on the fishing and prawning industry as breeding and recruitment grounds will be destroyed |
| Queensland Conservation Council | Oppose | ▪ The proposal will impact significantly on matters protected by the EPBC Act<br>▪ The proposal should be declared a controlled action<br>▪ It should not be made a 'coordinated project' under the Queensland *State Development and Public Works Organisation Act 1971* |
| Queensland Wader Study Group (QWSG) | Oppose | ▪ The Federal Department of Environment's 'Conservation Plan for Migratory Shorebirds', launched by the Minister for the Environment in 2016 notes the importance of conserving shorebird habitat as the key strategy.<br>▪ There is a need to revitalise the Toondah Harbour ferry terminal, however the proposed development extends beyond the needs of the community<br>▪ If development occurs it should be undertaken in an environmentally sensitive way that |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | respects Australia's obligations under the Ramsar Convention and protects threatened species<br>▪ The proposed development will contribute to the on-going decline in the number of migratory birds<br>▪ There is no discernible strategy to address the long-term impacts of the lengthy development period on shorebirds<br>▪ The consultant reports produced state that the immediate site development will have a negative effect on the near by roosting site (Cassim Island) |
| Redlands 2030 | Oppose | ▪ There is no demonstrable demand for a development such as Toondah<br>▪ As the increasing effects of urban development along the coastline impact EPBC Act listed species, remnant habitat should be more highly regarded and preserved due to the dwindling areas of Protected Areas<br>▪ The studies suggest that the loss of salt marsh community is offset because similar habitat is nearby, however this is an endangered ecological community and needs to be considered more substantially |
| Sealink Travel Group | Support | ▪ Support a new marina, improved ferry facilities and improved amenities. |
| Secretariat – Ramsar Convention on Wetlands | Oppose | ▪ The proposed development extends into the Moreton Bay Ramsar Site<br>▪ The proposed project will have an adverse impact on the ecological character of the Moreton Bay Ramsar Site and the criteria under which the wetland was designated<br>▪ Loss of wetland habitat for development will set a precedent for other developments in the future<br>▪ The Referral document states that the proposed development will likely impact on the ecological character of the Ramsar Site and this impact will be significant<br>▪ The Government of the Commonwealth of Australia has an obligation to promote the conservation of the Moreton Bay Ramsar Site and to consider its international responsibilities |

| From | Support / Oppose | Key Issues |
| --- | --- | --- |
| | | for the conservation, management and wise use of the migratory shorebirds at the site<br>▪ The impacts from increased disturbance to the area from greater boat traffic has not been evaluated<br>▪ The impact from increased pollution have not been mentioned<br>▪ With reference to the Articles of the Ramsar Convention on Wetlands which are relevant to this case, it states that:<br>~ Contracting Parties shall "…formulate and implement their planning so as to promote the conservation…" of their Ramsar Sites (Article 3.1);<br>~ "Each Contracting Party shall consider its international responsibilities for the conservation, management and wise use of migratory stocks of waterfowl…" (Article 2.6);<br>~ "Each Contracting Party shall arrange to inform the Ramsar Secretariat "…at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference." (Article 3.2);<br>~ Contracting Parties have the right to restrict the boundary of their Ramsar Site because of "…urgent national interests…" and to inform the Ramsar Secretariat "…at the earliest time…" if this were to happen (Article 2.5);<br>~ "Where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources, and in particular it should create additional nature reserves for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat." (Article 4.2)<br>~ "If Contracting Parties make alterations to their list of Ramsar Sites or changes in the character of the Ramsar Sites, then the Secretariat will "…arrange for these matters to be discussed at the next Conference." (Article 8.2d) |
| s47F MSc (Conservation Biology), Ba Inf & Tech, Dip Applied Science (Marine Resources). Program Wildlife | Oppose | ▪ The proponent fails to adequately address the negative impacts to fauna<br>▪ The proponent fails to disclose the high fidelity migratory wader birds have towards their feeding sites and roosting areas |

