FOI 190505
Document 1

From: s47F on behalf of Price, Melissa (MP)
To: MinisterialCorrespondence
Subject: MC19-001430 - cover letter and briefing document from the Australian World Heritage Advisory Committee Workshop - the World Heritage Workshop Canberra 29 October 2018 - HRMD
Date: Friday, 8 February 2019 5:29:23 PM
Attachments: AWHAC_LettertoMinisterPrice8Feb2019.pdf
Brief_MinisterPrice_AWHACWorkshop29Oct2018.pdf

From: s47F
Sent: Friday, 8 February 2019 12:31 PM
To: Price, Melissa (MP)
Subject: Cover letter and brief from Australian World Heritage Advisory Committee Workshop

Dear Melissa

Please find as attached a cover letter and briefing document sent on behalf of the Australian World Heritage Advisory Committee from the World Heritage Workshop that was hosted in Canberra on 29 October last year.

If you would like any additional information, please do not hesitate to contact me.

Kind regards

Sue

Sue Sargent

Chair – Australian World Heritage Advisory Committee

s47F

Australian World Heritage Advisory Committee

s47F

The Hon. Melissa Price MP
Minister for the Environment
PO Box 6022
House of Representatives
Parliament House
Canberra ACT 2600

8 February 2019

Dear Minister Price

On Monday 29 October the Australian World Heritage Advisory Committee (AWHAC) met in Canberra to discuss a range of issues of relevance across Australia's 19 properties.

I am pleased to attach a summary of the key issues and actions discussed which included:

s22

Adapting to Climate Change.

I would welcome the opportunity to discuss the Committee's recommendations and meet with you as Chair at your earliest possible convenience. I look forward to hearing back from you.

Yours sincerely

s47F

Sue Sargent
Chair
Australian World Heritage Advisory Committee

Attachment 1: Brief from the AWHAC World Heritage Workshop 29 October 2019

Australian World Heritage Advisory Committee Workshop
October 2018

In October 2018, Chairs and representatives from thirteen Australian World Heritage properties were able to come together in Canberra for a one-day workshop and discuss a number of issues common to many of the properties. The workshop was the first face-to-face meeting of the Committee for 4 years and was a major opportunity for both the Chairs and departmental staff to network.

The Committee is guided in its actions by the Australian Heritage Strategy 2015 and the majority of items on the agenda related to this document.

Based on their discussions, the Committee would like to offer the following advice to the Minister for her consideration.

s22

s22

Adapting to Climate Change

Climate Change has significant implications for Australia's World Heritage properties. Already properties are recording changes in species distribution and abundance.

While properties cannot address the global issue of climate change, actions can be (and must be) taken to manage the likely impacts on Outstanding Universal Value (OUV) pending a reduction in global emissions.

The Garnaut Climate Change Review (2008), cautioned that "extreme weather events are likely to result in irreversible damage to geological, geomorphologic and physio-geographic heritage, whole values are expressed in UNESCO's criteria (viii)…." Key recommendations were to implement comprehensive vulnerability assessments for each property; to reduce stress factors

to increase resilience (e.g. pests) and ex-situ measures such a seeds banks and living collections for high risk species (pdf link attached). Similarly, the World Heritage Committee is updating its climate change Policy Document, expressing continued concern about climate impacts on OUV.

Considering this, measures to improve the resilience and conserve the integrity of our natural World Heritage Areas are a high priority for AWHAC and each of the individual properties. Collectively, our World Heritage Areas make a significant contribution to the environmental, recreation and economic services to Australia.

In light of coverage of climate and other impacts on the Great Barrier Reef, it is timely for the terrestrial World Heritage properties to proactively develop a coordinated adaptation response.

To undertake this, AWHAC suggests that the Australian Government support:

- All properties to undertake a Climate-Change Vulnerability Index (CVI) or a similar process for identifying key impacting threats to OUV from climate change;
- AWHAC members to continue to share knowledge and approaches to inform advice on climate change action;
- Individual properties to look at opportunities to improve the resilience of OUV to reduce vulnerability to the effects of climate change;
- Traditional Custodians to participate in adaptation planning;
- AWHAC members as they continue to work with Departments, academic institutions and communities to explore responses, including technological innovations; and
- Tangible responses for addressing the impacts of climate change in partnership with governments, land managers and science/researchers.

AWHAC members acknowledged the support of the Department of the Environment and Energy and their respective State and Territory Governments that enabled the October 2018 AWHAC workshop to take place.

THE HON MELISSA PRICE MP
MINISTER FOR THE ENVIRONMENT

MC19-001430

Ms Sue Sargent
Chair
Australian World Heritage Advisory Committee
s47F

5 APR 2019

Dear Ms Sargent

Thank you for your letter and summary report of matters arising from the October 2018 Australian World Heritage Advisory Committee (the Committee) Workshop.

In your letter, you suggest that additional resources need to be made available to s22
s22
a range of initiatives relating to climate change adaptation.

I note the issues raised in the summary report, and would be interested to receive further detail from the Committee on the proposed scope of these initiatives, approximate cost and timeframes, and any co-contributions or commitments from relevant jurisdictions or from other parties. The cooperation between the Shark Bay World Heritage Advisory Committee and the Australian Government's National Environmental Science Program's (NESP) Earth Systems and Climate Change Hub is a model for partnerships to inform climate change adaptation in Australia's World Heritage properties.

Australian Government funding for National Heritage places is available through the Australian Heritage Grants Program. The current application round has closed, however the program will run again in 2019-2020. I encourage managers of Australia's World Heritage properties to consider preparing detailed proposals in advance of the next round.

I also encourage the Committee to continue to provide input to relevant policy discussions as they arise, such as the review of the EPBC Act.

Thank you for bringing your concerns to my attention.

Yours sincerely

MELISSA PRICE

s22

From: s47F
Sent: Tuesday, 30 April 2019 4:31 PM
To: s22, s47F
'Bruce Leaver'
s22, s47F
'Di Walker' s22, s47F
'Graeme Potter'
s22, s47F
'Ian Cashen' s22, s47F
'Jamie Shulmeister' s22, s47F
'John Long' s22, s47F
'Leslie Shirreffs' s22, s47F
'Mahri Koch' s47F 'Malcolm Wells'
s22, s47F
'Nick Reid' s22, s47F
Stephen Oxley
s22 Peter Adams s22, s47F
'Simon Woodley' s22, s47F

s22, s47F [redacted] David Williams s22 [redacted]

Subject: AWHAC Meeting Wednesday 15 May 2-3pm Canberra time

Dear World Heritage colleagues

s22 [redacted]

Our next AWHAC meeting will be held on **Wednesday 15 May at 2 pm** (Canberra time). Details for the teleconference are attached, but please call s22 [redacted] or s22 [redacted]
The access code for everyone to use is s22 [redacted]

s22 [redacted]

Finally, please find as attached a statement released today by the Wet Tropics board to bring to attention new evidence of escalating impacts on the Wet Tropics of Queensland World Heritage Area from climate change. Sadly, it is a reality that will be, I am sure, familiar (although different) for many of you.

I look forward to catching up with you all again on 15 May.

Best wishes

Sue

Sue Sargent
Chair – Australian World Heritage Advisory Committee
s47F [redacted]

Australian World Heritage Advisory Committee
DRAFT AGENDA
Teleconference
Wednesday 15 May 2019, 2.00-3.00pm EST

Conference Name:	Heritage Branch Teleconference
Australia Toll free:	s22
Australia Direct:	s22
Participant code:	s22

Time	Item No.	Item	Presenter
2.00	1.1	**Welcome, roll call and note apologies** *Note apologies*	Sue Sargent & Secretariat: s22
	1.2	**Adoption of Draft Agenda** *Agree agenda*	Sue Sargent
	1.3	**Actions Arising** *Note progress*	Sue Sargent & Secretariat
2.10	2	**Chair's update** s22 *Note update*	Sue Sargent
2:20	3	s22	TBA, Department of the Environment and Energy
2.25	4	**Climate Change** *Update from the newly formed AWHAC Climate Change Working Group and Wet Tropics board statement on : escalating impacts on the Wet Tropics of Queensland World Heritage Area from climate change* *Discussion*	Leslie Shirreffs
2.40	5	***AWHAC Working Group Updates*** s22	Sue Sargent Di Walker Nick Reid s47F

Time	Item No.	Item	Presenter
2:50	6	**Other Business** s22	Secretariat/Sue Sargent
3:00		**Meeting Close**	

A statement from the Board of the Wet Tropics Management Authority regarding serious climate change impacts on the Wet Tropics of Queensland World Heritage Area

Concerning new evidence has shown an accelerating decline in the Wet Tropics of Queensland World Heritage Area's unique rainforest animals as a result of climate change.

The Board of the Wet Tropics Management Authority (the Board) has now become aware that, following the hottest summer ever recorded, some of the key species for which the Wet Tropics World Heritage Area was listed are at imminent risk of extinction.

The Wet Tropics World Heritage Area is the world's oldest rainforest and land of the world's oldest living culture. It is ranked by the International Union on the Conservation of Nature as the second most irreplaceable World Heritage Area on earth, and the sixth most irreplaceable protected area, largely because of its endemic species. It provides economic benefits to the region of more than $5.2 billion per annum, significantly through visitation and tourism which enables people to experience and understand this important tropical wonder.

Climate change was identified as the most significant threat to the Wet Tropics in the *2015-16 State of the Wet Tropics Report on ancient, endemic, rare and threatened vertebrates of the Wet Tropics* (the Report). Based on long term monitoring, the Report identified that the biodiversity of the Wet Tropics World Heritage Area was declining with many rainforest species already reduced in both distribution and population size, largely as a result of climate change.

Professor Steve Williams from the Centre for Tropical Environment and Sustainability Science at James Cook University, and co-author of the Report, has been monitoring rainforest biodiversity for over 20 years across the whole Wet Tropics region. The long-term monitoring of the rainforest vertebrates conducted by Prof Williams has observed a systematic decrease in the abundance and distribution of many Wet Tropics endemic species. Normally found at elevations over 600 metres, these cool adapted species have progressively moved to higher elevations, leaving alarming population declines at the lower elevation areas of their distribution.

The lemuroid ringtail possum, a species for which the Wet Tropics World Heritage Area is renowned, has been steadily declining now for more than a decade. Prof Williams' recent monitoring has identified that the declines in possum and bird species have continued at a rate similar to the predictions made more than a decade ago and are now reaching alarming levels. If the trends continue, populations at sites that previously had the highest density of lemuroid ringtail possums in the region could become locally extinct as early as 2022. This species is currently not even classified as endangered.

There are similar trends for species such as the Herbert River ringtail possum and green ringtail possum, as well as bird species such as the tooth-billed bowerbird—species which only occur in the Wet Tropics World Heritage and for which it was World Heritage listed.

A model, using 400,000 data points collected over the past 10 years, predicted that the World Heritage Area could be facing the extinction of more than half of its endemic species by the end of this century. The latest rates of decline suggest that these extinctions are happening even sooner.

Since its appointment in 2015, the Board made it a key priority to pursue climate change adaptation and mitigation strategies to protect the Wet Tropics World Heritage Area. In June this year it will release a draft Climate Adaptation Plan, informed by the best available science. However, given the gravity of the new evidence, the Board feels that decisive action is needed now.

The 2017 International Union on the Conservation of Nature Outlook Report on the Wet Tropics also cautioned that "The Wet Tropics of Queensland World Heritage Area is particularly vulnerable to the impacts of climate

change. Climate change threatens to disrupt the finely balanced ecological and climatic conditions that support the distinctive assemblage of plants and animals and may result in rapid and catastrophic changes."

These scenarios are increasingly proving true, not only here but around the world, with measurable and rapidly growing impacts from climate change being experienced. In the Wet Tropics World Heritage Area this is exacerbated by introduced pests like pigs and myrtle rust also gaining access to higher altitudes due to a warming climate. Strong intervention is required immediately to secure the future of the Wet Tropics World Heritage Area.

While, understandably, the Great Barrier Reef has received significant funding to address climate change impacts in recent years, investment in terrestrial World Heritage Areas has not been commensurate with the urgency for mitigating climate impacts on their World Heritage values.

Extreme heat is the Wet Tropics World Heritage Area's coral bleaching event equivalent, with some mountain adapted species, like the lemuroid ringtail possum, unable to survive even a day of temperatures above 29 degrees Celsius. Mount Bartle Frere, (the highest mountain in the Wet Tropics), recorded an unprecedented 39 degrees Celsius at its peak on six days this past summer.

The Board is convinced that, given the evidence, these key species endemic to the Wet Tropics World Heritage Area are under severe and immediate threat from climate change. This is occurring now, not in the future, and requires an immediate response. With current trends, the world is locked into 20 years of increasing temperatures. Action and significant investment is needed to reduce other threats now to ensure these areas are as robust as possible to withstand those increasing temperatures.

Australia has the resources and expertise to be a leader in responding to local climate change challenges. The Board is optimistic that the measures listed below will improve the resilience of the Wet Tropics World Heritage Area's internationally significant values, together with strong global action to reduce emissions.

The World Heritage Convention is about protection, conservation and presentation of World Heritage areas—but it is also about transmission of these values to future generations. The Board is determined to meet this obligation but it will take considerable effort, across all sectors, all governments and all people who cherish the best of the best natural and cultural significant areas Australia has to offer.

Action is needed now, before it is too late.

Signed:

Ms Leslie Shirreffs PSM, Chair

Prof Iain Gordon, Director

Dr Leah Talbot, Director

Mr Phil Rist, Director

Mr John Courtenay, Director

Ms Anne Clarke, Director

Climate change in the Wet Tropics: a 10-point plan

A statement from the Board of the Wet Tropics Management Authority regarding serious climate change impacts on the Wet Tropics of Queensland World Heritage Area

Urgent action and investment from governments is needed to improve the resilience and protection of the Wet Tropics of Queensland World Heritage Area. Such actions include

1. **Land restoration**. Enhance resilience through restoration and enhancement of wildlife corridors and buffering of refugia.
2. **Monitoring.** Re-initiate and expand monitoring to increase information of the impacts on World Heritage Values / Outstanding Universal Value and identify potential refugia.
3. **Pest management**. Immediate and aggressive control of feral pigs and myrtle rust to prevent spread into the higher altitude refugia.
4. **Research and innovation**. In-depth assessment of possible measures, examples could include biobanking, genetic editing or potential for *ex-situ* conservation (e.g. captive breeding) and assisted migration in collaboration with Rainforest Aboriginal Peoples.
5. **Threatened species listing**. Urgent discussions with relevant agencies to nominate at risk species and ecosystems for listing under the Australian threat lists (Nature Conservation Act, Environmental Protection and Biodiversity Conservation Act, IUCN).
6. **Fire**. Assess vulnerability and reduce threats from increased risk to rainforests from fire.
7. **Partnerships and engagement**. Rainforest Aboriginal peoples, the tourism industry and the community to collaborate in the response.
8. **Cooperation**. Work with the Australian World Heritage Advisory Committee (AWHAC) and other Queensland terrestrial world heritage properties on cooperative research and responses.
9. **Climate Adaptation Plan.** Finalise the Wet Tropics Climate Change Adaptation Plan as a matter of urgency.
10. **Mitigation**. Call for urgent action on reducing global emissions.

s22

s47F

Sent: Friday, 7 December 2018 1:00 AM

To: s22, s47F

'Di Walker' s22, s47F

'Graeme Potter'

s22, s47F

s22, s47F

'Ian Cashen' s22, s47F

'Jamie Shulmeister' s22, s47F

'John Long' s22, s47F

Leslie Shirreffs' s22, s47F

'Mahri Koch' s47F 'Malcolm Wells' s22, s47F

'Nick Reid' s22, s47F

Stephen Oxley

s22 Peter Adams s22, s47F

'Simon Woodley' s22, s47F

David Williams s22

Subject: AWHAC Minutes 22 November 2018

Dear Chairs and Observers

With thanks to s22 as our minute-taker for the last AWHAC teleconference, please find the meeting minutes as attached. If there are any amendments needed, please let me know.

s22

Best wishes

Sue

Sue Sargent
Chair – Australian World Heritage Advisory Committee
s47F

Australian World Heritage Advisory Committee (AWHAC) Teleconference
DRAFT MINUTES
2.00PM – 3.00PM (AEST), 22 November 2018

Chairs

Name	Property
Peter Adams	Lord Howe Island
s47F	Purnululu
	Australian Convict Sites
Bruce Leaver	Greater Blue Mountains
Sue Sargent	AWHAC
Leslie Shirreffs	Wet Tropics
Di Walker	Shark Bay

Executive Officers / Observers

Name	Property
s22 s47F	Australian Government
	Naracoorte
	Fraser Island
	Heritage Victoria
	Greater Blue Mountains
	Australian Government
	Willandra Lakes
	Lord Howe Island
	Australian Government
	Gondwana
	Wet Tropics

Apologies

Aplogies - Chairs

Name	Property
Ian Cashen	Sydney Opera House
s47F	AWHIN
Mahri Koch	Gondwana
John Long	Naracoorte
Graeme Potter	Riversleigh
Nick Reid	Gondwana
s47F	Budj Bim
Jamie Shulmeister	Fraser Island
s47F	GBR
Malcolm Wells	Tasmanian Wilderness
Simon Woodley	Ningaloo Coast

Apologies - Executive Officers / Observers

Name	Property
s22	NSW Government
	Australian Government
s47F	Lord Howe Island
	Wet Tropics

s22	Australian Government
	Australian Government
s47F	Macquarie Island
	Purnululu
	Australian Convict Sites
s22	Australian Government
s47F	Sydney Opera House
	Naracoorte
Stephen Oxley	Australian Government s47F
s22	Australian Government
s47F	Riversleigh
	Tasmanian Wilderness
s22	Australian Government
David Williams	Australian Government

1.1 Welcome, roll call and note written apologies

Chair, Sue Sargent opened the teleconference, welcomed participants and acknowledged new member s47F – Heritage Officer with Heritage Victoria and s47F from Lord Howe Island.

1.2 Adoption of Draft Agenda

s22

1.3 Actions Arising

The Minutes from the previous meeting were discussed. Actions arising were discussed and progress was noted.

Action Number / Date	Action	Lead	Current Status
s47F, s22			

s47F, s22

1. August 2018	Discussion paper to be developed for distribution to AWHAC members prior to 30-31 October workshop. s22 Leslie Shirreffs and Sue Sargent: Climate Change Adaptation	AWHAC members	Completed

s47F, s22

The minutes were then proposed to be accepted by Sue Sargent CARRIED

2. Chair's Update

The Committee noted the advice from the Chair.

s22

s22

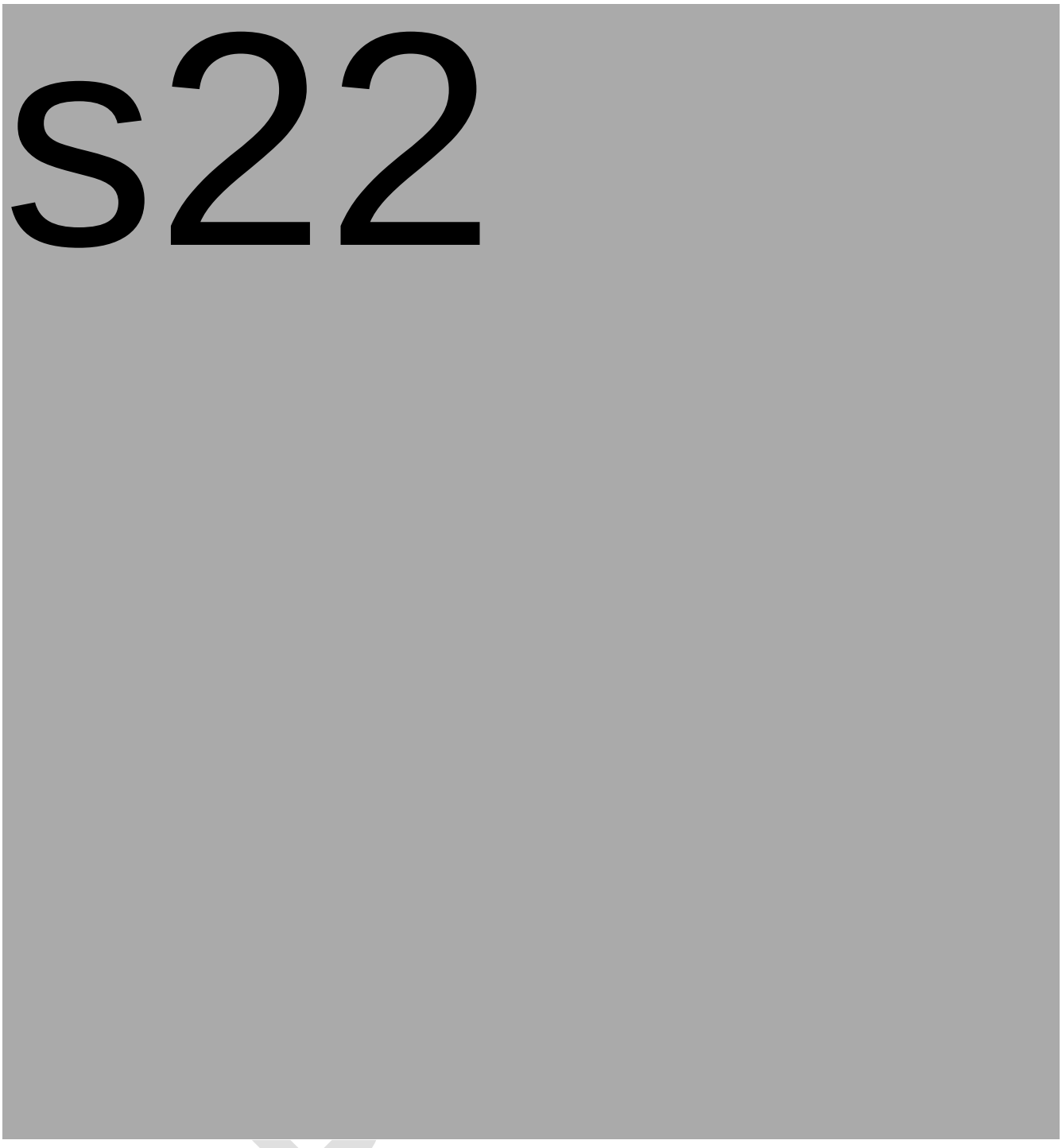
s22

5. *AWHAC Workshop Update*

s22

Key recommendations from the AWHAC Workshop:

s22



Climate change

- Properties consider using the Climate Change Vulnerability Index for identifying key impacting threats to OUV from climate change;
- AWHAC members continue to share knowledge and approaches to inform advice on climate change action;
- Individual properties look at opportunities to improve the resilience of OUV to reduce vulnerability to the effects of climate change;
- Traditional Custodians be invited to participate in adaptation planning;
- AWHAC members continue to work with Departments, academic institutions and communities to explore responses, including technological innovations; and
- AWHAC members seek tangible responses for addressing the impacts of climate change in partnership with governments, land managers and science/researchers.

Discussion points

s22

- Shark Bay progressing wok on climate change information and planning to invite ministerial attendance, keen to know the formal process for invitations.

s22

Actions 4-8:

s22

5. Chair will write to Minister Price with a brief about the AWHAC Workshop and our recommendations, after receiving available updates from the Department relevant to our discussions.

s22

4. *Other business*

s22

SUMMARY OF AWHAC ACTIONS NOVEMBER 2018 MEETING

Action No.	Action	Lead	Current Status
s22			
5	Write to Minister Price with a brief about the AWHAC Workshop and our recommendations, after receiving available updates from the Department relevant to our discussions.	Sue Sargent	Pending feedback from the DoEE
s22			

FOI 190505
Document 5

From: s22
To:
Cc:
Subject: FW: Department input on AWHAC Workshop Recommendations [SEC=UNCLASSIFIED]
Date: Friday, 18 January 2019 12:48:19 PM

FYI

s22

From: s47F
Sent: Friday, 18 January 2019 12:34 PM
To:
Cc: s22
Subject: RE: Department input on AWHAC Workshop Recommendations

Hi s22
Happy New Year! ☺
I was just wondering if you had any feedback for me yet?
Best wishes
Sue
Sue Sargent

s47F

From: s22
Sent: Monday, 17 December 2018 4:37 PM
To: s47F
Cc: s22

Subject: Re: Department input on AWHAC Workshop Recommendations

Thanks for following up Sue, I will be able to get back to you by the end of the week
Cheers
s22

Sent from my iPhone

On 17 Dec 2018, at 5:06 pm, s47F wrote:

> Hi s22
> I thought I should just follow up with you to see if the Department had any feedback to provide on the AWHAC Workshop recommendations (see attached summary)?
> I know that you were keen to provide AWHAC with an update regarding processes that were already underway before we submitted a brief to Minister Price (on the workshop and our recommendations) and wanted to make sure that we were able

to take your feedback into consideration (see Action 5 below).

> *Action 5 (22 November meeting): Chair will write to Minister Price with a brief about the AWHAC Workshop and our recommendations,* ***after receiving available updates from the Department relevant to our discussions.***

Are you able to liaise with and provide updates the appropriate Directors on our behalf? I am hoping to send the brief to the Minister in early January to ensure that our advice is timely and relevant.

Thank you for all your support in 2018, I look forward to working with you again in 2019.

Kind regards

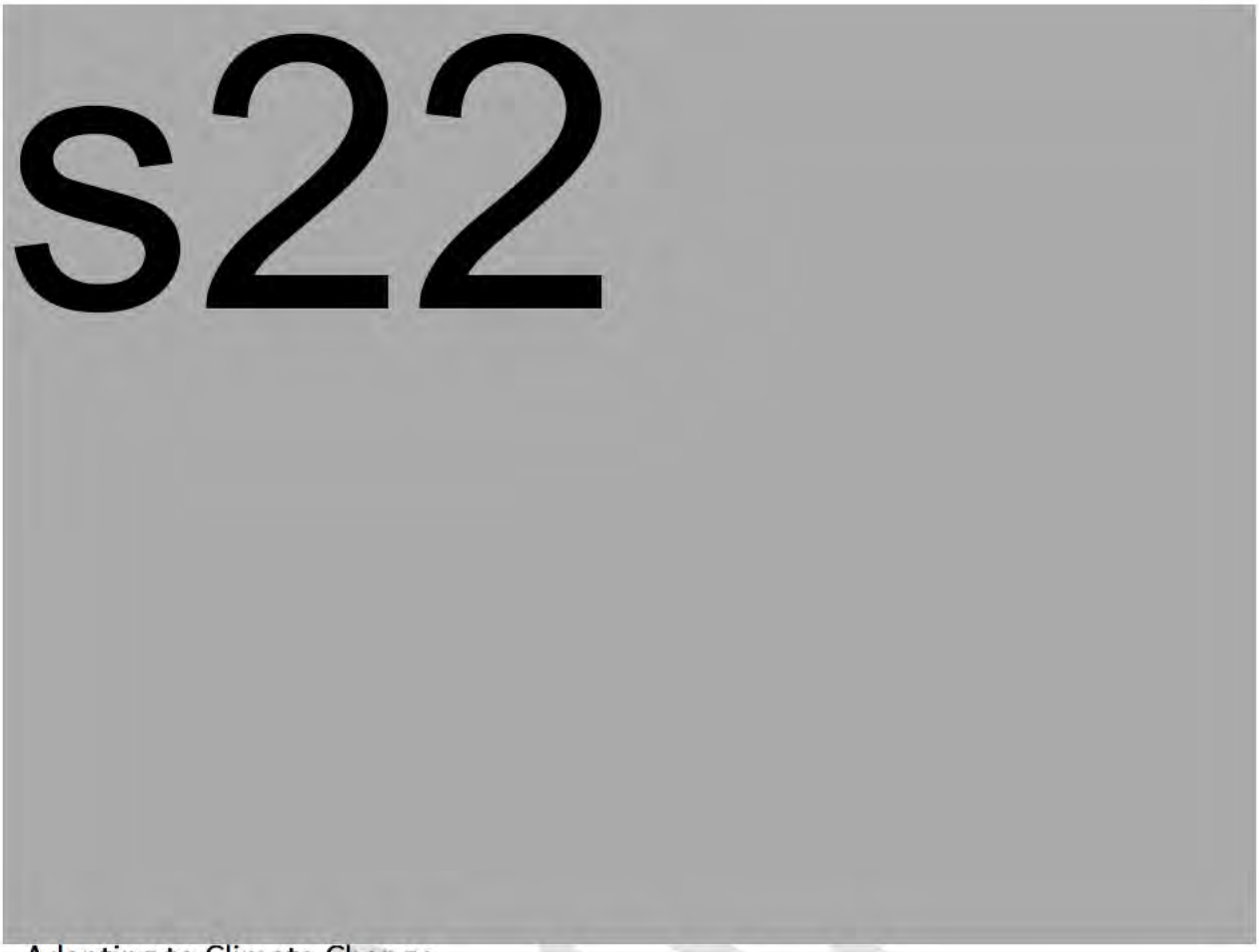
Sue

Sue Sargent

Chair – Australian World Heritage Advisory Committee

s47F

Summary of AWHAC Recommendations / Actions
World Heritage Workshop
29 October 2018:



Adapting to Climate Change

- Properties consider using the **Climate-Change Vulnerability Index (CVI)** for identifying key impacting threats to OUV from climate change;
- AWHAC members continue to share knowledge and approaches to inform advice on climate change action;
- Individual properties look at opportunities to improve the resilience of OUV to reduce vulnerability to the effects of climate change;
- Traditional Custodians be invited to participate in adaptation planning;
- AWHAC members continue to work with Departments, academic institutions and communities to explore responses, including technological innovations; and
- AWHAC members seek tangible responses for addressing the impacts of climate change in partnership with governments, land managers and science/researchers.

AWHAC members acknowledged the support of the Department of the Environment and Energy and State Governments to enable the October 2018 AWHAC workshop to take place.