| From | Support / Oppose | Key Issues |
|---|---|---|
| Queensland Coastal Citizen Science. Secretary, Wildlife Preservation Society of Queensland Bayside Branch (QLD) Inc. | | ▪ The subject site is an important site for migratory shorebirds<br>▪ Cumulative pressures are not addressed by the proponent, a matter raised in the 2016 State of the Environment Report<br>▪ The seagrass meadows within the subject site are regularly used by EPBC listed species<br>▪ Urbanisation of a wetland of international importance is not a wise use of a wetland |
| Southern Moreton Bay Islands Coastcare | Oppose | ▪ The Development should be refused due to the potential impacts on MNES<br>▪ Significant earthworks and construction will have long term and structurally significant impacts on the viability of the threatened species and ecological communities in the wider Moreton Bay area |
| Stradbroke Island Management Organisation Inc. (SIMO) | Oppose | ▪ The development will have negative impacts on MNES<br>▪ As a contracting party to the Ramsar Convention, Australia has an international obligation to protect Ramsar listed wetlands |
| Straddie Chamber of Commerce | Support | ▪ The area is already significantly impacted and an environmentally sensitive development may improve water quality<br>▪ There is only a small amount of intact habitat in the area<br>▪ Providing controls are implemented, the impact of the development could be managed and would not increase impacts on sensitive areas such as wading bird habitat or seagrass beds |
| Wildlife Preservation Society of Queensland Logan Branch Inc | Oppose | ▪ The proposal fails to demonstrate how the fauna will be adequately and appropriately protected. The area supports biodiversity of international significance<br>▪ The proponents have not adequately addressed how the marine life, mangroves and seagrass meadows will be protected<br>▪ The proposal does not address cumulative impacts on the Moreton Bay Marine Park<br>▪ The imposition of numerous and complex conditions tend to be meaningless as there are not the resources available to police the conditions |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | ▪ The development could be implemented if it did not propose to dredge a Ramsar wetland and kept all development on land |
| Individual Submissions<br><br>x 149 | Oppose | ▪ The proposal should be rejected because the referral states that it will have a significant impact on matters protected by the EPBC Act<br>▪ Australia has international obligations to protect wetlands, migratory birds and threatened species<br>▪ Dredging and reclamation of 40ha of Moreton Bay Ramsar Site goes against the obligations under the Ramsar Convention, it will impact other areas within the Moreton Bay Ramsar Site and will destroy habitat critical to the survival of turtles, dugongs, fish, prawns, seabirds, migratory wader species<br>▪ The impacts to migratory species such as the Eastern Curlew will be too significant for a critically endangered species<br>▪ The site will significantly impact the local koala population<br>▪ Concerns over the long-term impacts from the development, including noise, lighting and pollution on the species impacted<br>▪ The development should not be considered critical infrastructure as there are many other suitable sites and proposals that would benefit the community and have no need to dredge reclaim areas of a Ramsar Site<br>▪ The community supports an upgrade to the ferry terminal, but not the proposed development as it looks currently |
| Individual Submissions<br><br>x 4 | Support | ▪ The proposal will improve the ferry terminal and upgrade the local infrastructure<br>▪ There will be potential to increase access to North Stradbroke Island<br>▪ There is support for it to progress so the proposal is given a thorough Environmental Impact Assessment |

| From | Support / Oppose | Key Issues |
|---|---|---|
| | | ▪ There is support, as long as key environmental aspects of the area are preserved |
| Campaign Submissions<br>x 1238 | Oppose | ▪ This development proposal will have negative impacts on three Matters of National Environmental Significance protected under the EPBC Act<br>▪ Australia is a contracting party to the Ramsar Convention, and therefore has an international obligation to protect Ramsar-listed wetlands.<br>▪ Any development that intends to reclaim part of a Ramsar site should be declared a 'clearly unacceptable action' under the EPBC Act. |

FOI 180411
Document 15

| | |
|---|---|
| **From:** | Barker, James |
| **To:** | s22 [redacted] |
| **Cc:** | Tregurtha, James; s22 [redacted] de Brouwer, Gordon; Knudson, Dean; s22 [redacted] Taylor, Mark |
| **Subject:** | RE: Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour) [SEC=UNCLASSIFIED] |
| **Date:** | Wednesday, 21 June 2017 2:38:33 PM |
| **Attachments:** | image001.jpg<br>image002.jpg<br>image003.jpg |

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Yes, we'll action accordingly. Our standard practice is also to cc the proponent for natural justice reasons. So we'll forward a copy to Walker Group at the same time we send it out to HSI (today or tomorrow).