FOI 190505
Document 6

From: Sue Sargent
To: yourenvminister
Subject: MC18-016927 communique - Fraser Island (K"gari) World Heritage Area Community and Scientific Advisory Committees - HRMD
Date: Sunday, 16 September 2018 5:07:58 PM
Attachments: fraser_islandcac_communique_august2018.pdf
fraser_islandsac_communique_july_2018.pdf
final_-_fraser_islandcombinecommitteecommunique_april2018.pdf

Contact your Minister request notification

Contact your Minister webform submitted on 16/09/2018, 5:07

Minister name: The Minister for the Environment or the Minister for Energy

Title: Ms

First name: Sue

Last name: Sargent

Email: s47F

Organisation: Fraser Island World Heritage Area Community Advisory Committee

Address: s47F

Phone: s47F

Subject: Communiques from Fraser Island (K'gari) World Heritage Area Community and Scientific Advisory Committees

Comments: Dear Minister Price Can I first, on behalf of Professor Jamie Shulmeister and myself, congratulate you on your recent appointment as Federal Minister for the Environment. We feel particularly fortunate to have met you at the celebration of Fraser Island's (K'gari) 25th Anniversary of World Heritage earlier this year and hope that your visit showcased the spectacular beauty of Fraser Island (K'gari) and provided some insight into the challenges associated with a remote World Heritage Area. Please find attached the latest Fraser Island (K'gari) World Heritage Area Scientific and Community Advisory Committee Communiques. As with all the World Heritage properties, the Scientific and Community

Advisory Committee Chairs prepare a Communique at the end of each meeting. The Communiques highlight key issues and recommendations considered at each meeting. This Communique follows the productive and successful Scientific and Community meetings held recently in Brisbane and Hervey Bay respectively. Given your new portfolio, we have also attached the previous Communique from our combined committee meeting (held n April) for your information. The Advisory Committees generally seek responses to our Communiques from the Queensland Minister as one of the mechanisms to guide our future agendas and deliberations.

s22 [redacted] e thank you for your continued commitment to the management of the Fraser Island World Heritage Area and welcome your feedback. Sue Sargent (Chair - Fraser Island World Heritage Area Community Advisory Committee) and Professor Jamie Shulmeister (Chair - Fraser Island World Heritage Area Scientific Advisory Committee)

Attachments: 3 file(s) attached.

Community Advisory Committee Communique
August 2018

The Fraser Island (K'gari) World Heritage Community Advisory Committee (CAC) met in Hervey Bay on Monday 13 August 2018. The Committee had the opportunity to discuss a number of issues that have the potential to impact on the Outstanding Universal Value (OUV) of the World Heritage property which are summarised below:

Myrtle Rust – A major threat to the integrity of K'gari (Fraser Island)

The CAC expressed their real concerns for the future integrity of K'gari and the implications of myrtle rust. This pathogen has the potential to detrimentally impact the OUV of the island. It is noteworthy that the island's international significance has again been recognised through the recently announced 'Queen's Commonwealth Canopy' status of the island's rainforests – a key ecosystem threatened by myrtle rust.

Since the first detection of myrtle rust in Australia (central coast NSW), the spread has been rapid. Myrtle rust has now been observed in over 350 species from 57 different genera. In 2013, surveys of K'gari identified rust on five species: *Austromyrtus dulcis, Backhousia myrtifolia, Homoranthus virgatus, Melaleuca quinquenervia,* and *Rhodamnia acuminate.* Since then, it is likely that the rust has infected more species.

The CAC expressed their support for the *Myrtle Rust in Australia – Draft Action Plan* and recommend the need for Commonwealth funding to support urgent research; field surveys and emergency conservation actions (including preservation of collection and preservation of germplasm/seed of key species); identification of potential cultural impacts on both flora and fauna species associated with rainforest and wetland Myrtaceae; and impact monitoring of affected species/sites on K'gari. If funded, these roles could be performed by the newly formed Indigenous Land and Sea Ranger Team.

Adapting to Climate Change

The CAC welcomed the development of the *Queensland's Draft Biodiversity and Ecosystems Climate Adaptation Plan*. The CAC encourage both the Queensland and Commonwealth Governments to progress feedback from the Scientific and Community Advisory Committees and fund the development of property level adaptation planning for Queensland's terrestrial World Heritage Areas. With the exception of the Great Barrier Reef, Queensland's World Heritage Areas (WHAs) do not yet have integrated climate adaptation plans. The properties are likely to be important climate refugia in Queensland and climate change has been identified as a potential threat to the *Outstanding Universal Value* for which they are listed as World Heritage Areas. UNESCO has noted that the continued preservation of World Heritage Areas means understanding and addressing this threat.

Engagement with the State Party

The CAC was thrilled to have Commonwealth representation, including the Assistant Minister (now Minister) for the Environment, Hon. Melissa Price MP, at the 25th Anniversary Celebration of the Fraser Island (K'gari) World Heritage Area earlier this year. However, over the last few years we have seen a decline in participation by Commonwealth representatives from the Department of Environment and Energy. While it is recognised that attending committee meetings is costly, the significance of these sites to the World, and the opportunity to gain greater understanding of the property, cannot be understated. We urge the Commonwealth to increase their current commitment to participate in meetings via teleconference (to provide a Departmental update) and to attend the annual Combined Community and Scientific Committee Meeting (held on K'gari); and, given that committee members themselves also travel great distances to attend, urge both Governments to consider using technology such as video-conferencing to reduce financial barriers to participation by both the Commonwealth and committee members.

Recent Research – Ancient Dunes

The CAC noted preliminary results from Professor Jamie Shulmeister on dune sequencing for K'gari and the Cooloola Sand Mass. The University of Queensland team have recently demonstrated that the dune sequence on the island is over 800,000 years old. The results also have implications for the Butchulla people, as with permanent fresh water on the island established far earlier than previously thought, K'gari has the potential to be one of the East Coast's earliest sites for Aboriginal occupation – potentially increasing occupation of the island from 6,000 to 60,000 years.

Queensland Indigenous Land and Sea Rangers

The Committee noted with excitement, the recent employment of four Butchulla Land and Sea Rangers for Butchulla country – including K'gari. The Butchulla rangers will make an invaluable contribution to the management of K'gari including increased cultural mapping and onsite conservation of cultural heritage.

Celebrating 25 Years of World Heritage

The 25th Anniversary celebrations continue, with over 350 superb entries to the 'Snap Up Some Paradise' photo competition. The Committee looks forward to the announcement of winners by the Minister for the Environment, Leeanne Enoch. Winners will be featured in the December issue of *Wildlife* magazine as well as a limited edition K'gari Calendar. The Queensland Museum is also committed to working in collaboration with the department, Butchulla Aboriginal Corporation (BAC) and the Community and Scientific Advisory Committees in developing a commemorative Fraser Island (K'gari) World Heritage Area guidebook. A 'Science on the Couch' event is proposed for later this year which will also recognise the photo competition winners and showcase K'gari's incredible landscapes and ecosystems.

Communication Workshop

The CAC, QPWS and World Heritage team all participated in a workshop designed to identify key messages for the Fraser Island (K'gari) World Heritage Area. In our attempts to better manage visitation the island, it is important to celebrate what it is that brings them to K'gari - namely its Outstanding Universal Value and status as a World Heritage property. The Committee reflected on what was unique about K'gari including its ancient dune systems (over 800,000 years old), pristine perched lakes, rainforests on sand and wilderness. Words including awe, primitive, privilege, spiritual and connection were put forward by committee members and will be crafted by the Queensland World Heritage team to be used for future communication products. The CAC encouraged the World Heritage team and the QPWS managers to work with the BAC to develop a comprehensive 'key messages' document to help guide future interpretation and messaging for the island.

Scientific Advisory Committee Communique
July 2018

Critical - Myrtle Rust

The Scientific Advisory Committee (SAC) notes with extreme concern the likely implications of Myrtle Rust spreading across the Fraser Island (K'gari) World Heritage Area. This fungal plant pathogen has the potential to severely impact both Melaleuca (paperbark) swamps, a key ecosystem on the island, and even more significantly on the sub-tropical rainforest. The island's rainforests that grow from sand dunes, are a key value and are internationally recognised as a major part of the property's inscribed Outstanding Universal Value (OUV). These impacts of Myrtle Rust could potentially include the highly significant deterioration of the island's existing ecosystems, or at least cause a major change of species composition. These ecosystem changes are a direct threat to the property's OUV and its integrity. The Committee recognises that the significant potential impact of Myrtle Rust extends far beyond K'gari. Thus the SAC strongly recommends that the draft National Myrtle Rust Action Plan, once finalised, be immediately adopted by both the Federal and State Governments.

The Committee further recommends that a monitoring and management strategy for Myrtle Rust be implemented on K'gari. Myrtle Rust is established on the property, but as yet major damage has not been observed. We consider K'gari an excellent pilot location to establish a long-term monitoring program to assess impacts of Myrtle Rust on native flora. The rapid establishment of monitoring plots in Melaleuca swamps, rainforests and in other Myrtaceous communities, including the iconic Satinay forests, is also strongly advised. Ongoing general monitoring of the spread and impact of Myrtle Rust is also necessary. Further, because K'gari appears less affected so far, it may be a strong candidate for the collection of germ plasm and seeds of susceptible species, before infection occurs. We suggest that the newly established Butchulla Land and Sea Rangers could play a lead role, noting that Myrtle Rust also threatens Butchulla cultural heritage which encompasses natural values. Additional funding would be required to enable this leading role to occur. As biosecurity is primarily a Federal matter, we request that the Federal government consider providing emergency funding to enable an effective response before it is too late.

Other matters

The SAC welcomes the inclusion of Butchulla observers on the committee. We are very grateful for the insightful and valuable contributions during the meeting and strongly encourage a permanent presence and input to the committee.

The SAC endorses the proposed new Field Guide book for the 25th Anniversary of the Fraser Island (K'gari) World Heritage Area. The Field Guide is being produced by the Queensland Museum as part of the MOU between Queensland DES and the Queensland Museum. Committee members have been invited to be involved and look forward to contributing to the book.

The Committee welcomes the provision of data on visitor numbers. We encourage further refinements, notably the inclusion of passenger numbers on the ferries, as this will enable accurate total numbers to be determined. The Committee notes that the existing visitation strategy contains key information on the data requirements and encourages QPWS to refer to that document for direction in this area.

The Committee is enthusiastic to support Fraser Island (K'gari) World Heritage Area 25th Anniversary activities and was impressed by the proposed future activities. The Committee will work to support the Channel 10 documentary, photo competition and science night.

The Committee notes the presentation on the new Biodiversity and Ecosystem Climate Adaptation Plan. Because of the short lead time, it may not be possible to provide an official committee view but individual members are keen to participate in the feedback process.

April 2018

The combined Committees of the Fraser Island (K'gari) World Heritage Community Advisory Committee (CAC) and Scientific Advisory Committee (SAC) met in Hervey Bay and on Fraser Island (K'gari) between Monday 16 April and Wednesday 18 April 2018.

Crucial issues:

K'gari, identified as Fraser Island World Heritage Area (FIWHA) was internationally recognised over 25 years ago for its Outstanding Universal Value (OUV). It is, however, the collective view of the Committees, that currently neither the funding nor the management planning reflects this World Heritage status. The Committees request that both the Australian and Queensland Governments work to address this.

The Committees collectively recognise that K'gari (Fraser Island) WHA should be managed in a formally (legally) recognised and resourced partnership with the Butchulla Aboriginal Corporation (BAC) who are the Native Title holders.

The Committees recognise K'gari as a cultural landscape and support the urgent need for cultural mapping to be undertaken to enable cultural landscape values to be appropriately recognised, both nationally and internationally, and effectively integrated into management.

The Committees collectively endorse the recognition and resourcing of all aspects of management for Butchulla cultural values. A revised management plan undertaken in partnership with the Butchulla People must address the conservation, presentation and transmission (interpretation) of the Outstanding Universal Value (OUV) for K'gari within a Butchulla cultural framework.

Myrtle Rust

The Committees note with considerable concern, the presentations on Myrtle Rust by Dr Geoff Pegg and Mr Bob Makinson. With over 350 species from 57 genera affected, Myrtle Rust has the capacity to seriously compromise the Outstanding Universal Value of FIWHA over the next decade. Current research suggests that in a single decade, Myrtle Rust could

significantly compromise key Myrtaceae communities on the island, notably Melaleuca swamps and rainforest pioneer taxa, and consequently the natural and cultural landscapes associated with the OUV in these ecosystems.

The Committees call for urgent research funding to identify impacts of Myrtle Rust on K'gari and the implementation of management efforts to mitigate impacts including:

- Field surveys and emergency conservation actions to safeguard vulnerable species (including preservation, collection and conservation of germplasm/seed of key species);
- Identification of potential cultural impacts and necessary practice-change for both flora and fauna associated with rainforest and wetland Myrtaceae; and
- Impact monitoring of affected species, vegetation communities and sites.

Other points:

1. The Committees gratefully recognise the Cultural Knowledge training generously shared by the BAC and thank Elder Gayle Minniecon and Conway Burns for their outstanding presentation.
2. The Committees have repeatedly requested that accurate visitation numbers to the WHA be collected and made available for the purposes of planning, management, risk assessment and research. The Committees keenly anticipate a concrete outcome through the offer from QPWS to work with permit holders to compile these data.
3. In recognition of the resource constraints to both the Department and Butchulla Aboriginal Corporation, the Committees endorse a review of fees for Fraser Island (K'gari) with a view to contributing effective funding for the BAC. We note that this was supported by former Minister for the Environment, Hon Dr Steven Miles.

Scientific Advisory Committee (SAC)

The Scientific Advisory Committee would welcome the formal incorporation of one (or more) Butchulla representatives onto the SAC (as endorsed by the BAC).

The Committee recognises the fundamental role of monitoring in effective management planning and respectfully advise that the current draft Great Sandy Management Plan is deficient in this regard.

The Committee recognises the importance, and the right of the Butchulla people to be consulted in the initial planning for research and to approve applications for research.

The Committee also notes that it a requirement under Section 5(c) of the World Heritage Convention that research is undertaken on all World Heritage properties. The Committee urges prompt resolution of current disconnects between the Butchulla (BAC) and QPWS processes to minimise disruption in research effort and potential to compromise OUV.

FOI 190505
Document 7

From: Price, Melissa (MP)
To: MinisterialCorrespondence
Subject: MC19-000035 - Communique from Fraser Island (K"gari) World Heritage Area Community Advisory Committee - HRMD
Date: Monday, 31 December 2018 2:51:35 PM
Attachments: image001.jpg
Fraser IslandCAC_Communique_November2018.pdf
s22

From: s47F
Sent: F
To: Price, Melissa (MP)
Subject: Communique from Fraser Island (K'gari) World Heritage Area Community Advisory Committee

Dear Minister Price

Please find as attached the final Fraser Island (K'gari) World Heritage Community Advisory Committee (CAC) Communique for 2018. The Communique highlights the key issues considered, and recommendations provided, at the meeting and follows a full and productive meeting held recently in Hervey Bay, Queensland.

The Communique provides an overview of the meeting, but of particular note for you are the following recommendations:

s22

We seek a response to our Communique from you, as the Federal Minister for the Environment, to guide our future agenda and deliberations.

Again, we acknowledge your commitment to the management of the Fraser island (K'gari) World Heritage Area and for attending our celebration of 25 years of World Heritage in April. We thank you for your continued commitment to the management of the Fraser island World Heritage Area.

Kind regards

Sue Sargent
Chair – Fraser Island ((K'gari) World Heritage Community Advisory Committee

s47F

FRASER ISLAND

November 2018

The Fraser Island (K'gari) World Heritage Community Advisory Committee (CAC) met in Hervey Bay on Monday 12 November 2018. It was a rich meeting where the Committee received updates and discussed a number of issues that have the potential to impact on the Outstanding Universal Value (OUV) of the World Heritage property which are summarised below:

The Australian World Heritage Advisory Committee and Commonwealth World Heritage Workshop (29-31 October) and Queensland World Heritage Chairs' Meeting (8 November)

The Chair acknowledged the support from both the Commonwealth and Queensland Governments to enable collaboration and advice to be progressed not only at the individual property level, but also at the State (for Riversleigh Australian Fossil Mammal Site, Wet Tropics, Fraser Island-K'gari and the Gondwana Rainforests of Australia) and National levels (across Australia's nineteen World Heritage properties). Given that the Queensland World Heritage Chairs' meeting was held shortly after the National World Heritage Workshop, there was also the opportunity to raise a number of issues in both forums. Key topics of discussion were:

- The **need to resource and support the meaningful engagement and participation of Traditional Owners** in the management of World Heritage properties.
- **Environmental biosecurity** and the implications of pests such as myrtle rust that have the potential to impact on the Outstanding Universal Value (OUV) of Australia's natural properties.
- The need for **Tourism or Visitor Master Plans** to ensure development is appropriate and encourages the sustainable use and interpretation of Australia's World Heritage properties.
- **Planning and adapting to a Changing Climate future** – ensuring that we understand the impacts, and use research, monitoring and reporting to inform and implement actions that enable us to increase the resilience of World Heritage properties.
- **Monitoring World Heritage properties** and designing a program that is fit for purpose and meets the reporting needs of multiple audiences.

The Committee were also excited to hear about the launch of the *Queensland Climate Adaptation Strategy: Biodiversity and Ecosystems Adaptation Plan* on 9 November. The CAC recommend this be progressed to an individual property plan for Fraser Island (K'gari) WHA over the next 12 months.

Celebrating 25 Years of World Heritage

As a year of celebrations draws to a close, the CAC reflected on the opportunities the celebration had provided for Fraser Island (K'gari) to increase recognition of the property as a World Heritage site and for the island's Native Title holders – the Butchulla people. Visitors of particular note were His Royal Highness, Prince Harry, the Duchess of Sussex, Meghan Markle, The Hon. Melissa Price MP (now the Federal Minister for the Environment), Annastacia Palaszczuk (Queensland Premier) and Hon. Leeanne Enoch (Queensland Minister for Environment) as well as senior officials from both governments. The celebration enabled new partnerships to be developed with Network Ten and the Queensland Museum, while the 'Snap Up Some Paradise' photo competition demonstrated the beauty and significance of the island to all Queenslanders that will be featured in a 4-page feature in *Wildlife* magazine and a commemorative calendar for 2019.

Environmental Biosecurity and Myrtle Rust

The CAC were pleased to hear of progress in the fight against myrtle rust, which has the potential to severely impact both melaleuca (paperbark) swamps, a key ecosystem on the island, and more significantly on the sub-tropical rainforest. The Butchulla Land and Sea Rangers have received training in recognising and monitoring this pathogen.

The CAC recognise that more resources are urgently required to combat this pest, but also the need to develop a response plan for future biosecurity threats that may impact on the OUV of the property.

Upcoming Opportunities

The CAC were excited to hear about the upcoming Australian Heritage Grants 2018-19 Grant and identified several options for projects urgently needed for the World Heritage property. Funding of up to $400K will be available for Australia's National Heritage List places through a competitive grants process.

Governance – how can we achieve more for less?

With diminishing support, Advisory Committees are increasingly under pressure to achieve more outcomes with less resources. To address this, the CAC members participated in a workshop as part of the World Heritage Governance Review that is currently being undertaken by the Queensland Government. The review will identify best management practice and provide recommendations for contemporary engagement for Queensland's World Heritage Advisory Committees for the next term (which commences in October 2019).

Forward Planning

Finally, the CAC participated in a session to identify their priorities for 2019. These included:

- Developing a Communications and Engagement Plan for Fraser Island (K'gari) World Heritage Area.
- The urgent need to undertake erosion control and provide interpretation of the cultural significance of Indian Head (Takky Waroo) to enable visitors to make an informed choice on whether to access the site.
- Environmental Biosecurity - including the delivery of a response to Myrtle Rust.
- Climate Change Adaptation – developing a plan for Fraser Island (K'gari) that identifies threats to the OUV from Climate Change and identifies actions to increase the property's resilience.

s22

Australian Government
Department of the Environment and Energy

Ref: MC19-000035

Sue Sargent
Chair
Fraser Island (K'gari) World Heritage Community Advisory Committee
s47F

Dear Sue Sargent

Thank you for writing to the Minister for the Environment, the Hon Melissa Price MP on matters raised at the November 2018 Fraser Island (K'gari) World Heritage Community Advisory Meeting. Your letter has been passed to the Department of the Environment and Energy to reply.

In your letter you request additional resources for s22 and the need to plan and adapt to a changing climate. The Department would be interested to receive further detail from the Committee on the proposed scope of these initiatives, including approximate costs and timeframes, and the potential contribution of the Queensland Government or other parties.

As you are aware funding to support Australia's National Heritage properties is available through the Australian Heritage Grants Program. The objectives of the program are to strengthen the recognition, management, conservation and public engagement of Australia's National Heritage properties. The 2018-19 application round has closed however it is anticipated that the program will run again in 2019-20. Further information including how to apply for the next round of grants will be posted on the Department's website (http://www.environment.gov.au) under the "Grants and Funding" tab.

Thank you for your continued work on Fraser Island (K'gari) and for writing on these matters.

Yours sincerely

David Williams
Assistant Secretary
Heritage Branch

24 January 2019

FOI 190505
Document 9

From: Price, Melissa (MP)
To: MinisterialCorrespondence
Subject: MC19-002491 - Fraser Island World Heritage Area - Scientific Advisory Committee joint communique-HRMD
Date: Tuesday, 5 March 2019 4:07:59 PM
Attachments: image001.jpg
Communique - FIWHA SAC December -February final.docx

From: Jamie Shulmeister s47F
Sent: Tuesday, 5 March 2019 12:15 PM
To: Price, Melissa (MP)
Subject: Fraser Island World Heritage Area - Scientific Advisory Committee joint communique

Dear Minister Price

Please find as attached the Fraser Island (K'gari) World Heritage Scientific Advisory Committee (CAC) joint Communique for the December 2018 and February 2019 meetings. The Communique highlights the key issues considered, and recommendations provided, at the two meetings.

We would particularly like to highlight the following:

s22

Please note that these points strongly echo those of the Community Advisory Committee.

As an advisory committee we deeply value your input and request a response to our Communique from you, as the Federal Minister for the Environment, to guide our future agenda and deliberations.

Again, we acknowledge your commitment to the management of the Fraser island (K'gari) World Heritage Area and for attending our celebration of 25 years of World Heritage in April. We thank you for your continued support of the management of the Fraser island World Heritage Area.

Kind regards

siggy

Professor James Shulmeister
Chair – Fraser Island ((K'gari) World Heritage Scientific Advisory Committee

s47F

December 2018 and February 2019

The meeting unanimously agreed that when the terms of the committee are revised such that Butchulla representatives should move from observer status to full membership of the Fraser Island (K'gari) Scientific Advisory Committee (SAC).

The SAC welcomes the development of the Healthy Country Plan by the BAC and looks forward to providing advice as required.

The committee also appreciated the opportunity to visit the Secret Sacred Room at the Queensland Museum, accompanied by Butchulla representatives and the room's custodian, (Leonie Coghill).

The SAC is very concerned at the decision of QPWS to block access to information regarding scientific and education permits for K'gari. We are pleased that some progress on this issue has been made, however we are still denied access to key information including the permit reports and the names of the researchers working on these reports. Without access to the information in the permits, it is very difficult for the committee to monitor scientific research and its outcomes, thereby meet its fundamental duty as set out in the Terms of Reference. We look forward to a resolution in the near future.

The SAC discussed the great Sandy Marine Park Zoning Plan Review and is making a joint submission with the Fraser island Community Advisory Committee. Although the marine park falls outside the boundary of the world heritage area, the marine park has significant influence on heritage values on K'gari/Fraser Island World Heritage Area (and vice-versa). There is no mechanism to incorporate the inter-relationship between the land and sea into the zoning plan.

The SAC is pleased at the progress being made regarding funding for and the development of a Myrtle Rust Action Plan and on ground training. The SAC strongly encourages the engagement between the Butchulla Land and Sea Rangers and research scientists in the area of biosecurity. The committee encourages wider interactions in this area and planning to combat other biosecurity threats, including the consideration of vehicular disinfection stations at entry points to K'gari.

The SAC commends the new Queensland Biodiversity and Ecosystems Climate Adaptation Plan. The integration of scientific and Indigenous knowledge is important and well represented in the document.

The committee deeply appreciates the support given by the Queensland Government for the celebrations around the 25th Anniversary of the inscription of Fraser Island as a World Heritage Area. The committee looks forward to leveraging off the 25th Anniversary celebrations to raise the scientific and cultural profile of K'gari, including via the new Queensland Museum publication.

FOI 190505
Document 10

7 April 2019

Your Ref: MC19-000035

David Williams
Assistant Secretary, Heritage Branch
Department of the Environment and Energy
GPO Box 787
Canberra ACT 2601

Dear David

Thank you for your letter dated 24 January in response to the Fraser Island (K'gari) World Heritage Community Advisory Committee's November 2018 Communique, which was forwarded to the Hon. Melissa Price MP, Minister for the Environment.

The Committee's Communique and accompanying letter highlighted s22 the urgent need to plan for the impacts of a changing climate.

The Committee appreciates the Department's interest in receiving further detail on these initiatives. I am continuing to liaise with our State Government colleagues to prepare and finalise draft briefs which incorporate the requested detail. I am sure you can appreciate that these projects are important and complex, and require input from a number of different interested parties, including the Butchulla community in order to properly harness the potential opportunity offered by the Department. In light of this, I hope to have these completed very soon, and will forward details to you as soon as I am able.

Thank you once again for the opportunity to provide an update on these important World Heritage priorities for K'gari (Fraser Island) World Heritage area. We look forward to working with the Department to address these challenges.

Yours sincerely,

s47F

Sue Sargent
Chair

FOI 190505
Document 11

From: s22
To:
Subject: FW: Gondwana Rainforests advisory committee meeting - climate change session
Date: Wednesday, 24 October 2018 6:28:43 PM
Attachments: image001.jpg
4. draft agenda paper - Gondwana Rainforests adaptation planning.docx
s45
4. Laidlaw et al 2011The potential impact of climate change on Australian subtropical rainforest.pdf
4. Hagger et al - Subtropical rainforest vertebrates and climate change.pdf

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FYI
… not coming to the meeting ?
Sorry, forgot to cc you !
Thanks all
s47F

s47F

From: s47F
Sent: Wednesday, 24 October 2018 6:27 PM
To: s22, s47F
'Mahri Koch s22, s47F
'Nick Reid s22, s47F
Subject: Gondwana Rainforests advisory committee meeting - climate change session

Hi all
Climate change adaptation will be the key agenda item for our February meeting in Brisbane and it is intended to use the session in this upcoming meeting as **preliminary preparation for the February meeting**, noting that there is much to report on and we could spend a whole week on this material (and some!!)
Please review the agenda paper and prepare for the session as per the paper (as your capacity permits)
The attached documents include the draft of s45 **report**. Note that, as per the attachment title –this report is NOT FOR DISTRIBUTION as it **remains in draft** with some further changes to be made. Also note that this report is an informed opinion piece, rather than a peer reviewed paper, so it is intended to be used **to inform continuing deliberations** rather than itself being the focus.
Thanks much, see you soon
s47F

s47F

GONDWANA RAINFORESTS ADVISORY COMMITTEES – 3 November 2018

ITEM 4.	**TITLE: Gondwana Rainforests adaptation pathways**	**TIME** 1 hour

PURPOSE OF AGENDA ITEM

To determine agreed Gondwana Rainforests species and ecosystems for further targeted consideration in two current climate change projects:

- NPWS climate change adaptation pathways
- National Environmental Science Program (NESP) case study investigating the impacts of changing climates on cloud forests

BACKGROUND

There have been several pieces of work which contribute to the understanding of potential climate change impacts in the Gondwana Rainforests. Specific advisory committee actions have included:

- At the February 2018 meeting, s47F presented the results of his literature review investigating climate change and the Gondwana Rainforests.
- At the June 2018 meeting of the Gondwana Rainforests advisory committees, there was agreement to seek to develop adaptation pathways for specific attributes of outstanding universal value using the NPWS climate change adaptation pathways approach.
- Initiating the development of a National Environmental Science Program (NESP) case study investigating the impacts of changing climates, and specifically rising cloud base, on the OUV of the Gondwana Rainforests.
- Provision of feedback to the Queensland Biodiversity and Ecosystems Sector Adaptation Plan.

It is intended to have a climate change session/workshop at the Brisbane February meeting including working through draft adaptation pathways for key species and ecosystems in the Gondwana Rainforests using the NPWS methodology.

The NESP Hub is planning to have their next meeting in Brisbane in February and it is anticipated we will be able to receive an update and combine this with the next advisory committee meeting.

SESSION OUTLINE

1. Executive Officer will outline the current work to date and the various sectors and projects underway (presentation).
2. s47F will present her work which highlights the need for further data on cloud base and the contribution of cloud water to maintaining the existing ecosystem.
3. Facilitated discussion to identify key species and/or ecosystems for the development of adaptation pathways
4. Determine which species to focus on with the NESP project

PREPARATION

Using existing literature (including those listed below), members are asked to identify key focus species for the two pieces of work:

NESP project

10 species in cool temperate rainforest – 5 plant, 5 animal

NPWS pathways

Cool temp rainforest – 2 threatened species

Subtropical rainforest – plus 2 threatened species

Littoral rainforests of Iluka - plus 2 threatened species

Dry rainforests – 2 key threatened species

SPECIFIC REFERENCES

s45

Hagger, Valerie, Fisher, D, Schmidt, S and Blomberg, S, 2013, *Assessing the vulnerability of an assemblage of subtropical rainforest vertebrate species to climate change in south-east Queensland*, Austral Ecology, 38 465-475.

Laidlaw, MJ, McDonald, WJF, Hunter, RJ, Putland, DA, Kitching, RL, 2011, *The potential impacts of climate change on Australian subtropical rainforest,* Australian Journal of Botany, **59** 440-449.

Austral ECOLOGY A Journal of ecology in the Southern Hemisphere

Austral Ecology (2013) **38**, 465–475

Assessing the vulnerability of an assemblage of subtropical rainforest vertebrate species to climate change in south-east Queensland

VALERIE HAGGER,[1,3]* DIANA FISHER,[1] SUSANNE SCHMIDT[2] AND SIMON BLOMBERG[1]

[1]*School of Biological Sciences, The University of Queensland, Brisbane, Qld 4072, Australia (Email: vhagger@globalskm.com),* [2]*School of Agriculture and Food Science, The University of Queensland, and* [3]*Sinclair Knight Merz, Brisbane, Queensland, Australia*

Abstract Global climate change is a threat to ecosystems that are rich in biodiversity and endemism, such as the World Heritage-listed subtropical rainforests of central eastern Australia. Possible effects of climate change on the biota of tropical rainforests have been studied, but subtropical rainforests have received less attention. We analysed published data for an assemblage of 38 subtropical rainforest vertebrate species in four taxonomic groups to evaluate their relative vulnerability to climate change. Focusing on endemic and/or threatened species, we considered two aspects of vulnerability: (i) resistance, defined by indicators of rarity (geographical range, habitat specificity and local abundance); and (ii) resilience, defined by indicators of a species potential to recover (reproductive output, dispersal potential and climatic niche). Our analysis indicated that frogs are most vulnerable to climate change, followed by reptiles, birds, then mammals. Many species in our assemblage are regionally endemic montane rainforest specialists with high vulnerability. Monitoring of taxa in regenerating rainforest showed that many species with high resilience traits also persisted in disturbed habitat, suggesting that they have capacity to recolonize habitats after disturbance, that is climate change-induced events. These results will allow us to prioritize adaptation strategies for species most at risk. We conclude that to safeguard the most vulnerable amphibian, reptile and bird species against climate change, climatically stable habitats (cool refugia) that are currently without protection status need to be identified, restored and incorporated in the current reserve system. Our study provides evidence that montane subtropical rainforest deserves highest protection status as habitat for vulnerable taxa.

Key words: biodiversity, climate change, extinction risk, subtropical rainforest, vulnerability.

INTRODUCTION

Global climate change is a threat to biodiversity (McCarty 2001; Hughes 2003; Williams *et al.* 2003; Hennessy *et al.* 2007). Predictions for Australia are that climate change will affect the distribution and abundance of species and ecosystems, including possible extinctions of cool-adapted species (Hilbert *et al.* 2001; Kanowski 2001; Howden *et al.* 2003; Williams *et al.* 2003; Shoo *et al.* 2005; Jones & Krockenberger 2007; Stork *et al.* 2007), but for many ecosystems detailed knowledge of species vulnerability is lacking.

Due to large-scale clearing of lowland subtropical rainforest, much of the remaining subtropical rainforest of south-east Queensland (SEQ) and north-east New South Wales (NSW) occurs in a discontinuous arc in montane regions of the Great Escarpment. Extensive areas are protected in over 50 reserves. These habitats are rich in relict, endemic and threatened species (Hunter 2004). Many regionally endemic species are confined to cooler, higher altitudes, probably because they adapted to cool environments during past glacial cycles (Knowles *et al.* 2004; Mahony 2006). These species may be particularly vulnerable to climatic change because they are unable to move to higher altitudes in response to warming.

The distribution and diversity of tropical rainforests and species in northern Queensland (the Wet Tropics) is strongly influenced by climatic fluctuations of the late Quaternary glacial cycles, and similar fluctuations are likely to have shaped subtropical rainforests in SEQ. During glacial periods Australia's climate became cooler and drier and rainforest contracted to isolated refugia along high-rainfall coastal ranges (Nix & Switzer 1991; Kershaw *et al.* 2005; Graham *et al.* 2006, 2010; Hilbert *et al.* 2007; VanDerWal *et al.* 2008; Moussalli *et al.* 2009; Blois *et al.* 2010). These

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doi:10.1111/j.1442-9993.2012.02437.x

climatically stable areas acted as refugia for rainforest-restricted species and probably resulted in allopatric speciation and extinction filtering, where cool-adapted rainforest specialists were selected for their ability to persist for thousands of years in upland habitats (Moritz *et al.* 2009; Stewart *et al.* 2010). During interglacial periods warmer and wetter climate allowed rainforest to expand (Schneider & Moritz 1999; Hewitt 2004; VanDerWal *et al.* 2008; Bell *et al.* 2010); however, cool-adapted rainforest specialists remained restricted to upland refugia (Stewart *et al.* 2010).

Projections of past climates are useful in improving understanding of current distributions of taxa (Hilbert *et al.* 2007), but are insufficient for predicting species responses to a warmer and drier climate. Since 1950, average temperatures in Australia have increased by 0.6 to 1.2°C, and southern and eastern Australia have become drier (Hennessy *et al.* 2007). Future predictions for SEQ include mean warming of 0.3 to 2.7°C by 2050, increases in extreme daily rainfall, declines in run-off, and more frequent droughts (Hennessy *et al.* 2007). Although SEQ has experienced rainfall deficits since 1996 (Timbal 2010), projected changes in annual rainfall for the region are uncertain (Hennessy *et al.* 2007). A lifting cloud base resulting in a reduction in moisture levels at high altitudes is expected on mountains (Pounds *et al.* 1999).

A species vulnerability to environmental change is governed by its physiology, ecology, behaviour and genetic diversity (Williams *et al.* 2008). Factors that reduce vulnerability are (i) resistance (ability to withstand an environmental perturbation such as climate change) and (ii) resilience (ability to recover from the perturbation) (McKinney 1997). Species with high resistance are characterized by broad geographical range, high local abundance, generalist habitat requirements, broad physiological tolerance, high genetic variability and high phenotypic plasticity (McKinney 1997; Steffen *et al.* 2009; Stork *et al.* 2009). Species with high resilience have fast life history, good dispersal ability and low minimum viable population size (McKinney 1997; Knapp *et al.* 2001; Fjerdingstad *et al.* 2007; Williams *et al.* 2008; Steffen *et al.* 2009). A broad climatic niche may also promote resilience to climate change, because it facilitates colonization of habitats with changed climate (Crawford 1997). Broad niches imply physiological tolerance and large geographical ranges (Fisher & Blomberg 2011a), so traits that confer resistance and resilience are not mutually exclusive.

Rabinowitz (1981) and Kattan (1992) modelled traits likely to determine resistance to environmental change (geographical range, habitat specificity and local abundance) and used this to rank the vulnerability of Columbian birds to extinction. This approach has been applied to mammals (Yu & Dobson 2000), primates (Harcourt *et al.* 2002) and Wet Tropics vertebrates (Isaac *et al.* 2009). Wet Tropics species that were endemic had high habitat specialization and high local abundance. Isaac *et al.* (2009) also modelled traits likely to promote resilience (reproductive output, dispersal potential and climatic niche) and found that species with a marginal climate niche had low dispersal potential and low reproductive output, and were also endemics.

Here we assess the relative vulnerability of an assemblage of subtropical rainforest vertebrates using both the resistance and resilience models. The aims were to (i) determine species and taxonomic groups most vulnerable to climate change; (ii) identify traits that confer species resistance and resilience to climate change; and (iii) develop adaptation strategies for species most at risk.

METHODS

Study area

Subtropical rainforests of eastern Australia occur from Gladstone in SEQ to the Hunter River at Barrington Tops in north-east NSW. Northern and southern outliers occur at Eungella and Illawarra (20°57′12″S 148°34′38″E to 34°26′7″S 150°29′21″E). The study area encompassed subtropical rainforests in SEQ.

Target species and traits

The 38 vertebrates included seven amphibians, 18 reptiles, eight birds and five mammals (50% of amphibians, 47% of reptiles, 15% of birds and 17% of mammals that occur in the subtropical rainforests of SEQ). We chose regionally endemic rainforest species recorded in SEQ, or regionally non-endemic rainforest species recognized as threatened under State and/or Commonwealth legislation (species likely to have low resistance).

We obtained point records of species occurrence from the Department of Environment and Resource Management for SEQ and the Department of Environment, Climate Change and Water for north-east NSW. We collated the following life history and ecological traits for each species from the literature: geographical range size, local abundance, habitat characteristics, reproductive output and dispersal ability. Species traits are summarized in Appendix S1.

We categorized geographical range size of species as either endemic (restricted to SEQ and/or north-east NSW) or widespread across Australia. We categorized species as either locally abundant (reported as common or abundant) or sparse (listed as threatened with declining population sizes).

We determined habitat specificity using a measure of rainforest specialization. We obtained 1:5 million broad vegetation groups defined by Sattler and Williams (1999) for the occurrence point of each species from the Queensland Regional Ecosystem dataset (Department of Environment and Resource Management 2009). Species with at least 70% of observations within rainforest or wet eucalypt open-forest

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Table 1. Ranks for the Vulnerability Index (Kattan 1992), or potential for species to resist environmental perturbation

Geographical range	Widespread		Regionally endemic	
Habitat specificity	Broad	Restricted	Broad	Restricted
Local abundance				
Abundant	8	6	5	2
Sparse	7	4	3	1

were classed as 'high' rainforest habitat specialization; those with fewer than 70% of observations within these habitats were assigned 'low' rainforest habitat specialization. Records occurring within water, ocean or non-remnant vegetation were removed. We could not include records in non-remnant vegetation because vegetation types were not reported for those records. Results were verified with habitat information reported in the literature.

We classified reproductive output of species as either 'high' or 'low' based on the number of offspring produced in a single reproductive event, the length of the breeding season and the breeding frequency. For a few poorly known species, breeding traits were inferred from closely related species. Species were categorized relative to other species in their group, as it is not meaningful to compare a frog with a clutch size of 300 to a mammal with a litter size of one. Frogs that laid more than 300 eggs a year were assigned 'high' and those with less than 50 eggs a year 'low'. Reptiles that had three or more offspring a year were assigned 'high', and those with three or fewer offspring a year or that breed every alternative year 'low'. Birds that laid more than two eggs a year, or breed more than once a year were assigned 'high' and those that laid two eggs or fewer 'low'. Mammals that had three or more young a year, or breed twice a year were assigned 'high' and those with one to two young a year 'low'.

We calculated an index of dispersal ability for each species by adding the following scores: flight (yes = 1; no = 0); known movements from the literature (1 = sedentary <5 km; 2 = local dispersion 5–10 km; 3 = altitudinal migrations/nomadic 10–50 km; 4 = long-distance migrations >50 km); and body size (1 = 0–100 mm; 2 = 101–250 mm; 3 = 251–500 mm; 4 = 500–1000 mm; and 5 = ≥1000 mm). For frogs, we included an additional category of whether they had a freshwater tadpole dispersal stage (yes = 1; no = 0). Species with values greater than the median value for all species (3.4) were classed as having 'high' potential for dispersal; species below the median had 'low' potential for dispersal.

We estimated climatic niche from an analysis of current temperature and altitude for species occurrence points using ArcGIS (ESRI 2007). Spatial layers of climate were derived using Anuclim 5.1 software (Houlder *et al.* 2000) in combination with a 250-m resolution digital elevation model (DEM; Hutchinson 2008), which also gave altitude. Species with annual mean temperature greater than the median for the assemblage (16.13°C) were classed as having a 'broad' climatic niche; those with annual mean temperature less than the median were classed as having a 'narrow' climatic niche. We verified results by checking the current altitudinal distribution of species and their historic range reported in the literature.

Table 2. Ranks for the Resilience Index (Isaac *et al.* 2009), or potential for species to recover following perturbation

Dispersal potential	High		Low	
Reproductive output	High	Low	High	Low
Climatic niche				
Broad	8	6	7	4
Narrow	5	2	3	1

Resistance and resilience models

We applied the resistance model developed by Rabinowitz (1981) and Kattan (1992) to rank species in the assemblage in terms of their relative resistance to environmental change based on traits defining resistance (geographical range size, local abundance and habitat specificity). Species were assigned a value based on the combination of variables to form an eight-celled model, with each cell assigned a value between 1 and 8 to reflect vulnerability (Table 1). Species assigned the value 1 are vulnerable in all three traits, and species assigned the value 8 are resistant in all three traits. This model is termed the Vulnerability Index (VI) (Rabinowitz 1981; Rabinowitz *et al.* 1986; Kattan 1992).

We applied the resilience model developed by Isaac *et al.* (2009) to rank species with respect to their relative resilience to environmental change in an eight-cell model, based on traits defining resilience (reproductive output, potential for dispersal and climatic niche) (although the separation of climatic niche from geographical range in the resistance model is not always mutually exclusive) (Table 2). Species with low capacity to recover based on all three traits were assigned a value of 1, and those with a high capacity in all three traits were assigned a value of 8 (the Resilience Index (RI) (Isaac *et al.* 2009)). In the RI, the species climatic niche is weighted as the most important factor determining recovery under climate change. This is because if a species is able to disperse to a new habitat and reproduce, but does not have sufficient environmental tolerance to survive there, it will go extinct (Isaac *et al.* 2009).

Recolonization potential

We assessed the capacity of species to recolonize disturbed habitats as a surrogate for their resilience to environmental change. The assessment was based on:

1. Monitoring the presence/absence of target species in paired regrowth/remnant sites at O'Reilly's Rainforest

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Retreat (–28.2290°S, 153.1339°E) in Lamington National Park, SEQ. Monitoring methods are detailed in Appendix S2.

2. The proportion of target species occurrence points in the non-remnant broad vegetation group was extracted from the habitat specificity analysis.
3. Review of target species records from annual wildlife survey data for Lamington National Park (O'Reilly's unpubl. data, 2003–2010). Surveys for amphibians, reptiles, birds and mammals are undertaken annually at sites around O'Reilly's Rainforest Retreat using a combination of spotlighting, searches and Elliot, pitfall and harp trapping.

Target species with one or more records in regrowth or disturbed sites, or at least 10% of occurrence points within non-remnant vegetation were considered likely to recolonize habitats after disturbance; those with no records in regrowth or disturbed sites or with fewer than 10% within non-remnant vegetation were considered unlikely to recolonize habitats after disturbance.

Analysis

We added together the resistance and resilience indices of each species to define their overall vulnerability ranking. Species with a ranking of 6 or below were considered to have a high vulnerability to climate change. To test for independence between the three variables in each model, we used loglinear models in the MASS package of R 2.12.1 (Venables & Ripley 2002; R Development Core Team 2010). We used Kruskal–Wallis tests to assess if any of the taxonomic groups were significantly different from the others in each model. We used non-parametric Wilcoxon rank sum tests to determine if the distribution of the rank values in each model differed across the four groups. To test whether RI provides a measure of the observed capacity for species to recover after environmental disturbance, we examined RI values and recolonization potential using a linear regression analysis.

RESULTS

Resistance

The majority of amphibians (57%), reptiles (61%) and birds (63%) were rainforest-restricted endemics that fell into the two least resistant categories (VI 1 and 2) whereas no mammals fell into these categories (Fig. 1a). The majority of mammals (80%) had moderate to high resistance (VI 5, 6 and 7) as a result of more widespread distributions. Loglinear models showed that the three variables in the VI were independent of one another and no variables interacted in a pairwise manner (Table 3).

The distribution of species among the eight VI categories between the taxonomic groups did not differ significantly (Kruskal–Wallis test, $\chi^2 = 0.15$, d.f. = 1, $P = 0.6985$). However, closer analysis of the pairwise differences using Wilcoxon rank sum tests (Table 4) found that the distribution of species between the reptile and mammals groups differed ($P < 0.05$).

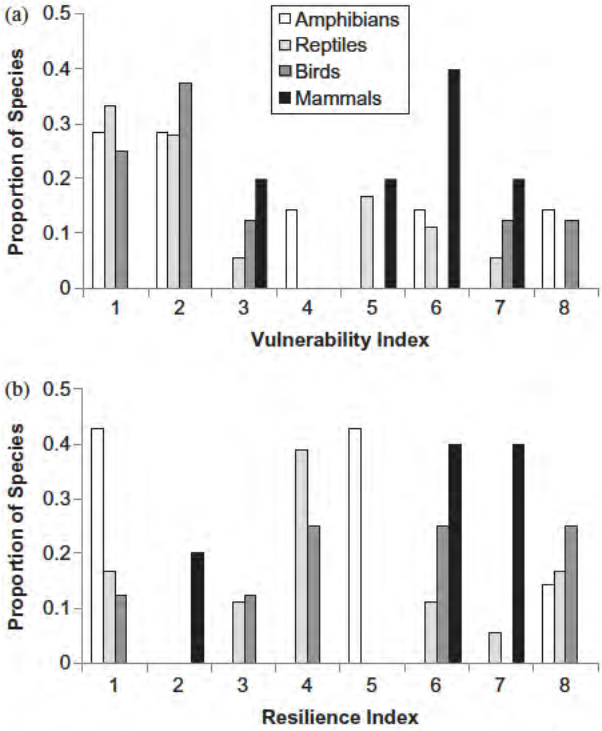

Fig. 1. Proportion of species within each vertebrate group that falls within each category of the (a) Vulnerability Index, (b) Resilience Index.

Resilience

The number of species that fell within the different RI categories varied between taxa. A high proportion of amphibians (43%) had low resilience to environmental change (RI 1), with low dispersal abilities and reproductive outputs and narrow climatic niches. Most reptiles (38%) had moderate resilience (RI 4) because of broad climatic niches (Fig. 1b). Most birds (50%) and mammals (80%) had higher resilience due to broad climatic niches and high dispersal potentials. According to loglinear models, the three variables in the RI were not independent. Dispersal potential and reproductive output interacted ($P < 0.05$); other variable interactions were independent (Table 3). The distribution of species among the eight RI categories between the taxonomic groups differed (Kruskal–Wallis test $\chi^2 = 11.04$, d.f. = 1, $P < 0.001$). Wilcoxon rank sum tests did not find significant pairwise differences (Table 4).

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Table 3. Results of loglinear models to test for independence between the three variables in the vulnerability and resilience indices

Interaction	Degrees of freedom	Likelihood ratio	*P*-value
Vulnerability Index			
Range *versus* Abundance	1	0.3426	0.5583
Range *versus* Habitat	1	–0.002	1
Abundance *versus* Habitat	1	0.2818	0.1309
Resilience Index			
Dispersal *versus* Reproduction	1	3.7423	0.0531*
Dispersal *versus* Climatic Niche	1	2.1772	0.1401
Reproduction *versus* Climatic Niche	1	0.5778	0.4472

*Statistical significance at $P < 0.05$.

Table 4. Results of Wilcoxon rank sum tests (W) to test for differences in the rank values between taxonomic groups in the vulnerability and resilience indices

	Vulnerability Index		Resilience Index	
Interaction	W	*P*-value	W	*P*-value
Amphibian *versus* Reptile	69	0.7318	57	0.7339
Amphibian *versus* Bird	28.5	1	20.5	0.4094
Amphibian *versus* Mammal	69	0.1892	8	0.1368
Reptiles *versus* Amphibian	57	0.7318	69	0.7339
Reptile *versus* Bird	65.5	0.7310	62.5	0.6068
Reptile *versus* Mammal	15.5	0.0275*	32	0.3419
Bird *versus* Amphibian	27.5	1	35.5	0.4094
Bird *versus* Reptile	78.5	0.7310	81.5	0.6068
Bird *versus* Mammal	10	0.1597	17	0.7094
Mammal *versus* Amphibian	26	0.1892	27	0.1368
Mammal *versus* Reptile	74.5	0.0275*	58	0.3419
Mammal *versus* Bird	30	0.1597	23	0.7094

*Statistical significance at $P < 0.05$.

Overall ranks and recolonization potential

The relative resistance and resilience indices of species and their total vulnerability ranking (Table 5) showed that amphibians had the highest proportion of species with high overall vulnerability (57%), followed by reptiles (44%) and birds (38%). A weak but significant relationship was found between RI and recolonization potential (t-value = 2.36, d.f. = 35, $P < 0.05$).

DISCUSSION

Species vulnerability

Predicting the effects of climate change on species is difficult as many are already under pressure from threats including habitat loss and fragmentation, which effect resilience and ability to adapt to change (Steffen *et al.* 2009). Increases in temperature and a lifting cloud bank are likely to negatively affect montane rainforest specialists particularly taxa requiring high and consistent moisture levels, that is microhylid frogs and litter skinks (Williams *et al.* 2003). Declines of amphibians and altitudinal shifts in the distributions of birds were linked with a lifting cloud bank in Monteverde, Costa Rica (Pounds *et al.* 1999). We examined the relative vulnerability of subtropical rainforest vertebrates to climate change, based on their capacity to withstand and recover from environmental disturbance. We found that many of the studied amphibians, reptiles and birds have physiological and life history traits that confer low resistance and low resilience and may be highly vulnerable to climate change (vulnerability ranking of 6 or less). Mammals generally had a higher resistance and resilience and may be less vulnerable compared to the other vertebrate classes in our study. As we targeted a subset of vertebrates that are regionally endemic and threatened species, our assessment is likely to be an overrepresentation of the vulnerability of vertebrate groups. However, this approach allows unbiased comparison of classes of endemic and threatened species which are high priorities for biodiversity protection.

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Table 5. Vulnerability Index (VI) and Resilience Index (RI) of subtropical rainforest vertebrates

Family	Species	Common name	VI	RI	Rank	RP
Amphibians						
Myobatrachidae	*Philoria kundagungan*	Mountain frog	2	1	3	Unlikely
Myobatrachidae	*Philoria loveridgei*	Loveridge's frog	2	1	3	Unlikely
Myobatrachidae	*Assa darlingtoni*	Pouched frog	2	1	3	Likely
Myobatrachidae	*Mixophyes fleayi*	Fleay's barred frog	1	5	6	Likely
Myobatrachidae	*Lechriodus fletcheri*	Fletcher's frog	6	5	11	Likely
Hylidae	*Litoria pearsoniana*	Pearson's green tree frog	4	8	12	Likely
Hylidae	*Litoria revelata*	Revealed frog	8	5	13	Likely
Reptiles						
Scincidae	*Harrisoniascincus zia*	Rainforest cool-skink	1	1	2	Unlikely
Scincidae	*Saproscincus spectabilis*	Pale-lipped shadeskink	1	1	2	Unlikely
Gekkonidae	*Phyllurus caudiannulatus*	Ringed thin-tail gecko	1	1	2	Unlikely
Scincidae	*Eroticoscincus graciloides*	Elf skink	1	4	5	Likely
Scincidae	*Eulamprus tryoni*	Tryon's skink	2	3	5	Unlikely
Scincidae	*Saproscincus rosei*		1	4	5	Likely
Gekkonidae	*Saltuarius swaini*	Southern leaf-tailed gecko	2	4	6	Likely
Scincidae	*Saproscincus challengeri*	Orange-tailed shadeskink	2	4	6	Unlikely
Scincidae	*Ophioscincus truncatus*	Short-limbed snake-skink	3	4	7	Likely
Scincidae	*Lampropholis colossus*	Bunya sunskink	5	3	8	Likely
Scincidae	*Coeranoscincus reticulatus*	Three-toed snake-tooth skink	1	8	9	Unlikely
Scincidae	*Eulamprus murrayi*	Murray's skink	2	7	9	Unlikely
Scincidae	*Ophioscincus ophioscincus*	York-bellied snake-skink	5	4	9	Likely
Gekkonidae	*Saltuarius salebrosus*	Rough-throated leaf-tail gecko	5	4	9	Unlikely
Agamidae	*Hypsilurus spinipes*	Southern angle-headed dragon	2	8	10	Likely
Elapidae	*Tropidechis carinatus*	Rough-scaled snake	6	6	12	Likely
Elapidae	*Hoplocephalus stephensii*	Stephen's banded snake	7	6	13	Unlikely
Scincidae	*Bellatorias major*	Land mullet	6	8	14	Likely
Birds						
Atrichornithidae	*Atrichornis rufescens rufescens*	Rufous scrub-bird	1	4	5	Unlikely
Menuridae	*Menura alberti*	Albert's lyrebird	1	4	5	Likely
Orthonychidae	*Orthonyx temminckii*	Australian logrunner	2	3	5	Likely
Acanthizidae	*Dasyornis brachypterus*	Eastern bristlebird	7	1	8	Unlikely
Podargidae	*Podargus ocellatus plumiferus*	Marbled frogmouth	2	6	8	Unlikely
Psittacidae	*Cyclopsitta diophthalma coxeni*	Double-eyed fig parrot	3	6	9	Likely
Paradisaeidae	*Ptiloris paradiseus*	Paradise riflebird	2	8	10	Likely
Ptilonorhynchidae	*Sericulus chrysocephalus*	Regent bowerbird	8	8	16	Likely
Mammals						
Vespertilionidae	*Kerivoula papuensis*	Golden-tipped bat	7	2	9	Unlikely
Muridae	*Pseudomys oralis*	Hastings River mouse	3	7	10	Unlikely
Dasyuridae	*Antechinus subtropicus*	Subtropical antechinus	5	7	12	Likely
Macropodidae	*Thylogale stigmatica*	Red-legged pademelon	6	6	12	Likely
Macropodidae	*Thylogale thetis*	Red-necked pademelon	6	6	12	Likely

VI and RI were summed to rank species overall vulnerability to climate change. Recolonization potential (RP) of the species was determined by its ability to persist in disturbed habitats.

Although there was no significant interaction between range size or habitat specialization, our assemblage had many endemic amphibian, reptile and bird species with high habitat specialization, some also with high local abundance. Our results are consistent with studies showing that narrow geographical range is associated with habitat specialization in primates (Harcourt *et al.* 2002), Columbian birds (Kattan 1992) and Wet Tropics vertebrates (Isaac *et al.* 2009). Species with both small range and low local abundance are at high risk of extinction (Johnson 1998). However, endemic specialist vertebrates in the Wet Tropics have compensated for geographical rarity with higher and more uniform local abundance (Williams *et al.* 2009). This pattern also occurs in montane bird communities (Manne & Pimm 2001; Reif *et al.* 2006), suggesting that extinction filtering resulted in persistence of rainforest specialists with small range and high abundance for long periods of time in glacial refugia (Williams *et al.* 2009).

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We found a significant association between reproductive output and dispersal potential. Those species with both low reproductive output and low dispersal ability are less likely to recover from extreme events, such as cyclones and fire, which are predicted to occur more frequently under climate change (Hennessy *et al*. 2007). We also found an association between resilience and recolonization potential, suggesting that species with high resilience traits are likely to recolonize habitats after disturbance such as climate change-induced events.

The most vulnerable frogs were the terrestrial breeding species, the pouched frog (*Assa darlingtoni*), mountain frog (*Philoria kundagungan*) and Loveridge's frog (*Philoria loveridgei*), and the stream-breeding species, Fleay's barred frog (*Mixophyes fleayi*). These are regionally endemic specialists restricted to montane rainforest with high rainfall (Ingram & Corben 1975; Knowles *et al*. 2004; Mahony 2006) and possess traits consistent with those associated with declining frogs in upland areas of eastern Australia (restricted ranges, low clutch size, in some cases stream-dwelling tadpoles) (Hero *et al*. 2005). Low resistance and resilience in terrestrial breeding frogs may be compensated by their independence of stream habitats and high local abundance acting to maintain population stability (Williams & Hero 1998; Green 2003; Hero *et al*. 2005). Although low resistance in Fleay's barred frog is exacerbated by its dependence on breeding in fast-flowing mountain streams and susceptibility to frequent chance disturbance (Hero *et al*. 2005), its higher reproductive output and dispersal potential may increase population resilience. Montane rainforest frogs, particularly stream-dependent species, are also particularly under threat from the chytrid fungus, *Batrachochytrium dendrobatidis* (Skerratt *et al*. 2007; Puschendorf *et al*. 2011). Chytrid infections increase in cool climates (Berger *et al*. 2004), so the chance of infection in montane areas is likely to be reduced with climate warming, but pronounced in climate refuges. Many amphibians shelter in cool, moist microhabitats (i.e. logs, fallen trees and riparian boulder microhabitats), and retention of these microclimate refuges may aid in species resistance to climate change (Shoo *et al*. 2011a).

Reptiles had the greatest number of vulnerable species, including the rainforest cool-skink (*Harrisoniascincus zia*), pale-lipped shadeskink (*Saproscincus spectabilis*), *Saproscincus rosei*, orange-tailed shadeskink (*Saproscincus challengeri*), ringed thin-tail gecko (*Phyllurus caudiannulatus*), elf skink (*Eroticoscincus graciloides*), Tryon's skink (*Eulamprus tryonii*) and southern leaf-tailed gecko (*Saltuarius swaini*). These are regionally endemic rainforest lizards (Cogger 2000; Wilson 2005) with low resistance. Among these, Tryon's skink may have higher resistance because of its high local abundance (Williams *et al*. 2009). The rainforest cool-skink, pale-lipped shadeskink and Tryon's skink also possessed traits with low resilience (low dispersal ability and narrow climatic niche). Isolation among disjunct montane refugia during past cooler and drier climates is responsible for phylogeographical genetic structuring among montane rainforest skinks and the land snail (*Gnarosophia bellendenkerensisin*) in the Wet Tropics (Hugall *et al*. 2002; Bell *et al*. 2010). Similar phylogeographical separations were found among the rainforest-restricted Pearson's green tree frog (*Litoria pearsoniana*) in SEQ, north and south of the Brisbane River Valley (McGuigan *et al*. 1998). This suggests that herpetofaunal diversity in SEQ rainforests may be attributed to persistence in isolated refuges during the last glacial maximum. It is possible, however, that species may not occupy their full climatic range. Species that contracted to refugia during the last glacial maximum may remain confined to upland areas due to poor dispersal ability and/or habitat fragmentation, preventing them from moving downwards when rainforest expansions occurred (G. Laves *et al*., unpubl. data, 2010).

The elf skink, orange-tailed shadeskink and southern leaf-tailed gecko had higher resilience due to their broad climatic niches. Modelled palaeo-distributions of *Saproscincus* spp. (relatives of the elf skink) in the Wet Tropics have indicated that species with broader climatic niches maintain higher and more structured genetic diversity because they have persisted through varying past climates (Moussalli *et al*. 2009). The southern leaf-tailed gecko has limited genetic variation among individuals and between localities, which may reduce its potential to survive severe population declines (Couper *et al*. 2008).

We also need to consider the evolutionary and ecological potential of species to adapt to change (Williams *et al*. 2009). There is evidence that adaptation has occurred in response to climate change over relatively short time spans (5 to 30 years) (Bradshaw & Holzapfel 2006). For example, O'Connor and Moritz (2003) found evidence for major habitat shifts from rainforest towards drier habitats in eastern water-skink (*Eulamprus quoyi*) and barred-sided skink (*Eulamprus tenuis*) across Queensland and NSW. These ecological transitions suggest that there is capacity for ecological adaptation in Tryon's skink and Murray's skink (*Eulamprus murrayi*). In contrast, the evolutionary history of southern leaf-tailed gecko is one of continuous rainforest ancestry, which may reduce its ability to adapt during rapid climate change (Couper *et al*. 2008).

Ground-dwelling insectivorous birds, rufous scrubbird (*Atrichornis rufescens rufescens*), Albert's lyrebird (*Menura alberti*) and Australian logrunner (*Orthonyx temminckii*) were identified as the most vulnerable due to low resistance. Poor dispersal abilities, dependence on specific microhabitats for food (e.g.

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ground debris and leaf litter) and predation of ground nests (Sodhi *et al.* 2004) make them particularly vulnerable to habitat disturbance. Rufous scrubbird and Albert's lyrebird have former ranges in low-altitude rainforest, suggesting that rainfall rather than temperature is a more important determinant of their distributions (Garnett & Crowley 2000; Gilmore 2000). Their broader climatic ranges suggest that these species have some resilience to climate change by maintaining their ranges when temperature increases.