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**From:** s22 [redacted]
**Sent:** Wednesday, 21 June 2017 9:32 AM
**To:** Barker, James <James.Barker@environment.gov.au>
**Cc:** Tregurtha, James <James.Tregurtha@environment.gov.au>; s22 [redacted] @environment.gov.au>; de Brouwer, Gordon <Gordon.deBrouwer@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; s22 [redacted] @environment.gov.au>
**Subject:** RE: Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour) [SEC=UNCLASSIFIED]

Yes – I assume this is how we normally deal with these matters.

Thanks

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**From:** Barker, James
**Sent:** Wednesday, 21 June 2017 9:27 AM
**To:** s22 [redacted] @environment.gov.au>
**Cc:** Tregurtha, James <James.Tregurtha@environment.gov.au>; s22 [redacted] @environment.gov.au>; de Brouwer, Gordon <Gordon.deBrouwer@environment.gov.au>; Knudson, Dean <Dean.Knudson@environment.gov.au>; s22 [redacted] @environment.gov.au>
**Subject:** RE: Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour) [SEC=UNCLASSIFIED]

Hi s22 [redacted]

The Minister signed a statement of reasons for this decision, as enclosed. If ok with you, we will send this to the applicant under a short cover letter from the Department.

Thanks
James

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**From:** s22 [redacted]
**Sent:** Tuesday, 20 June 2017 6:25 PM
**To:** Barker, James <James.Barker@environment.gov.au>
**Cc:** Tregurtha, James <James.Tregurtha@environment.gov.au>; s22 [redacted]@environment.gov.au>
**Subject:** FW: Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour) [SEC=UNCLASSIFIED]

For action please.

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**From:** Frydenberg, Josh (MP) [mailto:Josh.Frydenberg.MP@aph.gov.au]
**Sent:** Tuesday, 20 June 2017 6:23 PM
**To:** MinisterialCorrespondence <MinisterialCorrespondence@environment.gov.au>
**Cc:** s22 [redacted]@environment.gov.au>
**Subject:** FW: Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour)


s22 [redacted]
Office of the Hon Josh Frydenberg MP
Federal Member for Kooyong | Minister for the Environment and Energy

Electorate Office | 695 Burke Road, Camberwell VIC 3124 | t: 03 9882 3677
Parliament House Office | M1:17, Parliament House, Canberra ACT 2600 | t: 02 6277 7920

e: s22 [redacted]@aph.gov.au | w: www.joshfrydenberg.com.au


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**From:** Laura Muir [mailto:laura@hsi.org.au]
**Sent:** Tuesday, 20 June 2017 4:36 PM
**To:** Frydenberg, Josh (MP)
**Subject:** Request for Statement of Reasons - Controlled Action Decision - EPBC 2017/7939 (Toondah Harbour)

Dear Minister Frydenberg,

Please find attached a request from Humane Society International for a written statement of reasons for the controlled action decision you made under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) on 8 June 2017 regarding EPBC Act Referral 2017/7939 (a copy of the notification of your decision is also attached).

Thank you for your attention to this request, we look forward to your response.

Regards,
Laura


Laura Muir
Project Officer
Humane Society International

(02) 9973 1728

PO Box 439
Avalon NSW 2107

Download your copy of *Threatened*, HSI’s new policy book

FOI 180411
Document 16

# THE HON JOSH FRYDENBERG MP
## MINISTER FOR THE ENVIRONMENT AND ENERGY

MC17-012016

The Hon Steven Ciobo MP
Minister for Trade, Tourism and Investment
Member for Moncrieff
Parliament House
CANBERRA ACT 2600

Dear Minister

Thank you for your letter concerning the proposed Toondah Harbour development.

I note the matters raised by Cr Williams in her letter to you, and that the Toondah Harbour proposal has been granted Tourism Major Project Facilitation status.

As you are aware, the original proposal was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in November 2015. To allow for further consultation, the timeframe for making a decision on whether or not the project required assessment under the EPBC Act was extended at the request of the proponent, the Walker Group.