Most mammals in our assemblage had high resistance due to large ranges and high resilience due to good dispersal ability. In contrast to the Wet Tropics, SEQ rainforests have a relatively low diversity of endemic mammals (Williams *et al.* 2003; Isaac *et al.* 2009). The most vulnerable mammal was Hastings River mouse (*Pseudomys oralis*). The contraction of upslope rainforest could disadvantage this species due to its reliance on rainforest for fire refuges (Jerry *et al.* 1998), fragmented distribution and low dispersal ability. Although the subtropical antechinus (*Antechinus subtropicus*) was found to have a low vulnerability, this species is geographically restricted and has male semelparity (Crowther *et al.* 2003) and high energy demand of females during lactation (Fisher & Blomberg 2011b). These life history traits make them particularly vulnerable to climate change if the peak of insect abundance no longer coincides with the timing of peak lactation. Insect abundance is controlled by climate variables such as rainfall and temperature seasonality (WallisDeVries *et al.* 2011), but breeding is controlled by photoperiod and is therefore fixed, regardless of food availability (McAllan *et al.* 2006).

Adaptive management: reserve systems to promote species resilience to climate change

We can potentially improve species resilience by minimizing pre-existing threats, preparing for the effects of major natural disturbances and strengthening off-reserve conservation efforts and connectivity. In SEQ, the most vulnerable species were found to be montane rainforest frogs and reptiles. Fortunately, the majority of montane subtropical rainforest in SEQ is already protected in the existing reserve system; however, we suggest that species resilience to climate change would improve from a reserve system that restores and/or incorporates currently unprotected habitat and cool refugia (Hughes 2003; Steffen *et al.* 2009; Lindenmayer *et al.* 2010).

A landscape or multi-species approach which conserves habitat maximizes biodiversity (Marsh *et al.* 2007). The four regional ecosystems represented in montane subtropical rainforest (12.8.18 'Simple notophyll vine forest with *Ceratopetalum apetalum* on Cainozoic igneous rocks', 12.8.6 'Simple microphyll fern forest with *Nothofagus moorei* on Cainozoic igneous rocks', 12.8.7 'Simple microphyll fern thicket with *Acmena smithii* on Cainozoic igneous rocks' and 12.8.5 'Complex notophyll vine forest on Cainozoic igneous rocks') have respectively 66%, 99%, 94% and 86% of their remnant areas protected. Strengthening protection of these ecosystems off-reserve would achieve more protection of habitat for vulnerable taxa.

Studies of the palaeo-distribution of ecosystems and species show that landscapes interact with meteorological processes to generate climatically stable habitat (cool refugia) in otherwise hostile environments, and that factors other than elevation potentially ameliorate local temperatures (Shoo *et al.* 2011b). Locating these refuges is important for protection of cool-adapted species threatened by climate change (Ashcroft 2010), specifically the pouched frog, mountain frog, Loveridge's frog, rainforest cool-skink, pale-lipped shadeskink and Tryon's skink. Climatically stable habitats have been identified in the Wet Tropics through spatial modelling (Shoo *et al.* 2011b). To apply modelling to SEQ rainforests and overlap it with species distribution models would allow us to identify cool refugia for vulnerable species (Graham *et al.* 2010; Reside *et al.* 2010). Restoration and inclusion of currently unprotected cool refugia should be a priority. It is important to distinguish between *in situ* (occupied) and *ex situ* (unoccupied) refugia (Ashcroft 2010). *Ex situ* refugia might be maintained in the long term through creation of corridors or translocation of species. Despite arguments against translocations as a viable conservation strategy (Fazey & Fischer 2009; Ricciardi & Simberloff 2009), human-assisted colonization beyond the historical ranges of species is an option for narrow range endemics, provided that translocations take place in the broad geographical region and the destination lacks local endemics (Hoegh-Guldberg *et al.* 2008; Thomas 2011). Improved connectivity of cool refugia to facilitate movements of vulnerable species should also be considered (Pressey *et al.* 2007).

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Geographic range size, local abundance, habitat characteristics, reproductive output and dispersal ability of target vertebrate species.
Appendix S2. Monitoring methodology.

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The potential impacts of climate change on Australian subtropical rainforest

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Abstract. The potential for anthropogenic climate change to impact upon native vegetation has emphasised the need for monitoring and for dynamic management regimes. Potential impacts are numerous, but will likely include the upslope movement of species' ranges and increasing *in situ* turnover (compositional change) within plant assemblages. By assessing the potential impacts of climate change on subtropical rainforest communities in south east Queensland through the establishment of an altitudinal transect, we aimed to establish the baseline composition of the vegetation and to develop two hypotheses against which climate change scenarios can be tested. The study identified existing high levels of turnover across tree assemblages from low to mid elevations absent at higher elevations and we predict: (1) subtropical rainforest communities which currently sit at the level of the cloud base (800 900 m) will experience increasing floristic turnover, and (2) novel vegetation communities will emerge as species move upslope in response to a changing climate. Monitoring floristic turnover as a surrogate for shifting climatic habitats may be confounded both by a lack of knowledge regarding the underlying turnover rates of rainforest communities and by the disparity in temporal scales of tree community turnover and accelerating anthropogenic climate change. The identification of 'break points' in the relationship between current vegetation communities and gradients of precipitation and temperature will allow better direction of monitoring efforts.

Introduction

Areas of rainforest vegetation are constantly undergoing dynamic shifts at multiple temporal and spatial scales (Malhi and Phillips 2004; Lewis *et al*. 2006). As such, it can be difficult to make sense of long term directional changes from short term responses to natural variability due to the low availability of long term data, complex interactions between environmental axes and the lag times between events and vegetation responses. The generally mesic conditions under which subtropical rainforest communities currently thrive are predicted to be replaced by unprecedented climatic unpredictability in coming decades. Scenarios likely to impact on vegetation have been extensively reviewed (Clark 2007). Increased atmospheric CO_2 levels are predicted to have both positive and negative effects on vegetation such as increased photosynthesis, reduced photorespiration, increased water use efficiency, faster forest growth and turnover and increased density of smaller stem sizes (Malhi and Phillips 2004; Stork *et al*. 2007). Temperature increases of 1.4 5.8°C are predicted, as is increasing variation in the intensity, periodicity and predictability of rainfall and increases in severe weather events such as cyclones and storms (Walsh and Ryan 2000; Houghton *et al*. 2001). In addition and, most important for montane forests, the average altitude of cloud formation is predicted to rise, leaving forests dependent on occult precipitation vulnerable to water stress (Pounds *et al*. 1999; Still *et al*. 1999). These and other climatic changes can have direct impacts on rates of photosynthesis and respiration and flow on impacts on the productivity of plants, reproduction, recruitment, competition and mortality (Clark 2007).

Climatic changes predicted for the Gondwana Rainforests of Australia World Heritage Area, of which Lamington National Park is a part, include: an increase in average annual temperature of 1.3°C ± 0.6°C, an increase in the number of hot days, a drop in average annual rainfall of 3.5% ± 11% with increasingly severe dry seasons and extreme weather events, increasing annual moisture seasonality, higher evaporative demand and increasingly severe and frequent droughts and fires (Australian National University 2009). The Australian National University (2009) also predicts an increase in the basal altitude of the orographic cloud layer. Between 1950 and 2003 in the study region, mean annual maximum temperatures have increased by 1.5°C and annual mean temperatures have increased by 1°C, while annual total rainfall has dropped by 76 mm (Hennessy *et al*. 2004). The Australian National University (2009) has identified simple notophyll evergreen vine forest and microphyll fern forest to be at risk from these predicted climate changes. A rising cloud cap is predicted to be of particular threat to the latter community (Australian National University 2009). It is predicted that these climate impacts will

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jeopardise the World Heritage Values of the region (Australian National University 2009).

At a community level, a shift in complex environmental conditions is predicted to result in a measurable shift in floristic composition (Clark 2007). This may manifest as an *in situ* turnover of species composition or a geographical (and altitudinal) shift in species ranges. The impacts of this will be most obvious at higher altitudes where cold/moisture adapted species will most likely experience increasing moisture stress. According to Westoby and Burgman (2006), under a regime of as little as 3°C warming, any species with a latitudinal range of less than 300 km or an altitudinal range of less than 300 m, will experience a shift in the location of their present day temperature regimes totally beyond their current ranges. Such a change is predicted to occur by 2050 2100. Few long term studies of Australian vegetation capable of detecting the influence of a changing climate have been established.

The climatic variation found along an altitudinal gradient is a major driver of both abiotic and biotic forest processes (Bendix *et al*. 2008). Montane forests are stratified by the decline in temperature with altitude (Loope and Giambelluca 1998) and support high levels of biodiversity through their compression of many climatic zones, which would normally be spread over a large latitudinal range (Beniston *et al*. 1997). Montane cloud forests around the world are characterised by the presence of cloud and fog, which has the 2 fold impact of contributing high levels of moisture, while also lowering solar radiation levels and temperatures to give low evapotranspiration rates (Howard 1973; Bruijnzeel and Proctor 1995; Hamilton *et al*. 1995; Hutley *et al*. 1997; Loope and Giambelluca 1998; Bendix *et al*. 2008). Hutley *et al*. (1997) have also shown that subtropical rainforest trees may be able to absorb foliar moisture directly into their leaves and branches. As a result, cloud forests have many distinctive structural features which set them apart from other forest types such as high stem densities, reduced tree height, dense crowns of small, sclerophyllous leaves and high epiphyte loads (Loope and Giambelluca 1998). Every facet of cloud forests from morphology, structure, nutrient cycling to soil chemistry can be directly or indirectly attributed to the frequent presence of cloud (Loope and Giambelluca 1998; Still *et al*. 1999). Although requiring high rainfall, these forests are found in a wide range of conditions of varying seasonality and at a range of altitudes depending on local conditions such as distance to the sea (the *Massenerhebung* effect) (Flenley 1995; Loope and Giambelluca 1998). The single, conclusive common factor across all these forests remains regular cloud immersion (Bruijnzeel and Proctor 1995). Although occurring at lower altitudes than many of the world's cloud forests, the *Nothofagus* dominated microphyll fern forests of Australia's subtropics exhibit many of these distinctive features.

The rainforests of the subtropics of south east Queensland and northern New South Wales comprise one of the largest remaining areas of this vegetation type in the world (Floyd 1990). Within this region, the forests of Lamington National Park are an ideal location in which to investigate climate change because they are floristically and structurally diverse and, accordingly, allow for differential responses within the ecosystem. The region exhibits a high level of environmental heterogeneity, principally due to its mountainous terrain, which allows the investigation of often contiguous, subtropical and temperate forest types (Burbidge 1960). Precipitation in these forests is highly seasonal and they undergo regular dry periods when winter rainfall (totalled for June, July and August) can fall as low as 19 mm (recorded at 900 m a.s.l. in 1946) contrasted to a summer rainfall (totalled for December, January and February) of as much as 1864 mm (recorded at 900 m a.s.l. in 1974). However, the high altitude rainforests of Lamington National Park are located close to the sea and are frequently immersed in tradewind driven orographic cloud and mist.

Although current patterns of altitudinal (and in many cases latitudinal) variation in rainforest structure and composition are well known, there have been few quantitative surveys from which we can make predictions regarding the impacts climate change may have on subtropical rainforests. The multifaceted IBISCA Queensland study (Basset *et al*. 2007; Kitching *et al*. in press), which began in 2006, has the goal of providing baseline information on the faunal and floral biodiversity of a permanent altitudinal transect within subtropical rainforest and to identify target taxonomic groups for which changes can be monitored. Fundamental to this is the study of the vegetation community. In this paper we present results on the canopy and subcanopy tree community of the IBISCA Queensland transect and identify two testable hypotheses which future re surveys will be able to address. In particular, we know that patterns of juvenile survival are known to impact on the long term patterns in tree communities (Queenborough *et al*. 2007) and we examine the current rates of floristic turnover occurring within these forests by comparing the composition of the established and recruiting (juvenile) canopy and subcanopy tree communities as a surrogate for future tree community composition.

Materials and methods

Twenty permanently marked 20 × 20 m vegetation survey plots were established in 2006 in the Canungra Creek catchment of Lamington National Park, south east Queensland, Australia. These 20 400 m^2 vegetation survey plots were chosen in order to reduce the perimeter to internal area ratio per plot and minimise the chance of crossing soil and environmental boundaries within a plot. These plots sampled remnant subtropical rainforest vegetation at five altitudes: 300, 500, 700, 900 and 1100 m. Four plots were established at each of these altitudes with a minimum inter plot distance of 400 m along the contour. Where possible, the plots were located ≥50 m from permanent water and away from anthropogenic disturbance. All plots were positioned on basalt geology. The plots are located along a steep moisture and temperature gradient where lower altitudes generally experience hotter and drier conditions relative to the colder and moister upland sites. These trends can be strongly influenced by aspect. The location of these plots within a single catchment and, as far as possible, maintaining a general north north westerly aspect, attempts to reduce this topographic and microclimatic variation.

The presence of juvenile individuals of canopy and subcanopy tree species with a current stem diameter of <5 cm at breast height (dbh), but with the potential to reach a size class of ≥5 cm, were recorded within each plot. All canopy and subcanopy trees ≥5 cm

diameter at breast height (dbh: measured at 1.3 m height or directly above buttresses or below bole deformities) within each plot were numbered and measured for diameter and height and were identified to species by the Queensland Herbarium. Multi stemmed species were treated as separate individuals wherever stems were ≥5 cm dbh. Where vines and epiphytes obstructed the bole, these were gently lifted to allow accurate dbh measurement. For each altitude, values for basal area, family, generic and species richness have been calculated. Shannon index values (H′) and evenness were determined using the standard formulae found in Magurran (1988). Family importance values were calculated using the formula of Mori *et al*. (1983) and an individual value index for each species calculated using the formula of Cottam and Curtis (1956).

The pattern analysis software WinPATN (Belbin 2003) was used to examine the difference between sites based on their floristic composition and also to examine differences in species' composition between the established and associated juvenile (recruiting) assemblages of canopy and subcanopy trees. Only those species able to attain a dbh ≥5 cm at breast height were included in this analysis. The Bray Curtis dissimilarity metric (Bray and Curtis 1957) was used to determine the floristic dissimilarity between sites based on species presence/absence. The data was classified using unweighted pair group arithmetic averaging (β value = 0.1). Semi strong hybrid multidimensional scaling ordination was used to depict the association between sites based on their floristic composition in three dimensional space using a dissimilarity cut off value of 0.9 (Belbin 2003).

Principal component correlation (Belbin 2003) was used to investigate the relationship between associations of tree species, and climatic and topographic variables, both measured and modelled for the transect. Thirty five climatic variables were modelled using the Bioclim climate modelling package (Houlder *et al*. 2000), applied to an 80 m digital elevation model (a full description of the 35 bioclimatic parameters available via Anuclim can be found at http://fennerschool.anu.edu.au/publications/software/anuclim/doc/params.html, accessed 20 June 2011). Slope, aspect and total species richness were measured for each plot. A Monte Carlo Attributes in Ordination permutation test (MCAO) (1000 permutations) was used to test the significance of these relationships. Biplots of significant extrinsic variables were overlaid on the ordinations.

The impact of the size of the available species pool at each altitude and the effectiveness of the sampling regime was explored. Species accumulation curves were constructed for each altitude by adding the number of new tree species encountered through the establishment of each additional plot (a, b, c, d). The mean Bray Curtis dissimilarity between the established and juvenile tree communities at each altitude was also examined along the transect.

Results

A total of 1218 tree stems ≥5 cm dbh of 37 families, 90 genera and 115 species was recorded from the 20 plots (including two species of tree fern and one species of tree palm). Table 1 summarises the floristic results for trees ≥5 cm dbh for each altitude and a full floristic description of the vascular plant community along the transect can be found in Laidlaw *et al*. (in press). For all species authorities, please consult Bostock and Holland (2007). Shannon diversity (H′), as well

Table 1. Floristic summaries for trees ≥5 cm diameter at breast height summed for four plots established at each of five altitudes

Altitude (m a.s.l.)	300	500	700	900	1100
Location	153.13701 28.14818	153.14182 28.21617	153.12123 28.18834	153.14087 28.23368	153.15858 28.25821
Stems density	242	253	197	255	271
Species richness	51	44	35	48	29
Genera richness	43	39	33	44	25
Family richness	24	21	23	23	16
Basal area (m^2)	24.63	14.69	10.37	8.58	16.68
Shannon diversity	3.30	3.03	2.91	3.29	2.64
Evenness	0.84	0.80	0.82	0.85	0.78
FIV1[A]	Euphorbiaceae	Sterculiaceae	Sterculiaceae	Rutaceae	Cunoniaceae
FIV2	Sterculiaceae	Myrtaceae	Euphorbiaceae	Sterculiaceae	Grossulariaceae
FIV3	Moraceae	Euphorbiaceae	Cunoniaceae	Cunoniaceae	Cyatheaceae
FIV4	Myrtaceae	Cunoniaceae	Rutaceae	Lauraceae	Nothofagaceae
FIV5	Sapindaceae	Moraceae	Myrtaceae	Monimiaceae	Monimiaceae
IVI1[B]	*Cleistanthus cunninghamii*	*Argyrodendron trifoliolatum*	*Argyrodendron trifoliolatum*	*Cyathea leichhardtiana*	*Polyosma cunninghamii*
IVI2	*Argyrodendron trifoliolatum*	*Baloghia inophylla*	*Baloghia inophylla*	*Caldcluvia paniculosa*	*Cyathea leichhardtiana*
IVI3	*Capparis arborea*	*Cleistanthus cunninghamii*	*Pseudoweinmannia lachnocarpa*	*Acradenia euodiiformis*	*Caldcluvia paniculosa*
IVI4	*Diospyros pentamera*	*Diospyros pentamera*	*Cleistanthus cunninghamii*	*Quintinia verdonii*	*Doryphora sassafras*
IVI5	*Baloghia inophylla*	*Actephila lindleyi*	*Actephila lindleyi*	*Baloghia inophylla*	*Quintinia sieberi*

[A]Family importance value ranked from 1 to 5. [B]Individual value index ranked from 1 to 5.

as floristic richness at the level of families, genera and species, all decreased with increasing altitude along the length of the transect (Fig. 1).

Of the 37 families of tree ≥5 cm dbh, five families (13.5%) were recorded at all altitudes: Celastraceae, Cunoniaceae, Meliaceae, Myrtaceae and Rutaceae. Nine families were recorded at four altitudes, seven families were recorded at three altitudes, nine families were recorded at two altitudes and seven families were recorded at only one altitude. No tree species were recorded at all five altitudes, although 19 generalist species are likely to occur at all altitudes. Ten 'generalist' species (8.8%) were recorded at four consecutive altitudes: *Anthocarapa nitidula*, *Araucaria cunninghamii*, *Argyrodendron actinophyllum*, *Argyrodendron trifoliolatum*, *Baloghia inophylla*, *Brachychiton acerifolius*, *Diospyros pentamera* and *Pseudoweinmannia lachnocarpa* (300 900 m inclusively), and *Denhamia celastroides* and *Wilkiea huegeliana* (500 1100 m, inclusively). Twelve species were found at three altitudes, 38 were found at two altitudes and 55 species were recorded at only one altitude. Of the latter, 11 were recorded only at 1100 m, 10 only at 900 m, three only at 700 m, eight only at 500 m and 23 only at 300 m. Both of the high altitude sites (≥900 m) were found to be very different from those downslope (BC = 1) (Fig. 2). In addition, the 900 and 1100 m sites were quite different from one another (BC = 0.96). At 1100 m, the established tree assemblages were dissimilar from the juvenile ones (BC = 0.59), yet both groupings were largely unique to these high altitude sites. At 900 m, more of the established tree species were recorded as juveniles (BC 0.71), but again, both of these assemblages were largely unique to that altitude.

At elevations of 700 m and below, a strong division exists between established and juvenile assemblages, regardless of altitude (BC = 0.87) (Fig. 2). The set of juvenile trees found at 300 m is more dissimilar (BC = 0.66) than those at 500 and 700 m, which share a greater number of species. The pattern is similar in the established assemblages where three of the four 300 m sites show some separation from the higher altitude sites (BC = 0.66).

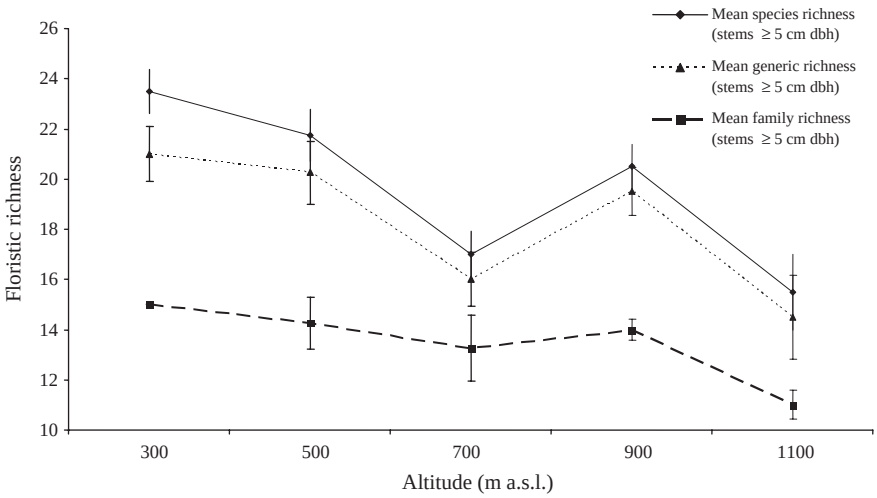

Fig. 1. Decline in floristic richness with increasing altitude. Data are means (and standard errors) from four 20 × 20-m plots per altitude.

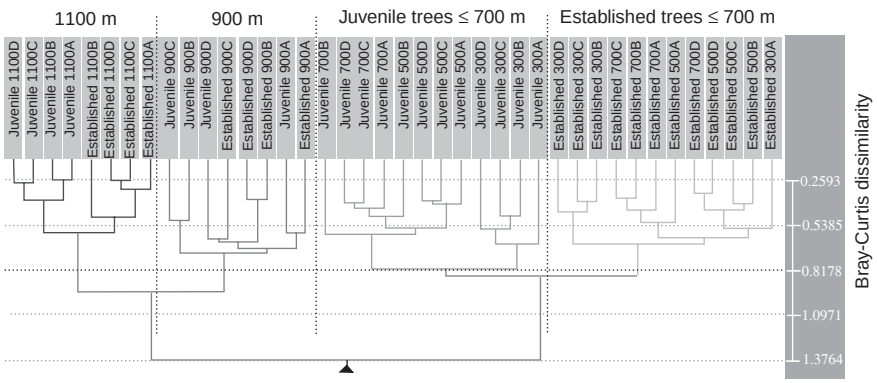

Fig. 2. Dendrogram displaying classification of established and juvenile canopy and subcanopy tree community floristic composition recorded from 20 plots at Lamington National Park, south-east Queensland, showing membership of sites to altitudinal groups.

The species overlap between the 500 and 700 m sites is stronger in the established assemblages than it is in those made up of juveniles.

A MCAO significance test on a principal components correlation for the transect showed that for those sites ≤700 m a.s.l., 29 species (24.58%) were found to be significantly associated (MCAO ≤1%) with two site groupings: the 'established' community and the 'juvenile' community. Six species were significantly associated with the canopy (in descending order of significance): *Argyrodendron actinophyllum*, *Argyrodendron trifoliolatum*, *Pseudoweinmannia lachnocarpa*, *Actephila lindleyi*, *Aphananthe philippinensis* and *Ixora beckleri*) and 23 were significantly associated with the understorey (*Akania bidwillii*, *Daphnandra apatela*, *Diploglottis australis*, *Wilkiea huegeliana*, *Elattostachys nervosa*, *Mischocarpus australis*, *Sarcopteryx stipata*, *Psychotria simmondsiana*, *Arytera distylis*, *Atalaya multiflora*, *Atractocarpus chartaceus*, *Cryptocrya triplinervis* var. *pubens*, *Claoxylon australis*, *Clerodendron floribundum*, *Alchornea illicifolia*, *Elattostachys xylocarpa*, *Mallotus philippensis*, *Mischocarpus anodontus*, *Pavetta australis*, *Cryptocarya bidwillii*, *Siphondon australis*, *Elaeocarpus obovatus* and *Mallotus discolor*) (Fig. 3).

Thirty four extrinsic variables were found to be significantly associated (MCAO ≤1%) with the site groupings: elevation, 11 temperature variables, eight precipitation variables, seven radiation variables and seven moisture index variables. As many of these variables co vary, extrinsic variables which grouped together in the Bray Curtis dendrogram were chosen and are plotted on the ordination (Fig. 4). High altitude communities (900 and 1100 m a.s.l.) were most strongly associated with the environmental variables of moisture and radiation. The modelled moisture inputs do not, however, include inputs from cloud and fog, which are known to contribute substantially to the annual moisture budget of these forests (Hutley *et al*. 1997). Mid to low altitude communities (≤700 m a.s.l.) were most strongly associated with higher temperatures and higher moisture seasonality.

Species accumulation curves (Fig. 5) show that at 900 and 1100 m, four 20 × 20 m plots capture much of the available species pool, while at 700 m and below, some species remain unsampled. Bray Curtis dissimilarity between the established and juvenile tree communities decreases with increasing altitude (Fig. 6). Tree species richness (established + juveniles), was found to be significantly associated (MCAO ≤1%) with the site groupings along the length of the transect (Fig. 4). It was not found to be significant using this same method, however, when restricted to altitudes at and below 700 m a.s.l.

Discussion

At mid to low altitudes (≤700 m a.s.l.), the recruiting tree community is currently not reflecting the composition of the canopy. This is of interest as, according to Debski *et al*. (2000), where the species composition of the recruiting community does not reflect that of the canopy, future changes in species composition may result. There are several possible explanations for this finding. Increasing forest dynamics, tree growth, basal area and floristic turnover identified in the Amazon via long term research plots have been attributed to the CO_2 fertilisation hypothesis (Laurance *et al*. 2004, 2009; Gloor *et al*. 2009). The currently observed patterns of floristic turnover at low to mid elevations may be influenced by increasing levels of atmospheric CO_2, either directly or in combination with climatic shifts. It is unlikely, however, that CO_2 levels differ greatly over such a small altitudinal range, although future resurveys of this transect may

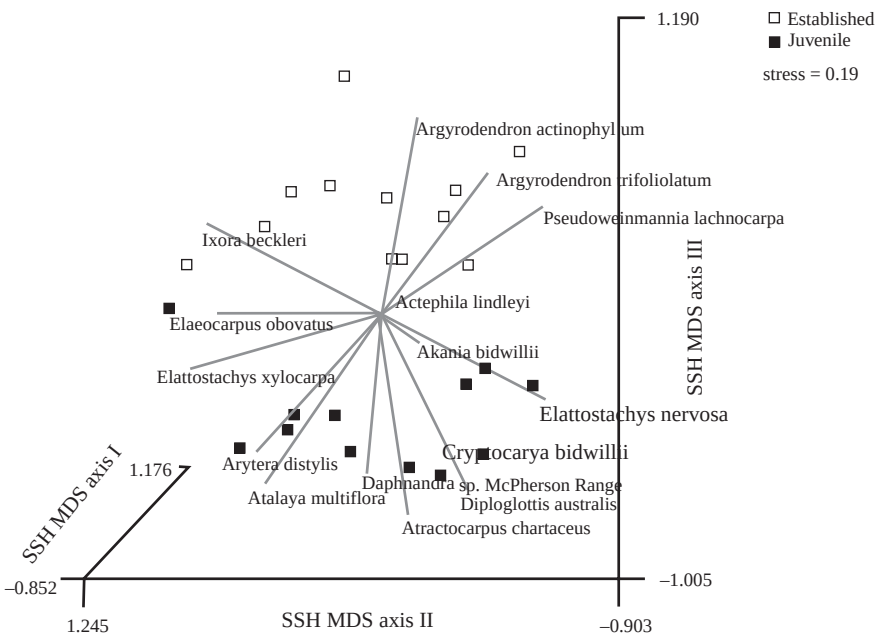

Fig. 3. Three dimensional semi-strong hybrid multidimensional scaling ordination of established □, and juvenile canopy and subcanopy ■ tree communities recorded at ≤700 m a.s.l. with biplot of selected significant species (Monte-carlo attributes in ordination permutation test ≤1%).

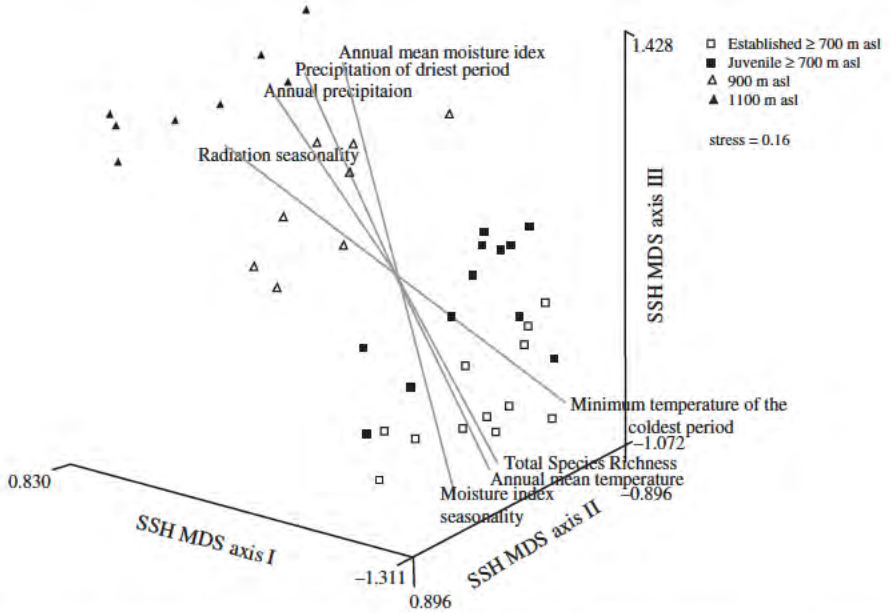

Fig. 4. Three dimensional semi-strong hybrid multidimensional scaling ordination of high altitude communities and established □, and juvenile canopy and subcanopy ■ tree communities recorded at ≤700 m a.s.l. with biplot of selected significant extrinsic variables (Monte-carlo attributes in ordination permutation test ≤1%).

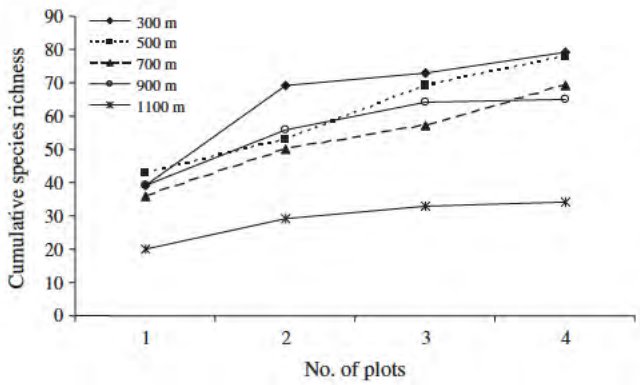

Fig. 5. Species accumulation curves for each altitude along the transect.

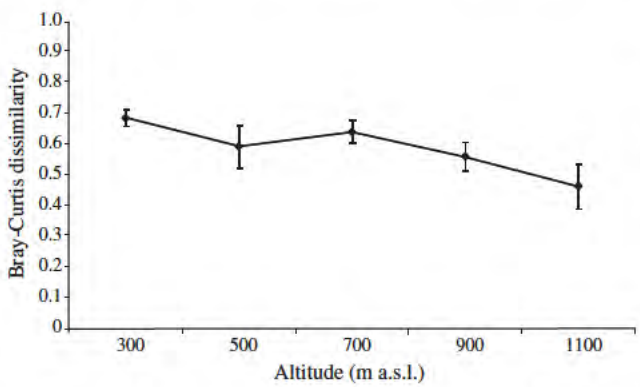

Fig. 6. Mean Bray Curtis dissimilarity between established and juvenile tree communities at each altitude.

allow changes in forest structure and floristics to be interpreted with respect to atmospheric CO_2 levels.

Sampling artefacts related to the small sample size used relative to the size of the species pool available at each altitude must be considered as a possible cause of the patterns described. Species accumulation curves for each altitude show that four 20×20 m plots are more effective at high altitudes in sampling the available canopy and subcanopy tree community than at mid to low altitudes. Total species richness was also found to be significantly associated with mid to low altitude sites (Fig. 4). Although the size of the locally available species pool is likely to contribute to dissimilarity between established and juvenile communities, we do not, however, believe this effect is dominant over the large environmental gradients examined.

It is possible that our findings have simply highlighted a naturally present state of flux within this forest which has not been recorded previously. Connell and Green (2000) recorded high variability in rainforest seedling abundance across both space and time in north Queensland. Norden *et al.* (2007) found that seedling densities varied significantly over short time scales such as 6 months, and attributed this to pulsed recruitment events. As such, one off surveys such as ours may suggest an imbalance between recruitment and mortality which may, or may not, be significant in the long term. There are also likely to be additional unmeasured ecological explanations for the observed patterns, such as variation in the disturbance regimes at each elevation, resulting in a mosaic of successional phases within the forest.

Destructive storms are known to be a regular occurrence within Lamington National Park (Olsen and Lamb 1984). Although areas of obvious disturbance were avoided, the long term implications of past disturbances on current vegetation

patterns are difficult to interpret (Baker *et al*. 2005). Baker *et al*. (2005) found that disturbance at multiple temporal and spatial scales and intensities play a vital role in forming observable floristic patterns. It may also be the case that some species missing from the juvenile canopy and subcanopy tree community may require disturbance for successful recruitment. Such species which rely on episodic disturbance, such as storms or cyclones, for recruitment are likely to exhibit size distributions different than species which do not (Wright *et al*. 2003; Feeley *et al*. 2007). For forests located to the west of Lamington National Park, Debski *et al*. (2000) suggest the current dominance of two species of *Argyrodendron* in the canopy may be due to a large scale disturbance one generation ago. A similar disturbance may have impacted these more easterly forests. A particularly widespread disturbance periodically experienced by rainforest is catastrophic drought (Baker *et al*. 2005). Drought, a 30 day running total of <100 mm of rainfall, (Potts 2003) is a regular event within Lamington National Park and as such, the forest is pre adapted to periodic moisture stress.

We speculate that the increased disassociation between established and juvenile tree assemblages at mid to low elevations in comparison with those found at higher altitudes may reflect a differential impact of an extended period of drought in the understorey. The forests under investigation had experienced below mean annual rainfall since 2000, with 2002 receiving less than 50% of the mean average and being the driest year on record (Tang 2008). Condit *et al*. (2004) found that during the 1998 El Niño event in Panama, mortality was higher at dryer sites than wetter sites within rainforest. We suggest that the impacts of this drought may have been mitigated at higher elevations by inputs from occult precipitation.

The high altitude forests of Lamington National Park and the endemic species they support such as *Pittosporum oreillyanum*, *Leucopogon* sp. (Lamington G.Leiper AQ633386), *Uromyrtus lamingtonensis*, *Parsonsia tenuis* and *Euphrasia bella*, rely on regular high levels of vertical precipitation, but also on receiving a large percentage of their annual moisture budget from occult precipitation in the form of mist and cloud (Pounds *et al*. 1999; Still *et al*. 1999; Floyd 2008). This orographic cloud is formed as coastal trade winds encounter mountains and are uplifted and cooled, thus causing condensation and cloud formation (Still *et al*. 1999). This is particularly vital during the winter dry season (May November) where, in the Australian subtropics, the contribution of horizontal precipitation may be as high as 40 50% in addition to that captured in a conventional rain gauge (Fisher and Timms 1978; Hutley *et al*. 1997). In the tropics this figure may be as high as 66% (Bruijnzeel and Proctor 1995; McJannet *et al*. 2007; Bendix *et al*. 2008). The significance of this precipitation in mitigating water deficits, particularly in marginal sites and dry years, is extreme.

Dry season mist frequency is negatively correlated with sea surface temperature in the tropics (Pounds *et al*. 1999). Evidence from the equatorial Pacific suggests that increases in sea surface temperatures since the 1970s have led to atmospheric warming and a lifting of the average orographic cloud base (Pounds *et al*. 1999). Richardson *et al*. (2003) have also found evidence of a significant increase in cloud base height in the eastern USA over a similar period of time. Global climate models predict that under the CO_2 doubling scenario and associated alteration to precipitation and temperature regimes, the relative humidity surface may shift upslope by hundreds of metres (Westoby and Burgman 2006). This will be of particular importance during local dry seasons, when evapotranspiration is at its highest and these forests are most reliant on moisture inputs from cloud (Beniston *et al*. 1997; Still *et al*. 1999; but see Sperling *et al*. 2004).

We can predict that future changes in temperature, rainfall, humidity and cloud cover are likely (Loope and Giambelluca 1998; Australian National University 2009). Little is known, however, about how these changes, particularly the reduction in cloud frequency, will impact on vegetation communities. A reduction in cloud cover may reduce diffuse radiation in forest ecosystems, increase shade and reduce the uptake of CO_2 and forest productivity (Roderick *et al*. 2001). A drying of montane regions may lead to high altitude communities being squeezed upslope by the advance of lower montane species and those restricted to the highest elevations may be lost (Foster 2001). Pounds *et al*. (1999) have suggested that cloud forests in Costa Rica may already be experiencing pressure from the upward invasion of lower altitude species. Similar predictions are made for the upslope expansion of warm subtropical rainforest types in the Gondwana Rainforests of Australia World Heritage Area (Australian National University 2009). These changes are a risk not only to local biodiversity, but the loss of high altitude endemic species will be a loss to global biodiversity. The ability for species to move will, however, depend on their ability to disperse into new climatic envelopes. The majority of tree species within the study region are wind or fauna dispersed and as such, their upslope movement would not be expected to be dispersal limited.

Tang (2008) suggests that within the study area, prolonged drought is likely to have a serious impact on the dynamics of the rainforest. The 1982 83 El Niño driven drought was found to result in a general increase in tree and seedling mortality among trees at Barro Colorado Island, Panama (Condit *et al*. 1995; Gilbert *et al*. 2001). *Nothofagus moorei* (Nothofagaceae) is already at its most northerly extent in the study region and reproduction here, in the absence of catastrophic disturbance (Hunter 1988), is largely restricted to vegetative coppicing (Turner 1976). This species currently occurs in regions with 1158 3089 mm of annual rainfall, and with not less than 45 mm falling in any month (Simpson 1976). With predicted changes to rainfall regimes and reduced inputs from cloud, it is possible that this iconic species will struggle to persist in Queensland in the future.

Our results show that the composition of the tree community changes in a non linear fashion and we note key altitudes, such as that at 900 m, across which vegetation transitions are most acute. The significant established tree species and families recorded at each of the four 900 m plots were highly variable and showed affinities with sites both upslope and downslope, suggesting that this altitude is a zone of overlap. This is also reflected in the higher than expected species, generic and family richness (Fig. 1), and H' (Table 1) for this altitude. Such results will allow future monitoring efforts to be targeted to specific altitudes and species. Like many similar studies, results here

suggest that endemic species at high elevations may be in danger of local extinction or, at the very least, reduction to largely vegetative 'relicts' of past assemblages as a result of a changing climate (Williams *et al*. 2007). Intervention may be necessary in order to preserve species with such restricted distributions. Predicted increases in Bray Curtis dissimilarity between the juvenile and established tree communities at the base of the current cloud cap (800 900 m a.s.l.) can be tested in future surveys. Species currently occurring just below this altitude can also be considered sentinel species for projected upward shifts in range. This, along with targeted cloud height monitoring and detailed seedling surveys, are priorities for further study.

The floristic composition of currently recognised Regional Ecosystems (Environmental Protection Agency 2007) and other floristic associations may alter in response to a changing environment, rather than simply move along with their environmental habitats. We may expect the emergence of vegetation communities which are not easily slotted into any of our current ecosystem classifications. The potential emergence of novel floristic associations within a region as a result of anthropogenic climate change (Hobbs *et al*. 2006) will be a challenge to community ecologists and management agencies alike. Methodologically one thing is clear. There is much to be gained, as intimated in the recent IPCC Report (IPCC 2007) by the establishment and careful analysis of results from permanent altitudinal transects such as those established under the IBISCA protocol. On our transect further, intercalary plots examining changes at a finer altitudinal scale, especially around the key altitude of 900 m indicated earlier, are being established to further pursue the hypotheses we have identified. The results from this study point to the necessity of further exploration of the role which occult precipitation plays in shaping the current floristic assemblages and how this is likely to change in the future.

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Manuscript received 1 December 2010, accepted 3 June 2012

MC19-001054

FOI 190505
Document 12

Hon Melissa Price MP
Minister for the Environment and Energy
PO Box 6022
House of Representatives
Parliament House
Canberra ACT 2600

GONDWANA RAINFORESTS OF AUSTRALIA
ADVISORY COMMITTEES

22 January 2019

Re: Gondwana Rainforests World Heritage advisory committee meetings – DoEE attendance

Dear Minister Price,

The Gondwana Rainforests Advisory Committees are appointed by the NSW and Queensland environment ministers to provide advice to the ministers and managing agencies on the protection and management of the World Heritage property. The chairs of the Advisory Committees are jointly appointed by the NSW, Queensland and Australian Government environment ministers.

There are two Advisory Committees: a Community Advisory Committee appointed to provide advice on the protection and management of the property from the viewpoint of the community, and a Technical and Scientific Advisory Committee appointed to provide advice on the scientific basis for conservation management of the property, including advice on research and monitoring.

The Gondwana Rainforests Advisory Committees met in Gloucester on Friday 2 November and Saturday 3 November. The first day was a field trip into Barrington Tops to discuss management of the World Heritage Area, hosted by the NSW National Parks and Wildlife Service. A communiqué from this meeting is attached which outlines some of the key issues and concerns considered by the committees.

The Advisory Committees were disappointed that a DoEE representative was not present at the meeting as DoEE input and advice is highly valued. The committees seek the continued participation of DoEE in Advisory Committee operations to support interstate, coordinated management of this serial, cross-jurisdictional property.

We thank you for the continued opportunity to support the management and protection of the Gondwana Rainforests of Australia World Heritage Area. If you or your advisors would like further information or clarification, our contact details are provided below.

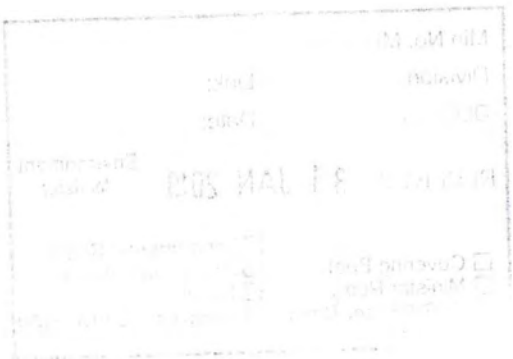
Yours sincerely,

s47F (1)

Dr Mahri Koch
Chair, Community Advisory Committee
Gondwana Rainforests of Australia World Heritage Area
s47F

s47F (2)

Professor Nick C. H. Reid
Chair, Technical and Scientific Advisory Committee
s47F



Meeting communiqué, 2–3 November 2018

Advisory Committees for the Gondwana Rainforests of Australia World Heritage Area

BACKGROUND

The Gondwana Rainforests of Australia World Heritage Area is a serial cross-jurisdictional property consisting of some 40 reserves across northeast NSW and southeast Queensland including the iconic Lamington, Springbrook, Main Range, Mount Barney, Border Ranges, Wollumbin, Nightcap, Washpool, Gibraltar Range, Dorrigo, New England, Oxley Wild Rivers and Barrington Tops National Parks.

Inscribed on the World Heritage list for outstanding universal value, it contains remnants of the rainforests that once covered the supercontinent of Gondwana and now contains endemic relict species found nowhere else in the world and closely related to those in the fossil record from millions of years ago. The dramatic landscapes tell the story of the development of the continent, including the Tweed Shield volcano, which is the best-developed erosion caldera in the world. The diversity of habitats and ancient species mixing with those newly evolved, makes this area one of Australia's biodiversity hot-spots containing the most important habitats for species of outstanding universal value for conservation and science.

The Gondwana Rainforests Advisory Committees are appointed by the NSW and Queensland environment ministers to provide advice to the ministers and managing agencies on the protection and management of the World Heritage property. The chairs of the Advisory Committees are jointly appointed by the NSW, Queensland and Australian Government environment ministers. There are two Advisory Committees: a Community Advisory Committee appointed to provide advice on the protection and management of the property from the viewpoint of the community, and a Technical and Scientific Advisory Committee appointed to provide advice on the scientific basis for conservation management of the property, including advice on research and monitoring.

The Gondwana Rainforests Advisory Committees met in Gloucester on Friday 2 November and Saturday 3 November. The first day was a field trip into Barrington Tops to discuss management of the World Heritage Area, hosted by the NSW National Parks and Wildlife Service. The second day was a meeting in Gloucester. The following notes outline key points from the meeting.

FIELD VISIT COMMENDATIONS AND CONCERNS

The Advisory Committees commend the passion and commitment of the NPWS staff who hosted the Advisory Committees' visit to Barrington Tops. The presentations about their work and the park were exceptional s22

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The Advisory Committees are also concerned that with climate change, the likelihood of damage to rainforest communities from wildfire is increasing, as well as the potential for too-frequent fire in the surrounding sclerophyll communities at Barrington Tops.

MEETING REPORT

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CONSERVATION – EMERGING THREATS

- The Advisory Committees welcome the release of the **Queensland Biodiversity and Ecosystems Sector Climate Change Adaptation Plan** and look forward to supporting the development of a Gondwana Rainforests climate change adaptation strategy. The committees noted that some of the actions to understand climate change impacts are not well supported and given the gravity of the impacts now unfolding, commend the agencies for their climate change initiatives in relation to the property.
- The Advisory Committees commend the work by the **Earth Systems and Climate Change Hub** (ESCCH) of the National Environment Science Program in supporting adaptation planning in a portion of the World Heritage Area in south-eastern Queensland, and encourage the development of further tools including downscaled projections and a Relative Humidity spatial layer. The committees commend s47F Executive Officer for the Gondwana Rainforests of Australia WHA, for facilitating the involvement of ESCCH scientists in the climate modelling and adaptation planning for the property.
- The Advisory Committees established a **climate change working group**, with the first task being identification of key species for further assessment of potential climate change impacts. The committees will also be seeking updates from managing agencies about projects mapping ecological buffers and refugia to support the protection and management of the Gondwana Rainforests in NSW and Qld.
- The Advisory Committees discussed **commercial water extraction** in the Tweed Caldera, which appears to be an increasing threat to the property. The committees are concerned about extraction proposals that may affect groundwater-dependent-ecosystems in Springbrook National Park, including the iconic Springbrook leatherwood tree, *Eucryphia jinksii*, which occurs in gullies. Monitoring the discharge of catchments draining the property would provide important baseline data for detecting the impact of water extraction approvals, as well as the impact of climate change in the longer term. A letter will be sent to the ministers about the potential impacts of groundwater extraction on the property, particularly given the combined risk of cumulative impacts from multiple extractions across the property and the changing climate.

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The Advisory Committees are pleased to support the continued efforts of the NSW, Qld and Australian Governments to transmit the outstanding universal value of the Gondwana Rainforests to future generations.

Sincerely,

s47F

Dr Mahri Koch
Chair, Community Advisory Committee

s47F

s47F

Professor Nick C. H. Reid
Chair, Technical and Scientific Advisory Committee

s47F

The Hon **Leeanne Enoch** MP
Minister for Environment
Queensland Government
PO Box 2454
Brisbane Queensland 4001

ADVISORY COMMITTEES

22 January 2019

s22

Dear Minister Enoch,

s22

We have forwarded copies of this letter to Ministers Upton and Price given their respective responsibilities for the protection and management of the Gondwana Rainforests. Should you or your advisors wish to discuss any of the matters raised above, we have provided our telephone numbers and email addresses below.

Yours sincerely,

s47F

Dr Mahri Koch
Chair, Community Advisory Committee
Gondwana Rainforests of Australia World Heritage Area

s47F

s47F

Professor Nick C. H. Reid
Chair, Technical and Scientific Advisory Committee

s47F

cc. The Hon Melissa Price and the Hon. Gabrielle Upton

FOI 190505
Document 13

From: s47F
To:
Subject: FW: Gondwana workshop products - NESP ESCCH climate change workshop
Date: Wednesday, 20 March 2019 6:11:18 PM
Attachments: image001.jpg
Gondwana CC workshop report.pdf
A4-2p-workshop-summary-gondwana.pdf
A4-2p-workshop-summary-gondwana-web.pdf

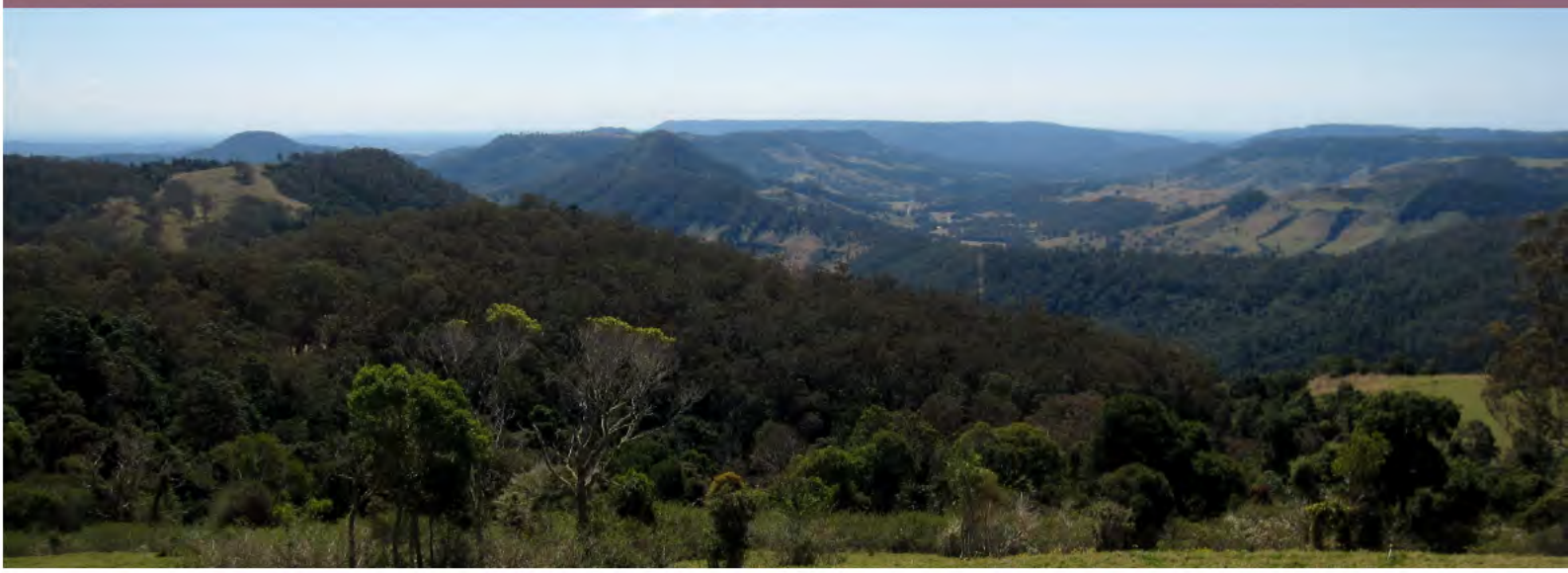
Hi team Gondwana Rainforests Coordinating Committee
Gondwana Rainforests reports and summary from the NESP project
I'll distribute further when I get back next week
s47F

s47F

From: s47F
Sent: Tuesday, 19 March 2019 3:39 PM
To: s47F
Cc: s47F
Subject: Gondwana workshop products
Hi s47F
Please find attached the workshop report and a couple of two pages one for printing and the other for the web.
I've just got to run the draft case study by s47F and then I'll send it on to you.
Kind regards
s47F

Earth Systems and Climate Change Hub

National Environmental Science Programme



WORKSHOP REPORT

Climate change impacts on the Gondwana Rainforests of Australia

March 2019

Earth Systems and Climate Change Hub Report No. 8

Australian Government

National Environmental Science Programme

The Earth Systems and C mate Change Hub s supported by fund ng through the Austra an Government s Nat ona Env ronmenta Sc ence Program. The Hub s hosted by the Commonwea th Sc ent f c and Industr a Research Organ sat on (CSIRO), and s a partnersh p between CSIRO, Bureau of Meteoro ogy, Austra an Nat ona Un vers ty, Monash Un vers ty, Un vers ty of Me bourne, Un vers ty of New South Wa es and Un vers ty of Tasman a. The ro e of the Hub s to ensure that Austra a s po c es and management dec s ons are effect ve y nformed by Earth systems and c mate change sc ence, now and nto the future. For more nformat on v s t www.nespc mate.com.au.

C tat on

NESP Earth Systems and C mate Change Hub. 2019. *Climate change impacts on the Gondwana Rainforests of Australia (workshop report)*, Earth Systems and C mate Change Hub Report No. 8, NESP Earth Systems and C mate Change Hub, Austra a.

Contact

Enqu r es regard ng th s report shou d be addressed to:

Earth Systems and C mate Change Hub
PMB 1
Aspenda e V c 3195

nfo@nespc mate.com.au

Pub shed: March 2019

Th s report s ava ab e for down oad from the Earth Systems and C mate Change Hub webs te at www.nespc mate.com.au.

Cover photo: Lam ngton Nat ona Park, Stefan Krasowsk /F ckr, CC-BY-2.0

Important d sc a mer

The Nat ona Env ronmenta Sc ence Program (NESP) Earth Systems and C mate Change (ESCC) Hub adv ses that the nformat on conta ned n th s pub cat on compr ses genera statements based on sc ent f c research. The reader s adv sed and needs to be aware that such nformat on may be ncomp ete or unab e to be used n any spec f c s tuat on. No re ance or act ons must therefore be made on that nformat on w thout seek ng pr or expert profess ona , sc ent f c and techn ca adv ce. To the extent perm tted by aw, the NESP ESCC Hub (nc ud ng ts host organ sat on, emp oyees, partners and consu tants) exc udes a ab ty to any person for any consequences, nc ud ng but not m ted to a osses, damages, costs, expenses and any other compensat on, ar s ng d rect y or nd rect y from us ng th s pub cat on (n part or n who e) and any nformat on or mater a conta ned n t.

The ESCC Hub s comm tted to prov d ng web access b e content wherever poss b e. If you are hav ng d ff cu t es w th access ng th s document, p ease contact nfo@nespc mate.com.au.

Contents

Executive summary

A workshop was convened in Brisbane at the University of Queensland on 8 October 2018 to bring experts from key agencies together to discuss available climate projections and identify specific data needs for ongoing climate change adaptation planning for the Gondwana Rainforests of Australia World Heritage Area.

Gondwana Rainforests

The Gondwana Rainforests of Australia is a serial World Heritage property containing 40 separate reserves within north-east New South Wales and south-east Queensland. Covering more than 366,000 hectares, the rainforests comprise warm temperate, cool temperate, subtropical and dry rainforests similar to those that covered the ancient supercontinent Gondwana. The rainforests are biodiversity hot-spots and are home to many rare and threatened plants and animals.

On-ground management of the Gondwana Rainforests is largely by the NSW National Parks & Wildlife Service (part of the NSW Office of Environment and Heritage) and Queensland Parks & Wildlife Service (part of the Queensland Department of Environment and Science). The Queensland Department of Environment and Science (DES) has developed a Biodiversity and Ecosystems Climate Adaptation Plan, designed to facilitate the adaptation of Queensland's biodiversity and ecosystems to the effects of climate change.

Climate change

Climate change refers to long-term changes in the average pattern of weather that occur over decades to longer timescales. Climate variability, for example, due to the El Niño Southern Oscillation, occurs at shorter timescales of years to decades, while weather occurs on the timescale of hours to days.

Climate change projections are not predictions, but they tell us about the response of the climate system to possible future scenarios of human greenhouse gas emissions. Climate projections for the broader Gondwana Rainforests region include:

- increased average temperatures in all seasons (*very high confidence*).
- more hot days and warm spells with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (*very high confidence*).
- uncertain rainfall change with the mean of the models projecting a modest decrease, strongest in winter (*low confidence*). There is a suggestion with a possible modest increase in summer rainfall in the northern part of the region in summer (*low confidence*) but the spread across models from increases to decreases is very large, Irrespective of average rainfall changes, extreme rainfall events will increase in severity.
- higher surface solar radiation (i.e. decreased overall cloud cover), decreased relative humidity (although modest in winter) and higher evapotranspiration in all seasons.

Changes projected generally increase for higher emissions scenarios and for further out in the century.

Detailed climate change projections for Australia are available at www.climatechangeinaustralia.gov.au – Gondwana Rainforests are in the East Coast cluster (both North and South sub-clusters).

Next steps

The ESCC Hub will collaborate with Gondwana Rainforests WHA managers on a case study to assess the impact of climate change on cloud cover in the region covered by the Border Ranges Rainforest Biodiversity Management Plan. The case study will be carried out in 2019–20.

The Gondwana Rainforests Management Committee will continue to investigate adaptation planning for the World Heritage area within their jurisdictions. Opportunities to coordinate and share information and learnings between jurisdictions will be investigated and optimised. Input and advice from the Gondwana Rainforests advisory committees shall be sought as projects and programs are developed, including identifying knowledge gaps along the way.

Background

The Gondwana Rainforests of Australia is a serial World Heritage property containing reserves within north-east New South Wales and south-east Queensland. Inscribed on the World Heritage for the outstanding universal value (OUV) of landforms and biodiversity, it contains numerous relict and endemic species, particularly those associated with rainforests.

Climate change has been identified as a threat to the OUV of the Gondwana Rainforests. Projected changes in temperatures and rainfall are likely to directly affect already restricted cool, moist habitats. Changes in fire regimes and severe storm events, coupled with changes in competition from pest species, are likely to further impact these habitats.[1]

One of the rainforest types which is considered to be under particular threat from climate change is the microphyll fern forests, typically dominated by Antarctic beech (*Nothofagus moorei*).[2] Upland forests, including 'cool temperate rainforests', have been shown to receive significant moisture inputs from cloud and fog.[3]

Research into the potential impacts of climate change on these biotic communities is hampered by a lack of data about the current and projected rainfall and cloud variables. This project focuses on the specific question of how to obtain better data and information on these parameters to assist in adaptation planning.

The ESCC Hub seeks to support governments and communities in adapting to climate change through the provision of climate modelling which meets specific information requirements. Managers of World Heritage at the state and federal level are seeking to develop adaptation plans to protect and conserve World Heritage. This project aims to deliver improved information and data for use by World Heritage managers in the development of these plans.

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[1] Austra an Nat ona Un vers ty (2009) Imp cat ons of c mate change for Austra a s Wor d Her tage propert es: A pre m nary assessment. A report to the Department of C mate Change and the Department of the Env ronment, Water, Her tage and the Arts by the Fenner Schoo of Env ronment and Soc ety, Austra an Nat ona Un vers ty.

[2] Tay or et a (2005) n Austra an Nat ona Un vers ty (2009).

[3] Hut ey LB, Do ey D, Yates DJ, Boonsaner A (1997) Water ba ance of an Austra an subtrop ca ra nforest at a t tude: the eco og ca and phys o og ca s gn f cance of ntercepted c oud and fog. *Australian Journal of Botany*, 45(2), 311–329.

About the workshop

A workshop was convened in Brisbane at the University of Queensland on 8 October 2018 to bring experts from key agencies together to discuss available climate projections and identify specific data needs for ongoing climate change adaptation planning.

Specifically, the workshop objectives were to:

- examine the impact of climate change on Queensland cloud caps and cloud forests, including projected change and likelihood of crossing important thresholds under various scenarios
- demonstrate the value of multi-disciplinary and collaborative, ‘end-to-end’ analysis to address issues of series of steps/aims to achieve this.

This report provides a summary of the information presented at the workshop and identifies possibilities for the next steps, pending agreement and resources.

The workshop program and participant list are included in the appendices of this report.

Gondwana Rainforests – a window into the past

The Gondwana Rainforests of Australia World Heritage Area (Gondwana Rainforests WHA) is a series of 40 separate reserves grouped into eight geographical areas on Australia's east coast (Figure 1). Covering more than 366,000 hectares, the rainforests comprise warm temperate, cool temperate, subtropical and dry rainforests similar to those that covered the ancient supercontinent Gondwana. The rainforests are biodiversity hot-spots and are home to many rare and threatened plants and animals.