In May this year the Walker Group submitted a new referral replacing its original 2015 proposal. After careful consideration of this new referral, I have decided that the proposed Toondah Harbour Development requires a comprehensive environmental assessment under the EPBC Act.

I understand that Walker Group is now considering whether to apply for 'coordinated project' status for the proposal, under the Queensland *State Development and Public Works Organisation Act 1971*. If the project is granted that status, it would be assessed by the Queensland Coordinator-General. That process is also accredited under a bilateral agreement between the Commonwealth and the State, to ensure that a single process can satisfy both State and Commonwealth environmental assessment requirements.

Thank you for bringing Cr Williams' correspondence to my attention.

Yours sincerely

JOSH FRYDENBERG

FOI 180411
Document 19

**From:** Barker, James
**To:** s22 [redacted]
**Cc:** de Brouwer, Gordon; Thompson, Malcolm; Knudson, Dean; Cahill, Matt; Tregurtha, James; Papps, David; Taylor, Mark; s22 [redacted]
**Subject:** FYI: Toondah harbour, outcome of pre-referral meeting on 26 April [SEC=UNCLASSIFIED]
**Date:** Friday, 28 April 2017 5:24:34 PM

Hi s22 [redacted]

Fyi as briefly mentioned this afternoon, we had a further discussion with Walker Group on Wednesday, and some points from that meeting are below.

Walker Group advised me this afternoon that they are likely to submit a new referral for the Toondah Harbour proposal on Tuesday/Wednesday next week (noting that it is a public holiday in Qld on Monday).

Regards
James

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**From:** Barker, James
**Sent:** Friday, 28 April 2017 4:55 PM
**To:** 'Peter.Saba@walkercorp.com.au' <Peter.Saba@walkercorp.com.au>
**Cc:** s47F [redacted] s22 [redacted] @environment.gov.au>; s22 [redacted] @environment.gov.au>
**Subject:** Toondah harbour, outcome of pre-referral meeting on 26 April [SEC=UNCLASSIFIED]

Hi Peter

Thank you for the opportunity to meet with you on Wednesday to discuss your proposed new referral for the Toondah Harbour Project.

One thing we flagged at the meeting was that we would follow up to confirm the key issues that we discussed. From our perspective these were:

- We discussed the pros and cons of submitting a new referral. Walker Group proposes to submit a new referral for the proposal in the coming week, including to reflect substantive changes to the project (in particular movement of the boundary in relation to Cassim Island), and provide more detailed assessment of impacts against Ramsar values.
- Walker Group are likely to seek a decision on the new referral within the ordinary statutory timeframe.
- A focus of the referral is to refine the methodology for considering the impacts to the ecological characteristics of the RAMSAR wetland. Walker Group considers the proposed methodology is a starting point from which to do further scientific analysis of the impacts.
- The Department provided some comments on the paper at the meeting. The Department advised that, in principle, the methodology seems reasonable but we will seek to provide further advice after having considered it in more detail.
- The Department advised that the more detail that can be included in the referral the better, including potential mitigations and offsets.
- The Department continues to have concerns with the project's footprint and impacts, including

the proposed reclamation within the RAMSAR wetland.

Actions:

- The Department will seek to provide comments on the proposed methodology as soon as possible, including with input from the Department's Ramsar area. Although Walker Group would like comments on the proposed methodology, Walker Group indicated that it may not wait for the comments before submitting the new referral.
- The Department will provide advice on recommended buffer zones for the Eastern Curlew (sent by email to s47F on 26 April).

Grateful if you can confirm whether this summary is consistent with your own notes of the meeting.

Please note that the Department cannot give any assurance about the particular statutory process that may be applied on a proposed action until it has been referred under the EPBC Act. Once the formal referral is received and the cost recovery fee is paid, the Minister or delegate will consider whether the proposed action in accordance with the EPBC Act. Further information may be requested by the Department for the purposes of making that decision.

I also note that I have spoken to your consultant s47F (in response to his call to me) earlier this afternoon. s47F advised me that you are likely to submit the referral Tuesday/Wednesday next week.

If you have any additional questions or clarification please contact me.

Regards
James

James Barker
Assistant Secretary | Assessments and Governance Branch
Environment Standards Division
Department of the Environment and Energy
t: 02 6274 2694 | e: james.barker@environment.gov.au