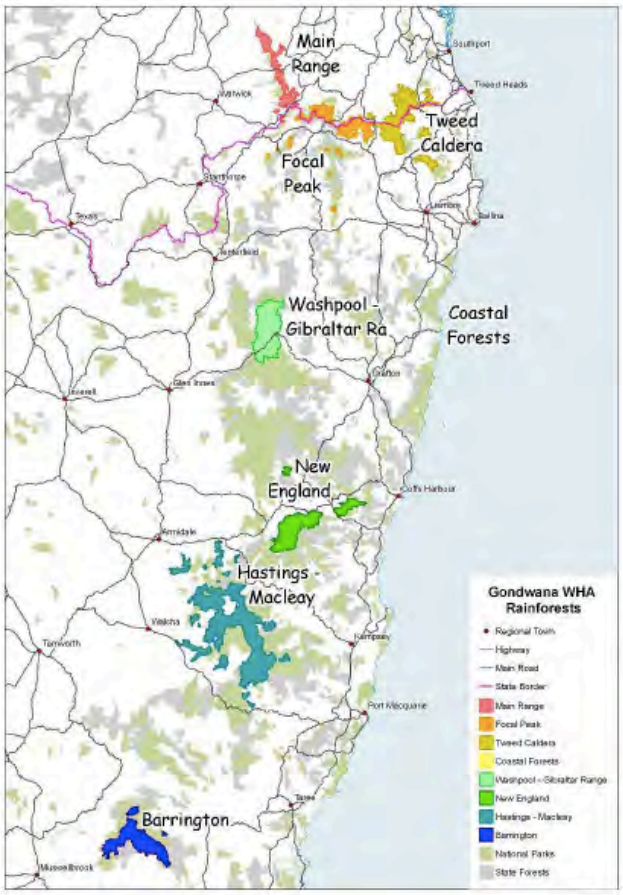

Figure 1. Map showing the eight geographical regions of the Gondwana Rainforests of Australia World Heritage Area (Source: workshop presentation by Tricia Waters)

The mountainous topography typical of the Gondwana Rainforests WHA has both driven the evolution of, and provided refuge for, unique species and communities dependent upon stable, moist microclimates. The high elevation forests in particular provide habitat for a number of narrow-range endemic and threatened species, temperate families and cool temperate rainforest communities which in part define the outstanding universal value (OUV) of the Gondwana Rainforests WHA.

At high elevations, moisture inputs from rainfall are supplemented by cloud and fog intercepted by the forest canopy. Experiments in nearby upland rainforest have shown that fog and cloud-water can contribute moisture inputs equivalent to 40% of annual

precipitation.[4] Future warming under climate change and any associated reduction or seasonal change in cloud water inputs could result in a reduction of annual moisture inputs, reduced stream-flows, increased dry-season moisture stress and in turn, threaten the OUV of the property.

World Heritage listing – what this means

The Gondwana Rainforests were first listed as a World Heritage Area in 1986 and were the first serial property to be listed. The original listing was as Australian East Coast Temperate and Subtropical Rainforest Parks. Additions were listed in 1994 and the name changed to Central Eastern Rainforest Reserves of Australia. The name was changed to Gondwana Rainforests of Australia in 2007 to better reflect the values for which it was World Heritage listed.

World Heritage properties are sites of global natural or cultural significance that have been recognised through the World Heritage Convention. The Convention, adopted in 1972 through UNESCO, came into force in 1975. It recognises the need to preserve a balance between World Heritage values and how people interact with nature.

All States Parties signed up to the World Heritage Convention – currently 167 countries (including Australia) – agree to adhere to the Convention and to nominate properties for inclusion on the World Heritage List. They commit to protecting World Heritage values, which includes having management plans in place to protect these values and report on their condition.

There are currently 1092 properties on the World Heritage List – 845 recognised for their cultural value, 209 for their natural value and 38 for both cultural and natural value.

World Heritage properties are to be preserved for the future on the basis of their OUV. Each property has a Statement of OUV (SoOUV) which is:

- the principal reference for all plans and legislation relating to future protection and management of the property
- a point of reference for all monitoring, state conservation reporting and a mandate to maintain the values as per at Listing.

The fundamental concept is passing on the property to future generations with the values/attributes as they are recorded in the SoOUV.

There are 10 criteria for OUV – four natural and six cultural.[5] Gondwana Rainforests WHA meets three of the four natural criteria:

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[4] Hut ey LB, Do ey D, Yates DJ, Boonsaner A (1997) Water ba ance of an Austra an subtrop ca ra nforest at a t tude: the eco og ca and phys o og ca s gn f cance of ntercepted c oud and fog. *Australian Journal of Botany*, 45(2), 311–329.

[5] http://whc.unesco.org/en/cr ter a/

viii. be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.

ix. be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.

x. contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

World Heritage properties must also meet the conditions of integrity (natural sites) or authenticity (cultural sites) – that is, they must have sufficient protection/management in place to ensure the World Heritage values at Listing are maintained and safeguarded into the future. The IUCN defines the integrity of a World Heritage property as:

> "… a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes. Examining the conditions of integrity, therefore requires assessing the extent to which the property:
>
> a) includes all elements necessary to express its outstanding universal value;
> b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;
> c) suffers from adverse effects of development and/or neglect."[6]

The integrity of the Gondwana Rainforests is considered to be vulnerable to the impacts of climate change. This has been a significant motivation for commencing a systematic evaluation of future climate scenarios and planning for the future.

Gondwana Rainforests of Australia Statement of OUV[7]

Brief synthesis

The Gondwana Ra nforests of Austra a s a ser a property compr s ng the major rema n ng areas of ra nforest n southeast Queens and and northeast New South Wa es. It represents outstand ng examp es of major stages of the Earth s evo ut onary h story, ongo ng geo og ca and b o og ca processes, and except ona b o og ca d vers ty. A w de range of p ant and an ma neages and commun t es w th anc ent or g ns n Gondwana, many of wh ch are restr cted arge y or ent re y to the Gondwana Ra nforests, surv ve n th s co ect on of reserves. The Gondwana Ra nforests a so prov des the pr nc pa hab tat for many threatened spec es of p ants and an ma s.

Criterion (viii): The Gondwana Ra nforests prov des outstand ng examp es of s gn f cant ongo ng geo og ca processes. When Austra a separated from Antarct ca fo ow ng the breakup of Gondwana, new cont nenta marg ns deve oped. The marg n wh ch formed a ong Austra a s eastern edge s character sed by an asymmetr ca marg na swe that runs para e to the coast ne, the eros on of wh ch has resu ted n the Great D v de and the Great Escarpment. Th s eastern cont nenta marg n exper enced vo can c ty dur ng the Cenozo c

[6] https://whc.unesco.org/document/115532

[7] https://whc.unesco.org/en/ st/368

Era as the Austra an cont nenta p ate moved over one of the p anet s hot spots. Vo canoes erupted n sequence a ong the east coast resu t ng n the Tweed, Foca Peak, Ebor and Barr ngton vo can c sh e ds. Th s sequence of vo canos s s gn f cant as t enab es the dat ng of the geomorph c evo ut on of eastern Austra a through the study of the nteract on of these vo can c remnants w th the eastern h gh ands.

The Tweed Sh e d eros on ca dera s poss b y the best preserved eros on ca dera n the wor d, notab e for ts s ze and age, for the presence of a prom nent centra mounta n mass (Wo umb n/Mt Warn ng), and for the eros on of the ca dera f oor to basement rock. A three stages re at ng to the eros on of sh e d vo canoes (the p aneze, res dua and ske eta stages) are read y d st ngu shab e. Further south, the remnants of the Ebor Vo cano a so prov des an outstand ng examp e of the ongo ng eros on of a sh e d vo cano.

Criterion (ix): The Gondwana Ra nforests conta ns outstand ng examp es of major stages n the Earth s evo ut onary h story as we as ongo ng evo ut onary processes. Major stages represented nc ude the Age of the Pter dophytes from the Carbon ferous Per od w th some of the o dest e ements of the wor d s ferns represented, and the Age of Con fers n the Jurass c Per od w th one of the most s gn f cant centres of surv va for Araucar ans (the most anc ent and phy ogenet ca y pr m t ve of the wor d s con fers). L kew se the property prov des an outstand ng record of the Age of the Ang osperms . Th s nc udes a secondary centre of endem sm for pr m t ve f ower ng p ants or g nat ng n the Ear y Cretaceous, the most d verse assemb age of re ct ang osperm taxa represent ng the pr mary rad at on of d coty edons n the m d-Late Cretaceous, a un que record of the evo ut onary h story of Austra an ra nforests represent ng the go den age of the Ear y Tert ary, and a un que record of M ocene vegetat on that was the antecedent of modern temperate ra nforests n Austra a. The property a so conta ns an outstand ng number of songb rd spec es, nc ud ng yreb rds (Menur dae), scrub-b rds (Atr chorn th dae), treecreepers (C macter dae) and bowerb rds and catb rds (Pt onorhynch dae), be ong ng to some of the o dest neages of passer nes that evo ved n the Late Cretaceous. Outstand ng examp es of other re ct vertebrate and nvertebrate fauna from anc ent neages nked to the break-up of Gondwana a so occur n the property.

The f ora and fauna of the Gondwana Ra nforests prov des outstand ng examp es of ongo ng evo ut on nc ud ng p ant and an ma taxa wh ch show ev dence of re at ve y recent evo ut on. The ra nforests have been descr bed as an arch pe ago of refug a, a ser es of d st nct ve hab tats that character se a temporary endpo nt n c mat c and geomorpho og ca evo ut on . The d stances between these s ands of ra nforest represent barr ers to the f ow of genet c mater a for those taxa wh ch have ow d spersa ab ty, and th s pressure has created the potent a for cont nued spec at on.

Criterion (x): The ecosystems of the Gondwana Ra nforests conta n s gn f cant and mportant natura hab tats for spec es of conservat on s gn f cance, part cu ar y those assoc ated w th the ra nforests wh ch once covered much of the cont nent of Austra a and are now restr cted to arch pe agos of sma areas of ra nforest so ated by sc erophy vegetat on and c eared and. The Gondwana Ra nforests prov des the pr nc pa hab tat for many spec es of p ants and an ma s of outstand ng un versa va ue, nc ud ng more than 270 threatened spec es as we as re ct and pr m t ve taxa.

Ra nforests covered most of Austra a for much of the 40 m on years after ts separat on from Gondwana. However, these ra nforests contracted as c mat c cond t ons changed and the cont nent dr fted northwards. By the t me of European sett ement ra nforests covered on y 1% of the andmass and were restr cted to refug a w th su tab e c mat c cond t ons and protect on from f re. Fo ow ng European sett ement, c ear ng for agr cu ture saw further oss of ra nforests and on y a quarter of the ra nforest present n Austra a at the t me of European sett ement rema ns.

The Gondwana Ra nforests protects the argest and best stands of ra nforest hab tat rema n ng n th s reg on. Many of the rare and threatened f ora and fauna spec es are ra nforest spec a sts, and the r vu nerab ty to ext nct on s due to a var ety of factors nc ud ng the rar ty of the r ra nforest hab tat. The Gondwana Ra nforests a so protects arge areas of other vegetat on nc ud ng a d verse range of heaths, rocky outcrop commun t es, forests and wood ands. These commun t es have a h gh d vers ty of p ants and an ma s that add great y to the va ue of the Gondwana Ra nforests as hab tat for rare, threatened and endem c spec es. The comp ex dynam cs between ra nforests and ta open forest part cu ar y demonstrates the c ose evo ut onary and eco og ca nks between these commun t es.

Spec es cont nue to be d scovered n the property nc ud ng the re-d scovery of two mamma spec es prev ous y thought to have been ext nct: the Hast ngs R ver Mouse (*Pseudomys oralis*) and Parma Wa aby (*Macropus parma*).

Integrity

The Gondwana Ra nforests conta ns the argest and most s gn f cant rema n ng stands of subtrop ca ra nforest and Antarct c Beech (*Nothofagus moorei*) coo temperate ra nforests n the wor d, the argest and most s gn f cant areas of warm temperate ra nforest and one of on y two rema n ng arge areas of Araucar an ra nforest n Austra a.

Quest ons re ated to the sma s ze of some of the component parts of the property, and the d stance between the s tes for the ong-term conservat on and cont nuat on of natura b o og ca processes of the va ues for wh ch the property was nscr bed have been ra sed. However, not ng that the ser a s tes are n reasonab e prox m ty and are jo ned by corr dors of sem -natura hab tats and buffers, compensat on for sma s ze and scattered fragments s be ng made through ntens ve management cons stent w th approved management p ans and po cy.

S nce nscr pt on, there have been s gn f cant add t ons to the protected area estate n both New South Wa es and Queens and n the reg on encompass ng the Gondwana Ra nforests. These areas have undergone a r gorous assessment to determ ne the r su tab ty for nc us on n the property and a s gn f cant extens on of the property s p anned as nd cated by the add t on of the property extens on to Austra a s Tentat ve L st n May 2010. In re at on to ongo ng evo ut on, the eve of eg s at ve protect on prov ded for Wor d Her tage propert es w m n m se d rect human nf uence and enab e the cont nuat on of natura b o og ca processes.

Protection and management requirements

Inst tut ona arrangements for the protect on and management of Gondwana Ra nforests are strong. The property s made up of 41 reserves, a most a of wh ch are w th n the protected area estate, and pr mar y managed by the Queens and Parks and W d fe Serv ce and the New South Wa es Nat ona Parks and W d fe Serv ce. Both States have eg s at on re at ng to protected areas and nat ve f ora and fauna that prov de protect on for the va ues of the Gondwana Ra nforests.

In 1993, Governments agreed to estab sh a Coord nat ng Comm ttee, compr sed of on-ground managers from these agenc es and the Austra an Government, to fac tate the cooperat ve management of the property at an operat ona eve . A Techn ca and Sc ent f c Adv sory Comm ttee and a Commun ty Adv sory Comm ttee have a so ass sted w th management adv ce s nce the r estab shment n 2002.

In 1994 when the property was extended, the Wor d Her tage Comm ttee requested the Austra an author t es to comp ete the management p ans of nd v dua s tes, part cu ar y those w th n Queens and. Management p ans have been produced for the major ty of nd v dua reserves w th n the property, and are n draft form or p anned for the rema nder.

In 2000 a Strateg c Overv ew for Management for the Centra Eastern Ra nforest Reserves of Austra a (now Gondwana Ra nforests) Wor d Her tage Area was pub shed. Th s overarch ng document s a major e ement n gu d ng cooperat ve management by the three Governments n re at on to the dent f cat on, protect on, conservat on, rehab tat on and presentat on of the Gondwana Ra nforests.

A Wor d Her tage propert es n Austra a are matters of nat ona env ronmenta s gn f cance protected and managed under nat ona eg s at on, the *Environment Protection and Biodiversity Conservation Act 1999*. Th s Act s the statutory nstrument for mp ement ng Austra a s ob gat ons under a number of mu t atera env ronmenta agreements nc ud ng the Wor d Her tage Convent on. By aw, any act on that has, w have or s ke y to have a s gn f cant mpact on the Wor d Her tage va ues of a Wor d Her tage property must be referred to the respons b e M n ster for cons derat on. Substant a pena t es app y for tak ng such an act on w thout approva . Once a her tage p ace s sted, the Act prov des for the preparat on of management p ans wh ch set out the s gn f cant her tage aspects of the p ace and how the va ues of the s te w be managed.

Important y, th s Act a so a ms to protect matters of nat ona env ronmenta s gn f cance, such as Wor d Her tage propert es, from mpacts even f they or g nate outs de the property or f the va ues of the property are mob e (as n fauna). It thus forms an add t ona ayer of protect on des gned to protect va ues of Wor d Her tage propert es from externa mpacts.

On 15 May 2007, the Gondwana Ra nforests of Austra a was added to the Nat ona Her tage L st; Nat ona Her tage s a so a matter of nat ona env ronmenta s gn f cance under the EPBC Act.

The mpacts of c mate change and h gh eve s of v s tat on, undertak ng effect ve f re management, and m t gat ng the effects of nvas on by pest spec es and pathogens present the greatest cha enges for the protect on and management of Gondwana Ra nforests. C mate change w mpact part cu ar y on those re ct spec es n restr cted hab tats at h gher a t tudes, where part cu ar m croc mat c cond t ons have enab ed these spec es to surv ve. Management responses nc ude mprov ng the res ence of the property by address ng other threats such as nappropr ate f re reg mes and nvas on by pest spec es, and try ng to ncrease hab tat connect v ty across the andscape.

Management of Gondwana Rainforests WHA

On-ground management of the Gondwana Rainforests WHA is largely by the:

- NSW National Parks & Wildlife Service (part of the NSW Office of Environment and Heritage)
- Queensland Parks & Wildlife Service (part of the Queensland Department of Environment and Science).

Queensland Biodiversity and Ecosystems Climate Adaptation Plan

At the workshop, Queensland's Department of Environment and Science (DES) provided workshop participants with an overview of its work underway with partners representing the Biodiversity and Ecosystems 'sector' in Queensland to develop a sector adaptation plan, under its Queensland Climate Adaptation Strategy (Q-CAS) 2017–2030. The plan, the Biodiversity and Ecosystems Climate Adaptation Plan (B&E CAP) is designed to facilitate the adaptation of Queensland's biodiversity and ecosystems to the effects of climate change.

DES relayed the context to development of the B&E CAP in terms of Q-CAS and in terms of the issues facing the sector. Indeed, Queensland, as NSW, is facing a future of increasing biodiversity loss and decline in ecosystem integrity and function. Contributing to this are climate factors such as human-induced changes in temperature and rainfall, and scenarios of increasingly impactful intermittent extreme weather events and climate hazards like heatwaves, droughts, fires, cyclones and floods. As well as their direct impacts, changes such as these are likely to compound the impacts of non-climate factors such as habitat loss, pollution and invasive species.

DES informed participants that it had engaged the National Climate Change Adaptation Research Facility (NCCARF) and Cath Moran Ecological Consultancy to lead development of the B&E CAP and its identification of priority measures for the management of climate change impacts on Queensland's unique biodiversity and ecosystems.

DES relayed that the B&E CAP (launched on 9 November 2018) would be the sixth sector adaption plan to be launched under Q-CAS.

DES also highlighted that, beyond release of the B&E CAP, it would be looking to partner with the sector, ideally on a matched-funding basis, to develop and deliver pilot projects aligned to the recommendations of the B&E CAP. DES highlighted that World Heritage areas were considered a priority under the B&E CAP, and that it would look to pilot projects within a Queensland National Park that forms part of one of its four terrestrial World Heritage areas.

Climate change

All climate and climate change figures in this report are from presentations by ESCC Hub researchers at the workshop

Weather, climate, climate variability and climate change

Weather is how we experience climate, but weather and climate are not the same thing. Weather refers to atmospheric conditions and events that occur over short periods of time, typically hours to days. Climate is the average pattern of weather over an extended period of time. Baseline climate features would ideally be derived from very long periods (traditionally around 30 years) so that they capture the 'average' climate as well as the intrinsic variability around this average. However, a rapidly changing climate means that we may need to reassess the appropriate length of such periods to sample when we define 'climate'.

Climate is what you expect, weather is what you get. — Robert A. Heinlein

The climate is not uniform, but varies over months, years and decades (Figure 2). These variations are due to natural processes. On a timescale of months, climate varies due to seasonal cycles. On a timescale of years, phenomena such as the El Niño–Southern Oscillation[8] causes variations in climate, while climate variability at a decadal timescale is influenced by processes such as the Interdecadal Pacific Oscillation (sometimes called the Pacific Decadal Oscillation[9]).

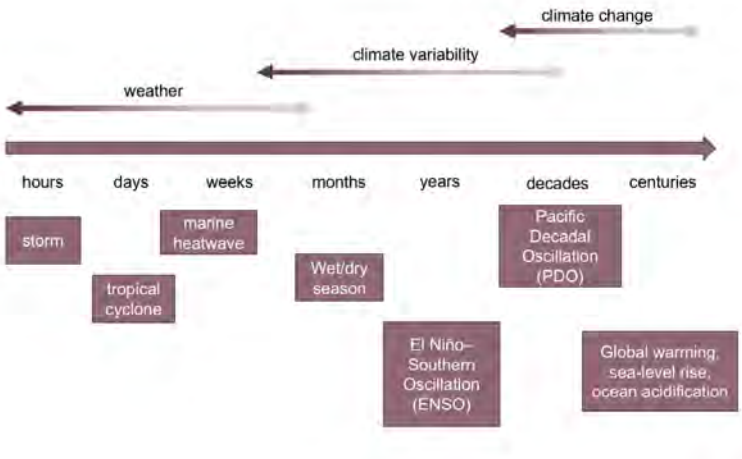

Figure 2. Climate and weather time scales

Climate change refers to long-term changes in the average pattern of weather that occur over decades or. Since industrialisation, rapidly increasing concentrations of greenhouse gases in the atmosphere have resulted in global warming. As the climate becomes warmer, other climate processes also change.

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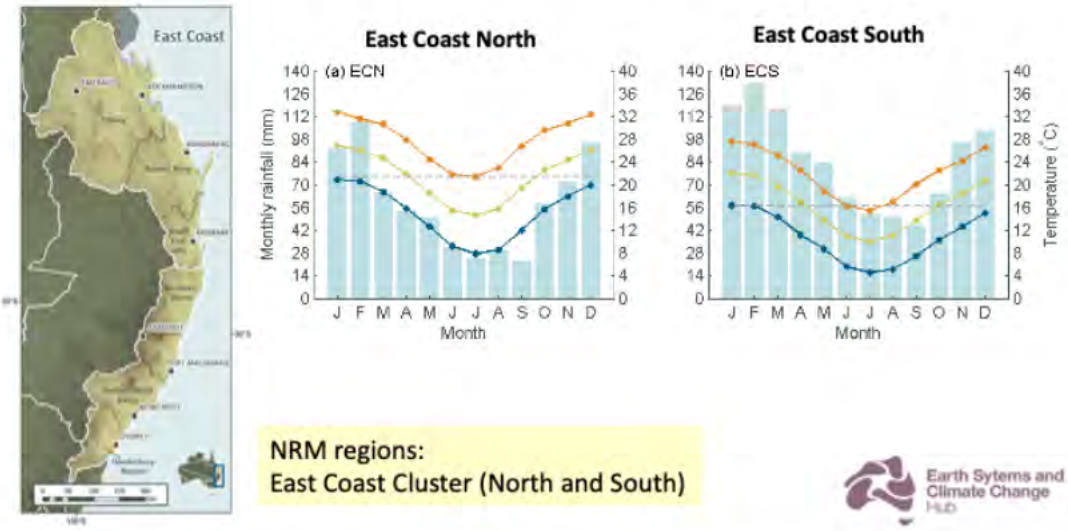
[8] http://www.bom.gov.au/wat /about-weather-and-c mate/austra an-c mate- nf uences.shtm ?bookmark=enso

[9] https://www.metoff ce.gov.uk/v deos/5580792782001

Present day climate of the Gondwana Rainforests WHA region

Present day climate

- Mean maximum temperatures range from 16°C to 28°C (EC South)
- Mean minimum temperatures range from 4°C to 16°C (EC South)



NRM regions:
East Coast Cluster (North and South)

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Present day temperature

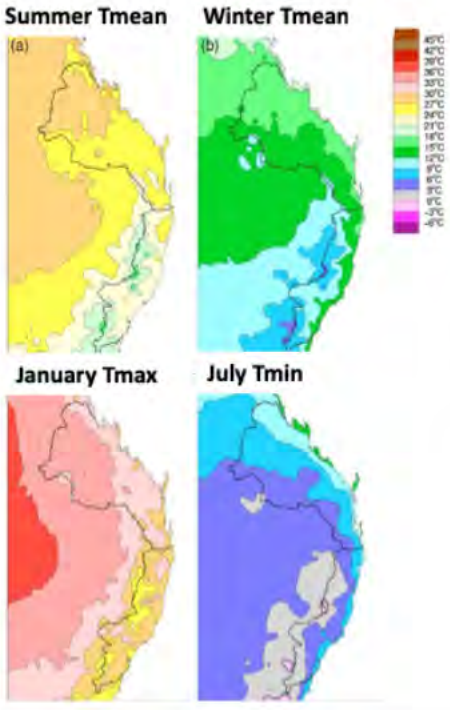

FIGURE 2.1: MAPS OF (A) AVERAGE SUMMER DAILY MEAN TEMPERATURE, (B) AVERAGE WINTER DAILY MEAN TEMPERATURE, (C) AVERAGE JANUARY MAXIMUM DAILY TEMPERATURE AND (D) AVERAGE JULY MINIMUM DAILY TEMPERATURE FOR THE PERIOD 1986–2005.

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Present day rainfall

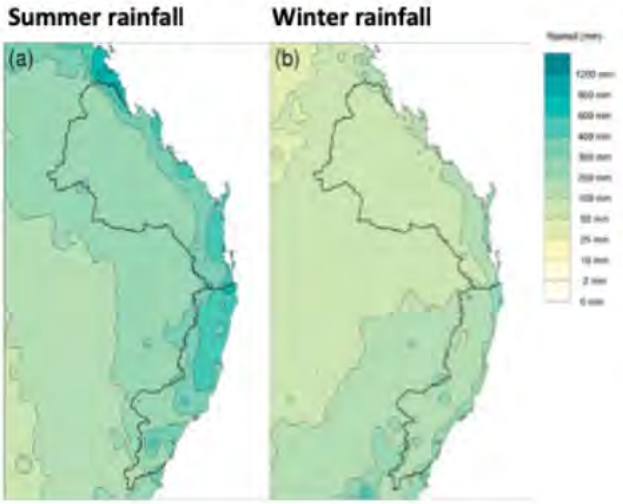

FIGURE 2.3: FOR THE 1986–2005 PERIOD, AVERAGE RAINFALL FOR (A) SUMMER (DECEMBER, JANUARY AND FEBRUARY) AND (B) WINTER (JUNE, JULY AND AUGUST)

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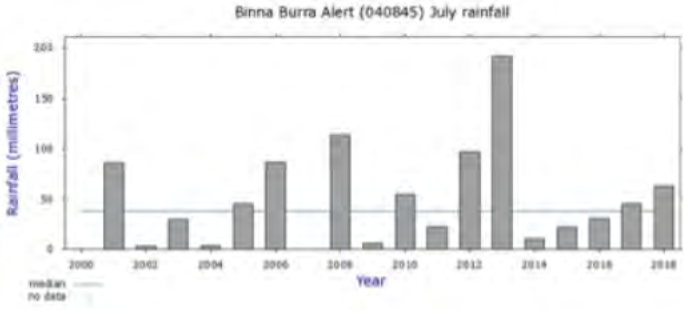
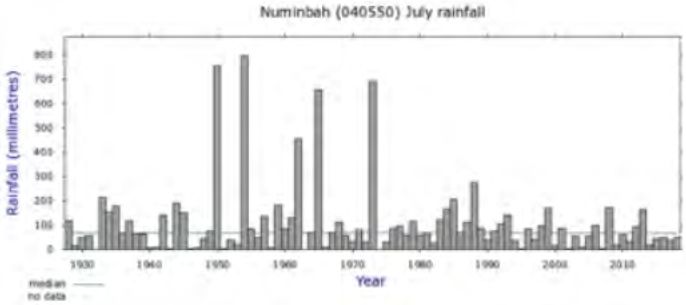
Winter rainfall is highly variable

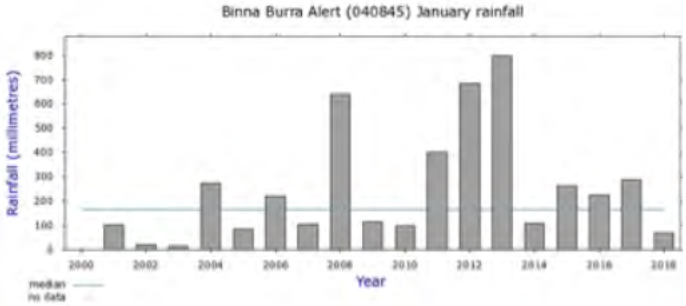


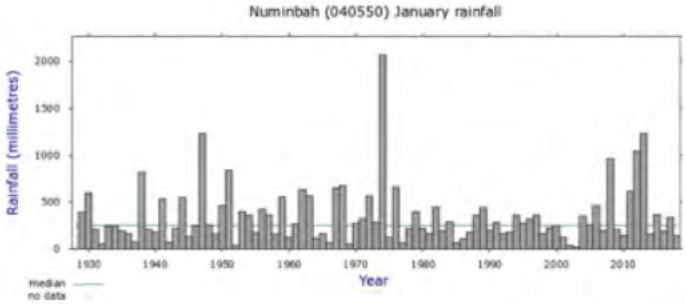


Data from www.bom.gov.au/climate/data/

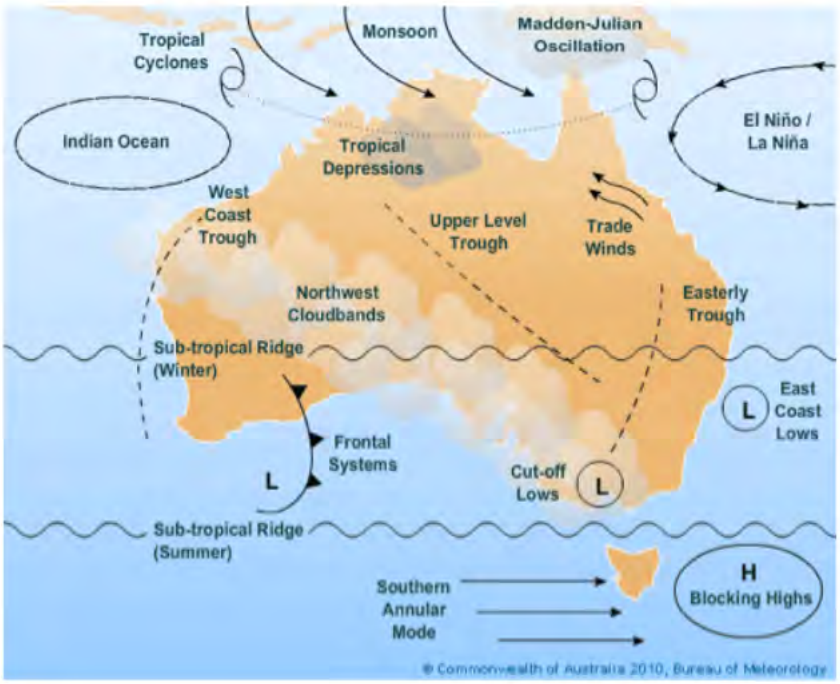
Summer rainfall is also highly variable

Data from
www.bom.gov.au/climate/data/



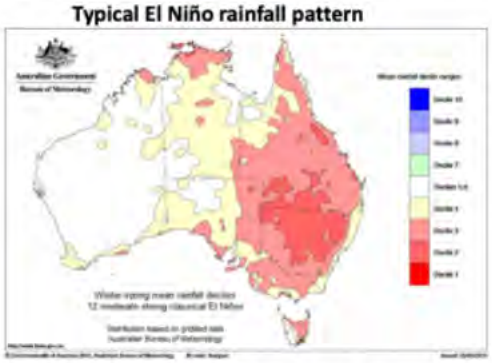


Present day climate drivers

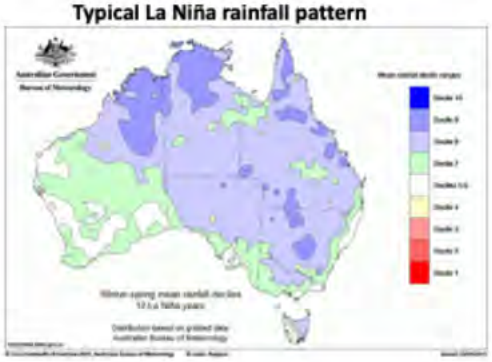


Present day climate drivers: ENSO

Typical El Niño rainfall pattern



Typical La Niña rainfall pattern



Rainfall varies with ENSO:

- dry years during El Niño
- wet years during La Niña

South-east Queensland rainfall versus SOI

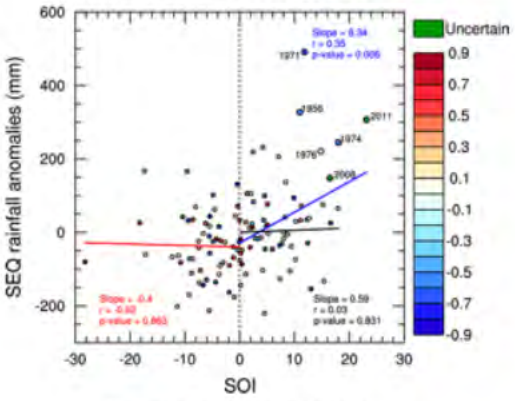


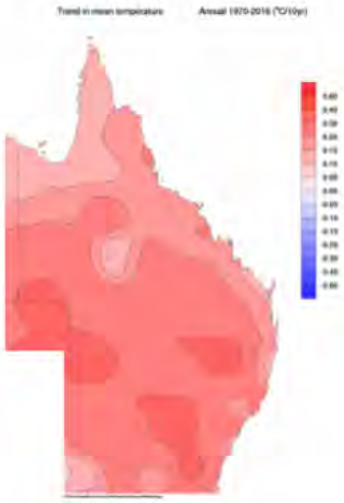
Figure from Cai et al. (2012)

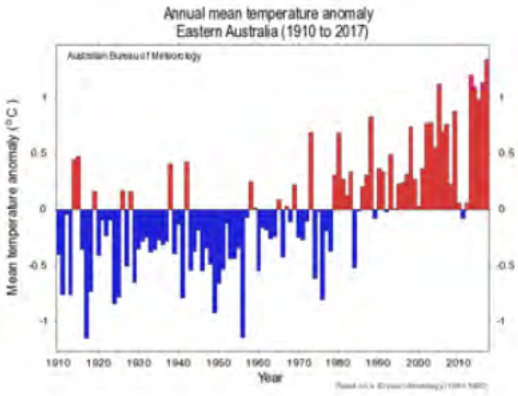
Observed climate trends

Temperature

Observed trends in temperature

Trend in mean temperature (1970-2016)





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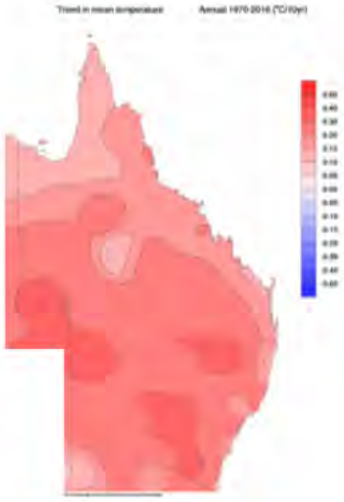
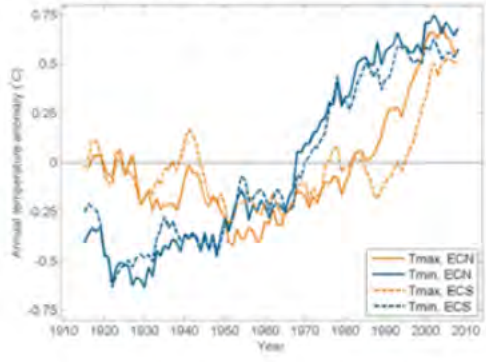
Observed trends in temperature

Trend in mean temperature (1970-2016)



Minimum and maximum temperature anomalies for East Coast North and South NRM regions.



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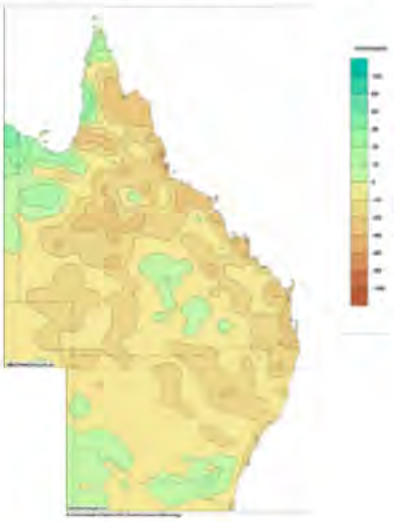
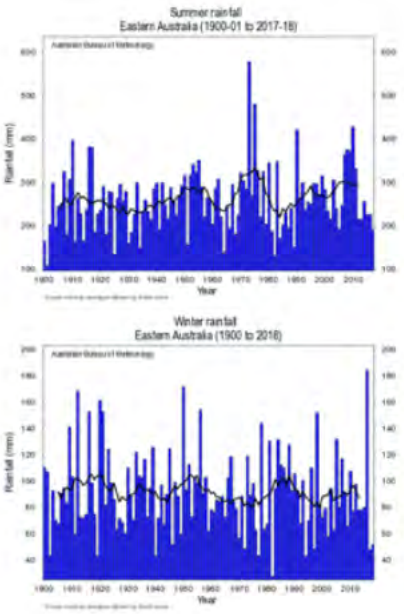
Rainfall

Observed trends in rainfall

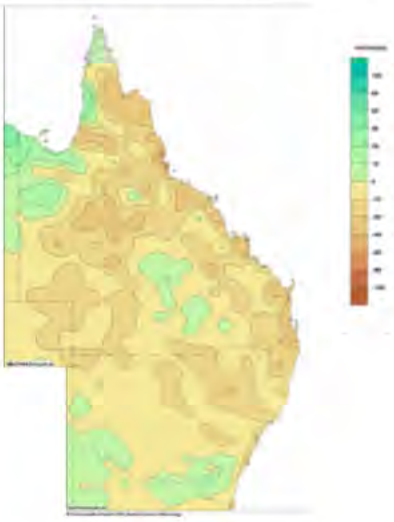
Trend in summer rainfall (1970-2016)



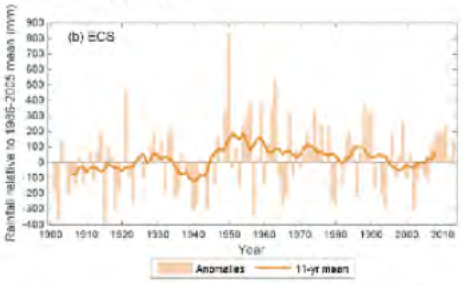


Observed trends in rainfall

Trend in summer rainfall (1970-2016)

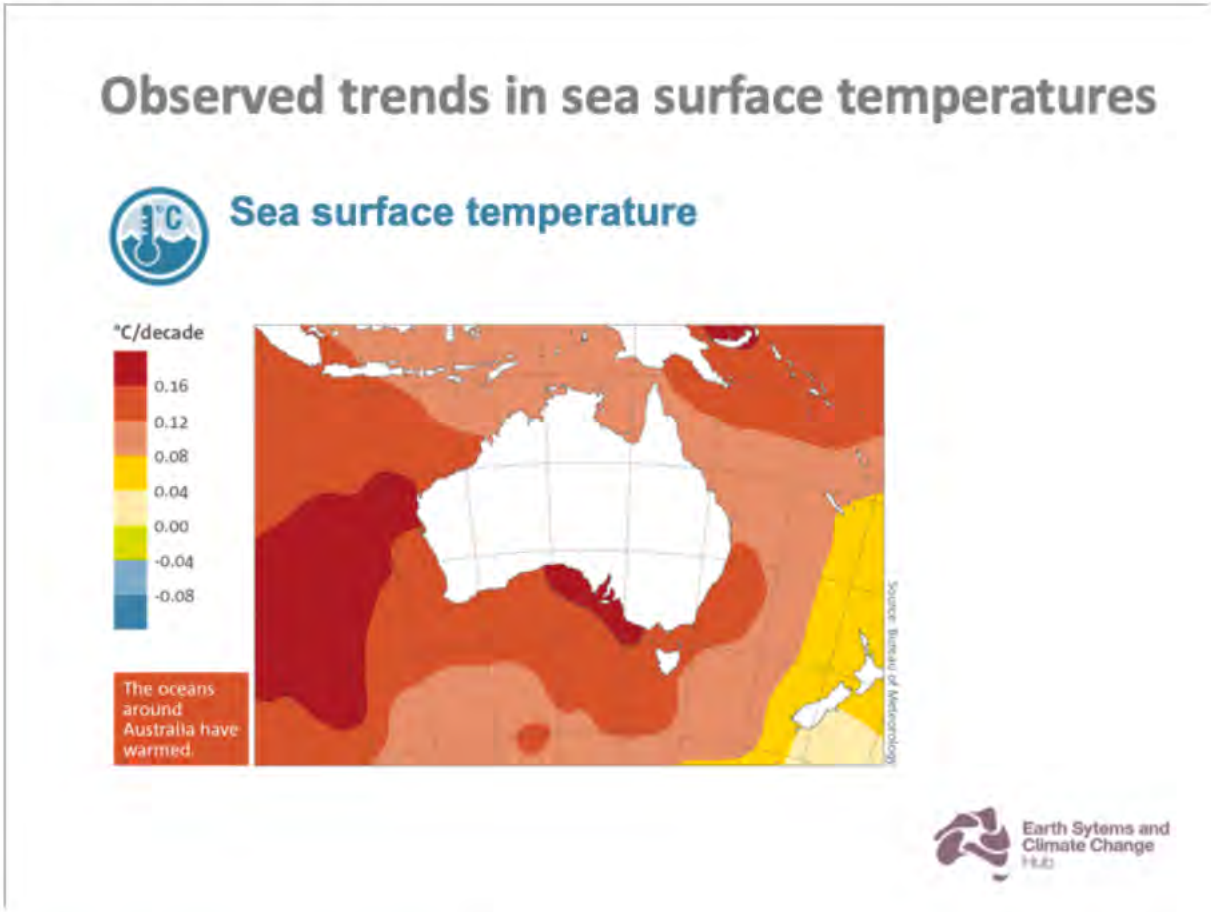


Rainfall anomalies for East Coast South NRM region



(From Climate Change in Australia East Coast Cluster report, Figure 4.3.1]

Sea surface temperature



Climate change projections

With the past no longer being a good indicator of what we can expect in the future, climate projections are useful tools for planning ahead. Climate projections are developed using global climate models, which simulate the future climate based on emissions scenarios (see *Representing emissions*, next page). They can be from an individual model, or the mean of many models (known as the multi-model mean). Projections are typically presented as averages over 20-year periods. For convenience they are referred to by the central year in the period, so projections for 2070 actually cover 2060–2079. Projections are relative to a baseline time period (e.g. 1986–2005), so if a projection was for a 2°C increase in temperature, it is relative to the baseline period and can be presented as the change between the historic and the future (e.g. an increase of 2°C), or change applied to an observational dataset (e.g. mean annual temperature of 30°C).

Climate projections are not predictions. A prediction estimates a sequence of events in the future, including the effect of climate change and variability. Given the timescale and uncertainties (such as emissions concentrations) associated with climate change, predictions are not possible. Instead, we use projections, which tell us about the response of the climate system to a possible future scenario. Climate projections do not tell us the climate of a particular day or month or predict a specific series of events, but rather how the

probabilities of climate conditions (including the changing odds of extremes) may change in our changing climate.

Global climate models

Global climate models (GCMs) are mathematical representations of the climate system based on the laws of physics. They take into account interacting processes that shape the global climate, including atmospheric dynamics and physics, oceans and sea ice, land surface processes, and aerosols, and some Earth system models also represent carbon and biogeochemical cycles. The models are very complex and run on powerful supercomputers.

GCMs have been developed in many centres around the world and are continually being improved. A global project – the Coupled Model Intercomparison Project (CMIP) – coordinates experiments and data archiving of climate model simulations. The most recent phase of this project, CMIP5, contains simulations from up to 50 models from 28 modelling centres (including ACCESS, Australia's national climate model).[10]

GCMs are tested for their ability to reproduce past climate, including mean values; seasonal cycle; major processes (e.g. ENSO). The better they are at reproducing the past, the more confidence we have in their simulations of the future.

Representing emissions

GCMs are comprised of various sub-models that interact to predict rates of global warming for different concentrations of greenhouse gases and aerosols. While the laws of physics govern the climate system, they cannot tell us about social, political and economic aspects of the future, which will have a bearing on emissions. Instead, the science community defined a set of four future scenarios called representative concentration pathways (RCPs) that represent a range of economic, technological, demographic, policy and institutional futures (Table 1).

Table 1. Summary of representative concentration pathways (RCPs)

	At the end of the century (2100)		
RCP	**CO_2 concentration***	**Radiative forcing****	**Warming*****
2.6 (ow em ss ons)	420 ppm	2.6 W m^{-2}	0.3°C to 1.7°C
4.5	540 ppm	4.5 W m^{-2}	1.1°C to 2.6°C
6.0	660 ppm	6.0 W m^{-2}	1.4°C to 3.1°C
8.5 (h gh em ss ons)	940 ppm	8.5 W m^{-2}	2.6°C to 4.8°C

* 2018 CO_2 concentrat on s 407 ppm
** Rad at ve forc ng s a measure of the energy absorbed and reta ned n the ower atmosphere; more forc ng = more warm ng.
*** G oba mean surface warm ng for 2081 2100 re at ve to 1986 2005.

[10] https://pcmd . n .gov/m ps/cm p5/ava ab ty.htm

Because of natural variability in the climate and inertia in the climate system, results from the different emissions scenarios are quite similar to 2030 – after this time, the higher the emissions, the more climate change signal is evident by 2100.

It is worth noting that these RCPs were developed prior to the Paris Agreement, so they do not align directly with the Paris targets of 1.5°C and 2.0°C (relative to pre-industrial) by 2100. However, RCP2.6 *could* be regarded as a trajectory that would arrive at around 1.5°C by 2100 – but this change is relative to 1986–2005.

Confidence in projections

Our confidence in climate change projections is determined by considering climate model results along with our physical understanding of the climate system and past observations. Confidence is higher for some projections (e.g. temperature) than others (e.g. rainfall).

It is important to recall that variability will continue, and the temperature or rainfall, say, in a particular year will be a result of climate variability, superimposed on the underlying climate trend (see figure below). In effect this means variability will be sometimes reinforcing and sometime opposing climate change. The internal variability of rainfall changes is particularly large over most Australian regions (including the Gondwana rainforests region) so it may take many years for the climate change 'signal' to emerge clearly from the year to year variability.

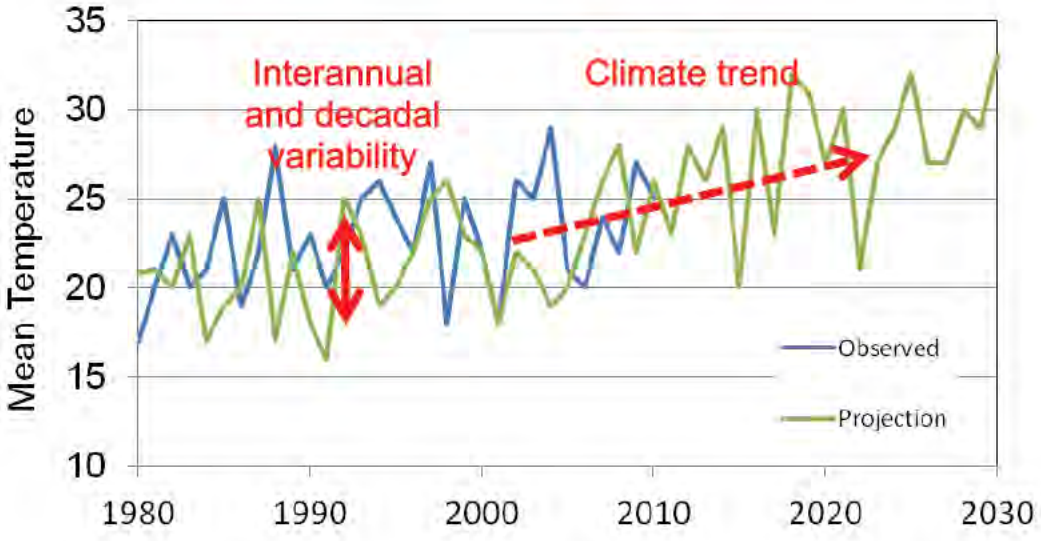
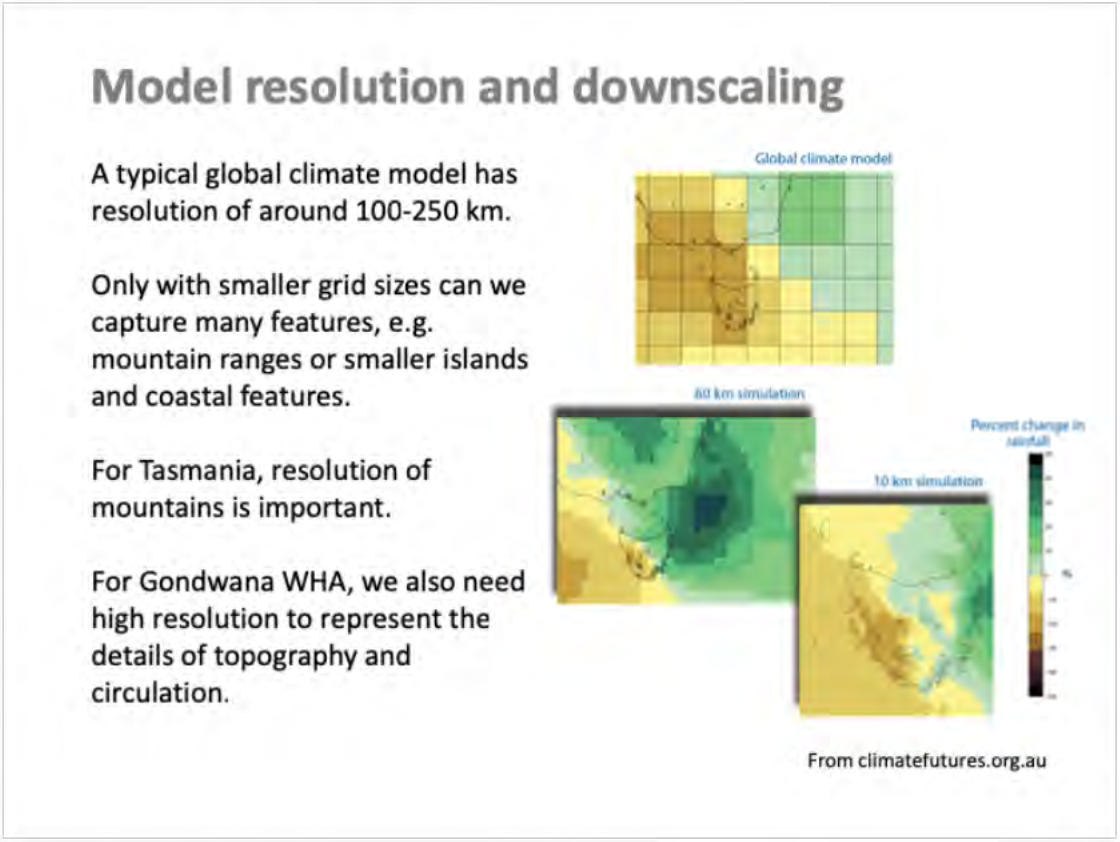


Figure 3. Confidence in climate change projections is based on the direction and size of the long-term trend, not the year-to-year variability.

Model resolution and downscaling



Future climate for Gondwana Rainforests WHA

While we do not know exactly how the future will unfold in the decades out to 2100, we can draw on climate change science to tell us what the future climate might be like.

We can use science-based climate change information to provide the evidence for developing 'climate smart' policies and plans for sectoral adaptation and disaster risk management.

Using the latest climate science and modelling, climate projections can help us plan for a smaller range of options by narrowing down the range of possible future climates.

Australia's national climate change projections

Australia's national climate change projections[11] were developed by CSIRO and the Bureau of Meteorology in 2015 for the Commonwealth Natural Resource Management funded projections project. They are reported on the basis of clusters, which correspond to the broadscale climate and biophysical regions of Australia (Figure 4). The reserves of the Gondwana Rainforests are in the East Coast cluster (both North and South sub-clusters).

[11] C mate Change n Austra a, www.c matechange naustra a.gov.au

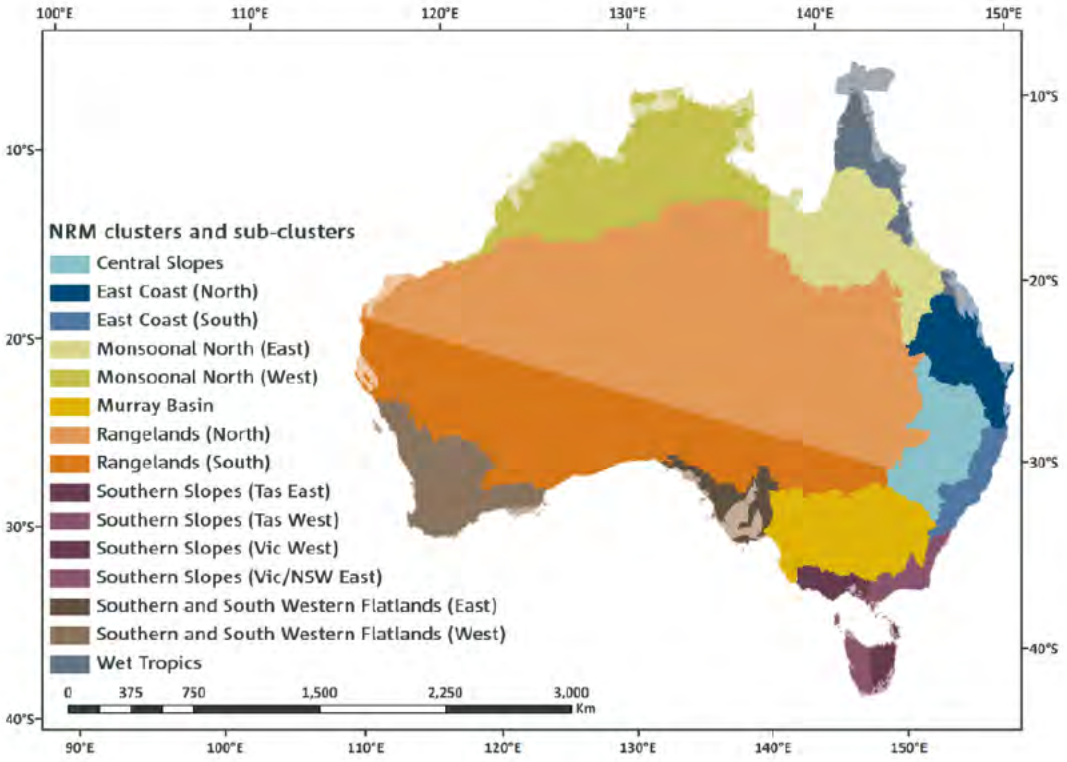
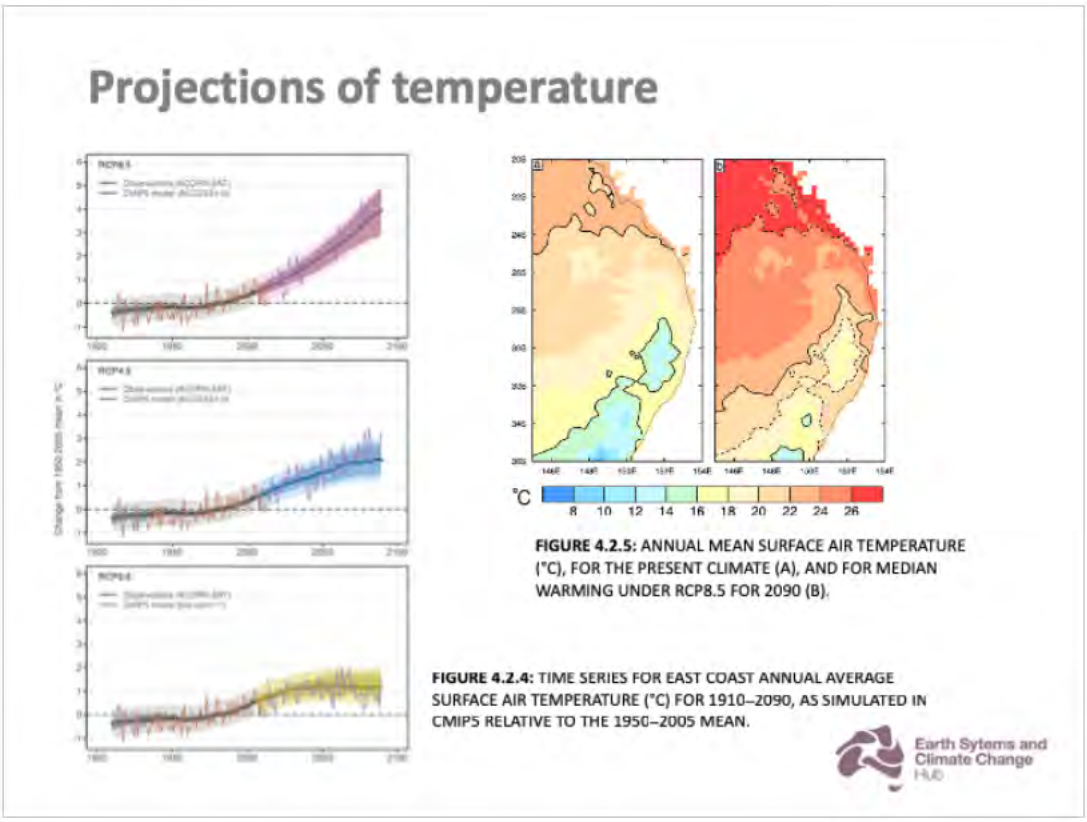


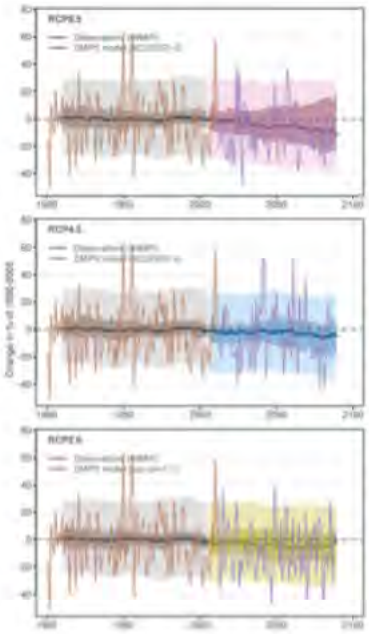
Figure 4. Clusters and sub-clusters used in Climate Change in Australia

Temperature



Rainfall

Projections of rainfall



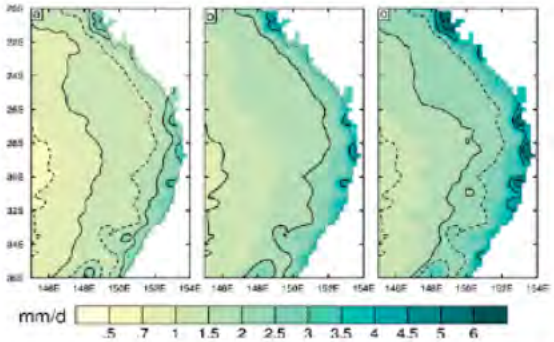


FIGURE 4.3.4: ANNUAL MEAN RAINFALL (MM/DAY), FOR THE PRESENT CLIMATE (B), AND FOR DRIER END OF THE PROJECTED MODEL RANGE (A) AND WETTER END OF THE PROJECTED MODEL RANGE (C).

FIGURE 4.3.3: TIME SERIES FOR EAST COAST ANNUAL RAINFALL FOR 1910–2090, AS SIMULATED IN CMIP5 MODELS, EXPRESSED AS A PERCENTAGE RELATIVE TO THE 1950–2005 MEAN.THE CENTRAL LINE IS THE MEDIAN VALUE, AND THE SHADING IS THE 10TH AND 90TH PERCENTILE RANGE OF 20-YEAR MEANS (INNER) AND SINGLE YEAR VALUES (OUTER).

Projections of rainfall

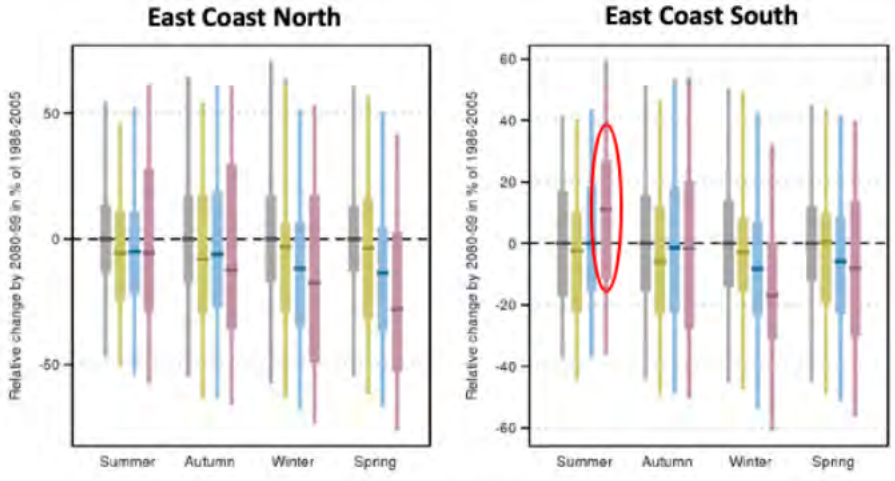


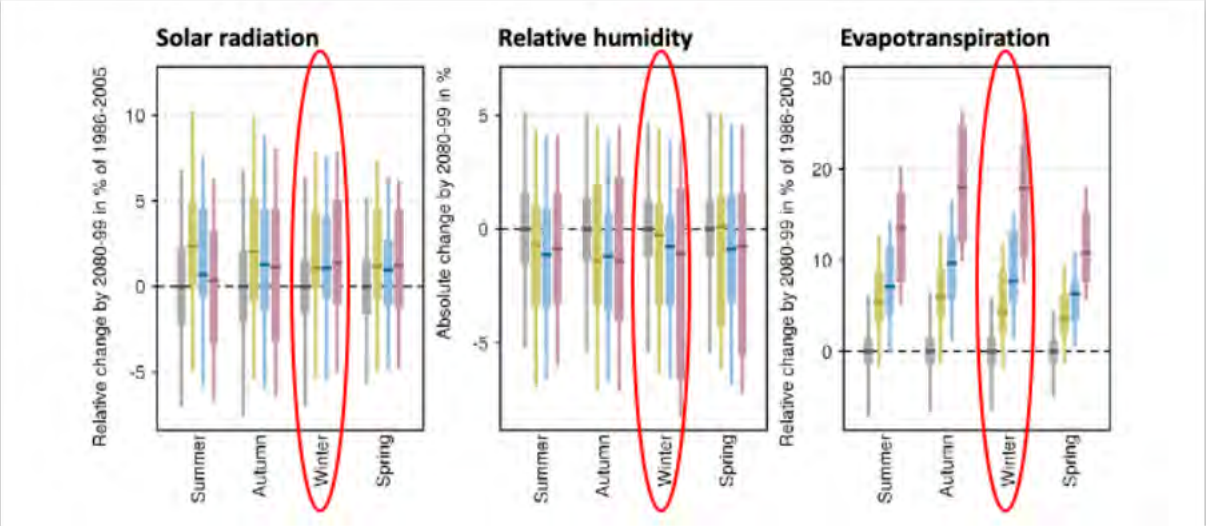
FIGURE 4.3.5: PROJECTED SEASONAL RAINFALL CHANGES. RAINFALL ANOMALIES ARE GIVEN IN PER CENT WITH RESPECT TO THE 1986–2005 MEAN UNDER RCP2.6 (GREEN), RCP4.5 (BLUE) AND RCP8.5 (PURPLE) FOR 2090.NATURAL CLIMATE VARIABILITY IS REPRESENTED BY THE GREY BAR.

Other variables

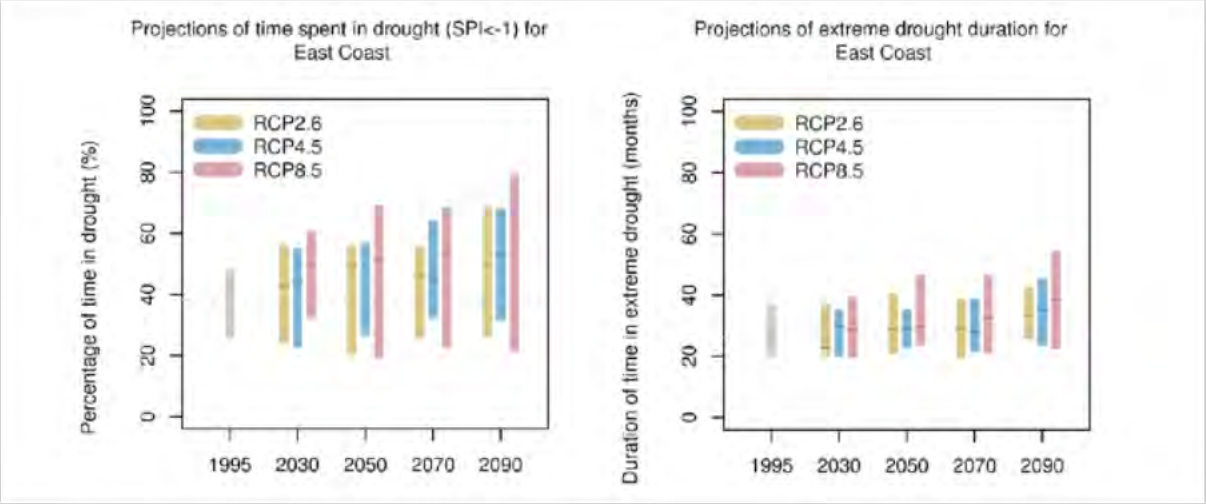
Higher surface **solar radiation** (i.e. decreased overall cloud cover)

Decreased **relative humidity** (although modest in winter)

Higher **evapotranspiration**



Increased frequency of **drought**, and longer drought duration



Climate drivers

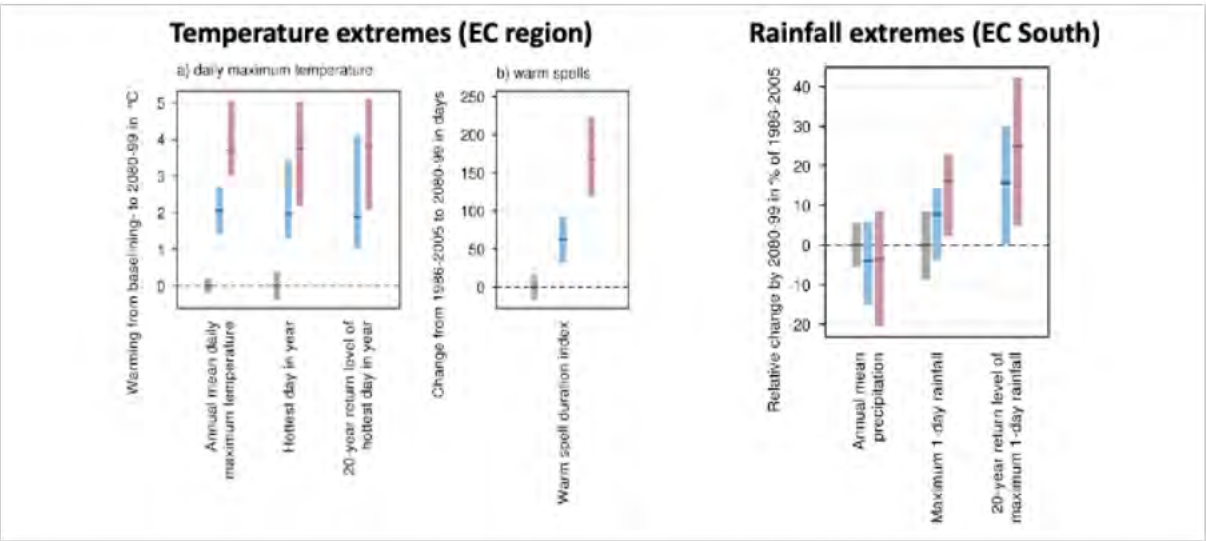
Climate models can be used to investigate how climate drivers will change in future.

Monsoons: models generally agree that rainfall variability will increase across a broad range of timescales (from daily to interannual).

Extremes

Models agree on an increase in **temperature** of the hottest days, the frequency of hot days and warm spell duration.

Heavy **rainfall** events will become more intense (even with reduction in annual mean rainfall).



Tropical cyclones are projected to occur less often, but with a greater proportion of high intensity storms (stronger winds and greater rainfall).

East coast lows are projected to occur less often but potentially be more intense when they do occur.[12]

Winter mid latitude storm systems will shift southward (hence fewer winter storms affecting the East Coast region).

Clouds

Observations and trends

Surface observer stations (Figure 5) have estimated cloud in 'octas' for many decades but:

- Station network is sparse (and the stations are some distance from the various Gondwana Rainforests reserves)
- Coverage estimate has a subjective component
- Record is incomplete
- Separate altitudinal data (high/mid/low) is not generally available.

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[12] Dowdy AJ, M s GA, T mba B, Wang Y (2014) Fewer arge waves projected for eastern Austra a due to decreas ng storm ness. *Nature Climate Change*, 4, 283–286.

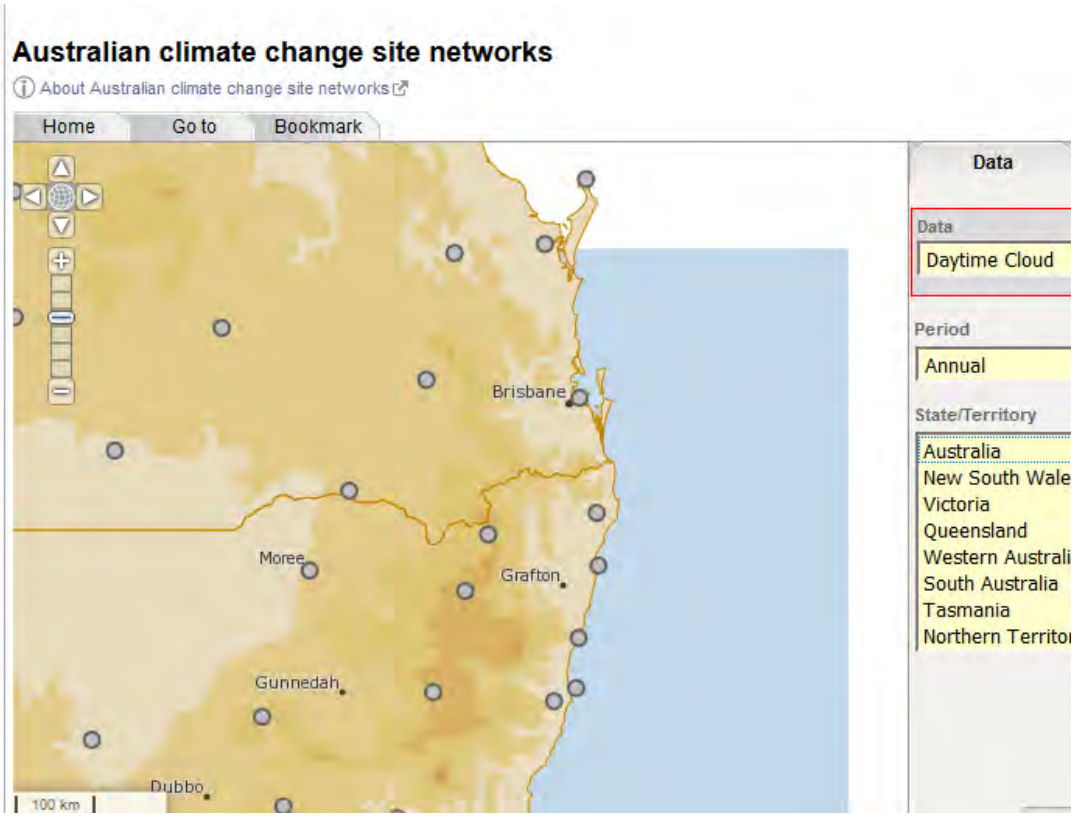

Figure 5. Surface observer stations

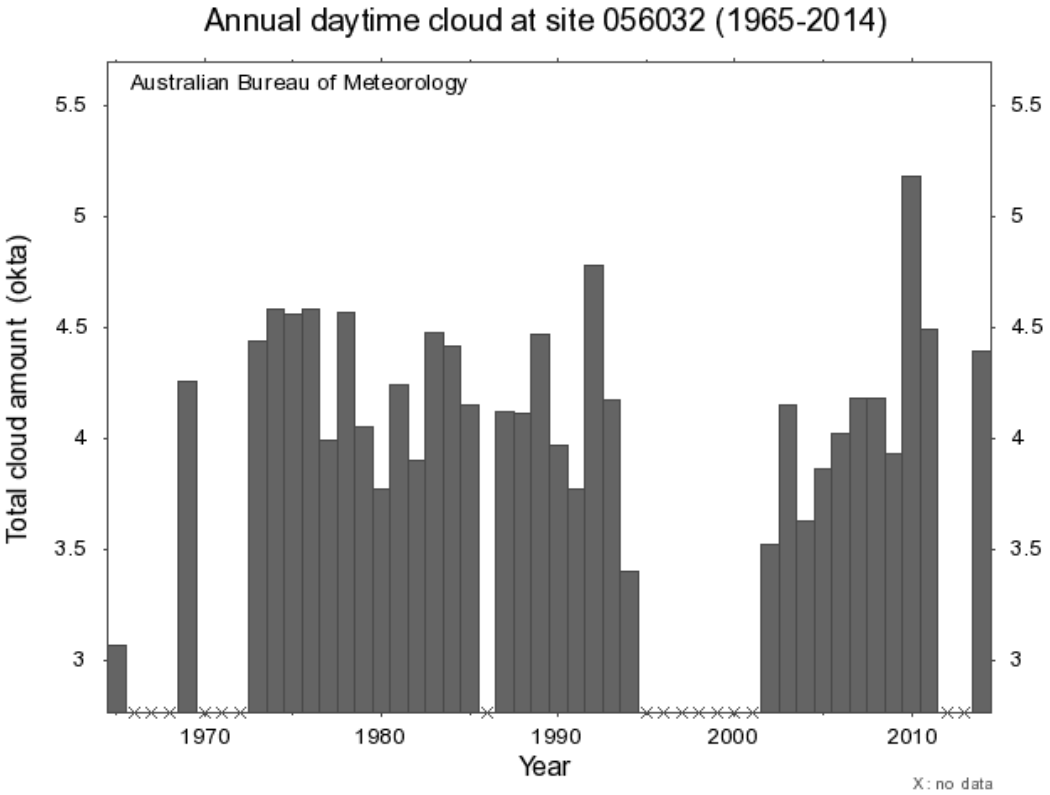

Figure 6. Annual daytime cloud at Tenterfield for the period 1965–2014.

Satellite observations also available but:

- the record is relatively short (since ~mid-1980s)
- the satellite record has issues of drifts in calibration, changes in satellites, orbital drifts, day/night
- low clouds can be obscured by higher-level clouds.

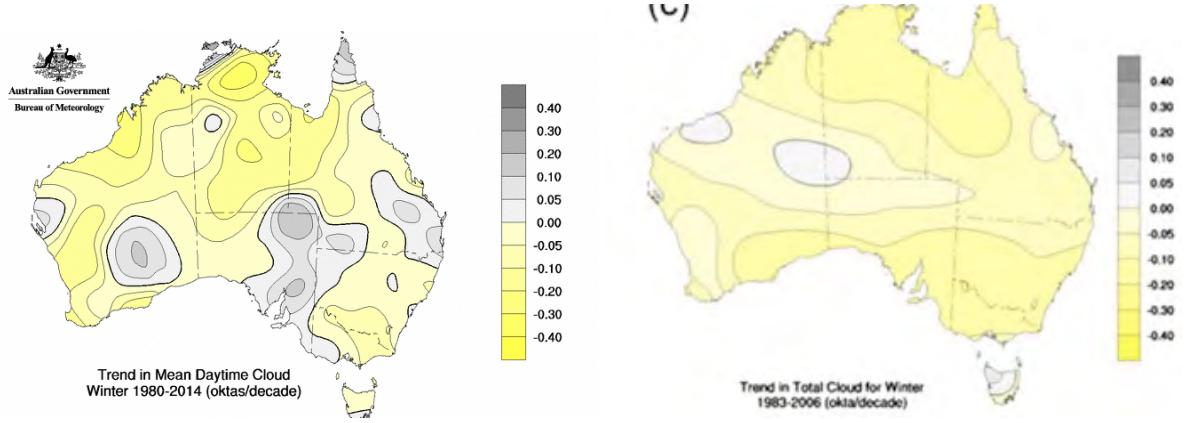

Figure 7. Cloud trends based on surface observations (left) and satellites (right)

Cloud caps

Cloud caps are caused by moist air lifting over mountains. The cloud base forms around height of lifting condensation level (LCL). Low cloud is also caused by other processes (e.g. boundary layer mixing), some of which is poorly understood.

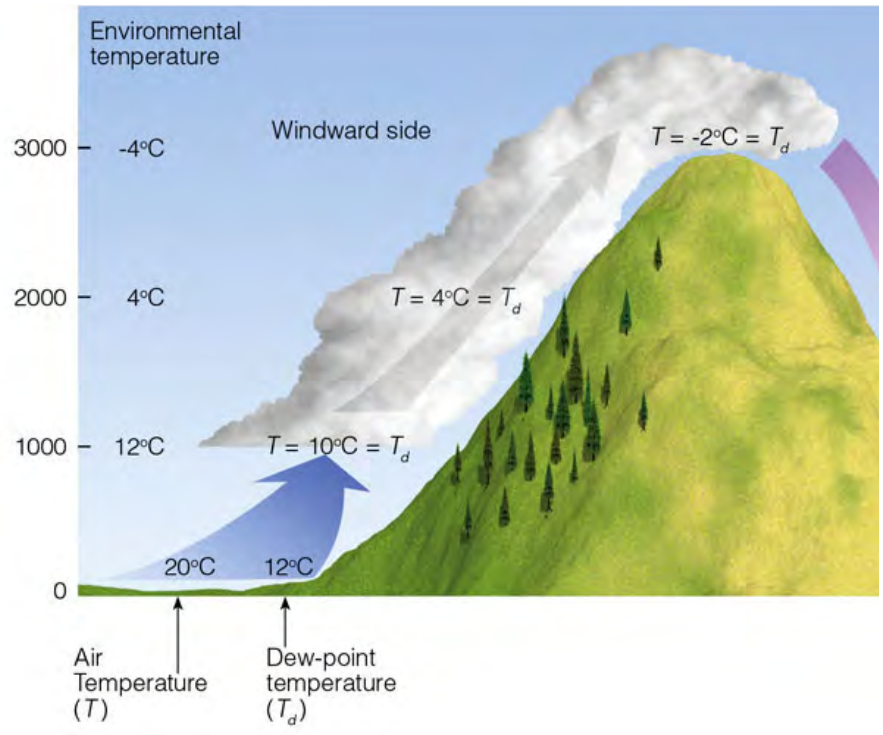

Figure 8. Cloud cap formation

Low cloud projections

Clouds are one of the key uncertainties in climate model simulations and projections. Low cloud projections in particular contain significant uncertainties because:

- clouds are not explicitly represented ('resolved') in climate models as they are too small to be 'seen' by the grid (~100 km across) – this means they must be represented indirectly from large scale temperature, moisture and wind fields ('parametrisations')
- mountain ranges such as the Great Dividing Range are also only coarsely represented in global models (as the mountains are too low and broad)
- cloud formation processes are still not well understood (observations are difficult, and clouds vary in complex ways on small scales).

This makes it difficult to configure parametrisations in the first place, and to then evaluate them. We have more trust in:

- large-scale processes in models, like 'synoptic' scale circulations (e.g. monsoon circulations, trade winds, mid-latitude highs and lows, locations of high and low pressure, regions of large-scale convergence)
- processes driven by physics that is well understood (e.g. increased water holding capacity of warmer air, land/sea surface differences, energy constraints on the system)
- changes where the various models show strong agreement (i.e. despite their different formulations and parametrisations) – this includes some broad scale cloud changes.

→ Cloud changes *partially* fall into these categories.

What do projections suggest for low cloud changes?

Models generally indicate:

- reduced low clouds in the tropics and subtropics – although very widely found, this is still not well understood as no single process dominates changes in cloud formation → *confidence only limited*
- reduced relative humidity over land – due to land warming faster than oceans. This is universally found in models and relatively well understood → *confidence high, but regional details will matter, e.g. close to the coast the effect is smaller as it warms less than inland.*

→ This suggests decreases in low cloud fraction, and increased cloud base height.

Some additional factors

Will the clouds that do form have higher moisture content as the air is warmer?

Intuitively yes, but the evidence from models and observations is mixed, suggesting this may not be a strong effect

Will wind strength changes occur, and will this impact on clouds?

A general slowing of tropical/sub-tropical circulations is expected. However, the impact on cloud caps is unknown

What about local effects such as sea-breezes, local circulations, etc?

These are not 'resolved' by climate models, so high resolution modelling (downscaling) is needed. There is currently relatively little information on this

What will happen to ENSO and its effects on the region?

Not certain. We know ENSO will continue, but changes to its frequency, strength or impacts are less clear. This is the subject of ongoing study.

Will evapotranspiration change?

Yes, evaporative demand increases in a warmer climate, but evaporation also depends on stability, water availability, wind speed and humidity – confidence very high of increase, but projected range varies

Will fire regimes change?

Increased bushfire risk due to higher temperatures and lower rainfall (30% increase in summed FFDI by 2090 under RCP8.5)

Have international climate assessments (e.g. IPCC) considered cloud cap/cloud base changes and their impacts?

Very little. The focus has been on oceanic cloud because of its strong impact on global energy balance.

Climate change information

Climate change information needs for the Gondwana Rainforests WHA

Gaps in the existing projections

- Current projections are not specific to the Gondwana Rainforests WHA (the East Coast North/South clusters are too large and do not cover homogenous climate region)
- Existing downscaled projections disagree on sign of rainfall changes
- Some of the relevant climate variables for changes in Gondwana Rainforests forest conditions are not available e.g. cloud base height, although it may be possible to infer cloud base height from other variables – for example lifting condensation level may be approximated from large scale variables of relative humidity and temperature.

What more could be done?

- (Updated) projections information specific to the Gondwana Rainforests WHA
- Additional specific process-related variables and understanding e.g. relating to LCL, rainfall, cloud cover and cloud base
- Targeted downscaling to provide high resolution projections
- Additional variables could be obtained for e.g. vegetation modelling
- Consider projections in terms of likelihood of crossing certain key thresholds for given emissions scenarios.

Climate information available for impact assessment

Discussions at the workshop made it clear that stakeholders/managers want information about how cloud base height and moisture transport associated with horizontal (occult) rainfall will change in future, as this is crucial to the diversity of flora and fauna in the upland rainforests. Today, there is an important threshold around 700–900 m above sea level associated with the current level of the cloud base.[13]

The ESCC Hub already has some climate projections data that is suitable to explore climate change impacts on the montane rainforests of the World Heritage Area. Additional data and information should be available by the end of 2020, after additional research and evaluation has been undertaken.

[13] La d aw MJ, McDona d WJF, Hunter RJ, Put and DA and K tch ng RL (2011) The potent a mpacts of c mate change on Austra an subtrop ca ra nforest. *Australian Journal of Botany*, 59, 440–449.

Currently available

Projections of seasonal means for air surface temperature and rainfall under a high (RCP8.5) and lower (RCP4.5) emissions scenario for a region covering the Tweed caldera.

This information would be from global climate model data (where grid cells are 200 km across).

Available by December 2020

Lifting condensation level (LCL) projections

LCL is a critical variable for cloud caps and can potentially serve as a proxy for cloud base height. Unlike the temperature and rainfall data, which are 'simply' extracted from datasets, LCL is a derived variable that will require some processing and research.

Cloud cover projections

Cloud cover (i.e. fraction) throughout the vertical column can be extracted directly from global climate models (with some processing to allow for differences in the way different models define cloud levels, and for a smaller number of models than for other fields). There are limitations on the confidence in representing clouds in models, and the processes determining low clouds are different in GCMs from the 'lifted parcel' cloud caps that occur in the real world are critical in the Gondwana Rainforests. This is because GCMs do not represent the mountains of the Great Divide well, and cloud processes contain uncertainties and approximations. Nevertheless, it may be worth examining the cloud changes in the bottom layers (e.g. 1000 hPa to 850 hPa layer) of the models, to at least (i) quantify what the GCMs project and (ii) determine the consistency with other fields. Preliminary work suggests that on average the GCMs project a decrease in cloudiness in the lower layers. More research is needed to deliver these, and climate models need to be evaluated.

Downscaled projections

Downscaled data allows for projections across smaller grid cells (i.e. higher resolution) and also has the potential to reveal regional details, such as the effects of mountain ranges. However, downscaled projections require more resources (computer and human) to produce than projections using GCM data. Downscaled data for the region of interest is available, but it is yet to be fully assessed and evaluated.

Next steps

ESCC Hub case study

In February 2019 the Hub met with representatives from the managing agencies for the Gondwana Rainforests WHA to determine the scope for ongoing collaboration between the Hub and the Gondwana Rainforests WHA managers.

The needs of the Gondwana Rainforests WHA were discussed in light of the available data, and it was decided there was value in carrying out a case study to assess the impact of climate change on cloud caps and cloud forests in the Gondwana Rainforests WHA. At this meeting it was noted that cloud projections generated in the case study would also be of benefit to the agriculture sector on the tablelands along the length of the eastern seaboard.

The case study will focus on the region covered by the Border Ranges Rainforest Biodiversity Management Plan. The Hub will provide projections for temperature, rainfall and LCL for 2030 (2020–2039)[14], 2050 (2040–2059) and 2070 (2060–2079) under high (RCP8.5) and lower (RCP4.5) emissions scenarios.

Dry season moisture stress is another variable of interest to the Gondwana Rainforests WHA. Projections for this variable may fall outside the scope of this case study.

Adaptation planning

The Gondwana Rainforests Management Committee will continue to investigate adaptation planning for the World Heritage area within their jurisdictions. Opportunities to coordinate and share information and learnings between jurisdictions will be investigated and optimised. Input and advice from the Gondwana Rainforests advisory committees shall be sought as projects and programs are developed, including identifying knowledge gaps along the way.

[14] Not ng that current va ues-based p ann ng for reserves s on a 5–10-year t me hor zon.

Appendix 1: Workshop agenda

AGENDA

Monday, 8 October 2018

University of Queensland
Global Change Institute, Level 2, Building 20, Staff House Rd
St Lucia, QLD 4067

Item	Description	Responsible	Time (mins)	Start
1.	Welcome: Introductions	Chair: Mandy Hopkins Roundtable	30	09.30
2.	QLD Government – Climate Change	Moira Rice	30	10.00
3.	Overview of the Gondwana Rainforests of Australia World Heritage area and the outstanding universal values	Tricia Waters	30	10.30
	Morning tea break		30	11.00
4.	The potential impacts of climate change on Australian subtropical rainforest	Melinda Laidlaw	30	11.30
5.	Title to be confirmed	Andrew Baker/Di Fisher TBC	30	12.00
6.	Title to be confirmed	Ian Gynther TBC	30	12.30
	Lunch		30	13.00
7.	Climate Change in the region and the outcomes of the literature review	Jo Brown – ESCC Hub	30	13.30
8.	Downscaled projection data	Jozef Sytkus	30	14.00
9.	Discussion and next steps for the case study	Led by Rob Colman and Jo Brown	90	14.30
	Working afternoon tea – get up stretch get a coffee			15.00
10.	Meeting close			16.00

Appendix 2: Workshop participants

NAME	ORGANISATION	EXPERTISE
Dr Rob Colman	NESP ESCC Bureau of Meteorology	Climate Scientist
Dr Jo Brown	NESP ESCC Bureau of Meteorology	Climate Scientist
Ms Mandy Hopkins	NESP ESCC CSIRO	Knowledge Broker
Mr John Clarke	NESP ESCC CSIRO	Team Leader – Regional Projections
Ms Tricia Waters	Gondwana Rainforests of Australia World Heritage Area	Executive officer
Dr Melinda Laidlaw	Queensland Herbarium	Senior Ecologist
Dr Di Fisher	University of Queensland	
Dr Jozef Syktus	University of Queensland	Regional Projections
Dr Ralph Trancoso	University of Queensland	Regional Projections
Dr Michael Mahoney		
Dr Bill MacDonald		
Dr Ian Gynther		

Earth Systems and Climate Change Hub

National Environmental Science Programme

www.nespclimate.com.au

WORKSHOP SUMMARY

Earth Systems and Climate Change Hub

National Environmental Science Programme

Climate change impacts on the Gondwana Rainforests of Australia

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The Gondwana Rainforests of Australia World Heritage Area is one of 19 listed World Heritage properties in Australia.

Extending across 40 reserves on Australia's east coast, the property is recognised by UNESCO for its examples of major stages of the Earth's evolutionary history, ongoing geological and biological processes, and exceptional biological diversity.[1]

The changing climate poses a threat to the unique habitats in the WHA and to the species that live there.

The Earth Systems and Climate Change Hub is working with the people responsible for managing the reserves to understand how climate change will impact the World Heritage Area.

1. Gondwana Rainforests of Australia Statement of OUV, https://whc.unesco.org/en/list/368

The workshop

In October 2018, a workshop was convened in Brisbane at the University of Queensland to bring experts from key agencies together to discuss available climate change projections for the Gondwana Rainforests of Australia World Heritage Area (Gondwana Rainforests WHA) and identify specific data needs for ongoing climate change adaptation planning.

Gondwana Rainforests of Australia World Heritage Area

The Gondwana Rainforests WHA is a serial World Heritage property containing 40 separate reserves within north-east New South Wales and south-east Queensland. Covering more than 366,000 hectares, the rainforests comprise warm temperate, cool temperate, subtropical and dry rainforests similar to those that covered the ancient supercontinent Gondwana. The rainforests are biodiversity hot-spots and are home to many rare and threatened plants and animals.

On-ground management of the Gondwana Rainforests WHA is largely by the NSW National Parks & Wildlife Service (part of the NSW Office of Environment and Heritage) and Queensland Parks & Wildlife Service (part of the Queensland Department of Environment and Science). The Queensland Department of Environment and Science (DES) have developed a Biodiversity and Ecosystems Climate Adaptation Plan, designed to facilitate the adaptation of Queensland's biodiversity and ecosystems to the effects of climate change.

Climate change has been identified as a threat to the integrity of the Gondwana Rainforests WHA. Changes in temperatures and rainfall are likely to directly affect already restricted cool, moist habitats. Changes in fire regimes and severe storm events, coupled with changes in competition from pest species, are likely to further impact these habitats and the plants and animals that live there.

The **Earth Systems and Climate Change Hub** is funded by the Australian Government's National Environmental Science Program

Climate change

Climate change refers to long-term changes in the average pattern of weather that occur over decades, centuries or longer. Climate variability, for example, due to the El Niño Southern Oscillation, occurs at shorter timescales of years to decades, while weather occurs on the timescale of hours to days.

Climate change projections are not predictions, but they tell us about the response of the climate system to possible future scenarios. Our confidence in projections is determined by considering climate model results along with our physical understanding of the climate system and past observations.

Climate projections for the broarder Gondwana Rainforests region include:

- increased average temperatures in all seasons (very high confidence)
- more hot days and warm spells with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (very high confidence)
- a possible modest decrease in rainfall that is strongest in winter and modest incease in summer rainfall in the northern part of the region – but there is low confidence in these projections due to a very large spread of increases to decreases across climate models.
- increased severity of extreme rainfall events
- higher surface solar radiation (i.e. decreased overall cloud cover)
- decreased relative humidity (although modest in winter)
- higher evapotranspiration.

Changes projected generally increase for higher emissions scenarios and for further out in the century.

Detailed climate change projections are available at climatechangeinaustralia.gov.au – Gondwana Rainforests are in the East Coast cluster (both North and South sub-clusters).

The importance of cloud for the Gondwana Rainforests WHA

In high elevation forests, water from cloud and fog provides up to half of the annual vegetation water requirements.

The shifting of the cloud base up or down the mountains associated with climate change will have important implications for the management of these forests and the fauna that lives in them.

For this reason, cloud projections are of particular interest to managers.

Next steps

The Hub will is working with Gondwana Rainforests WHA managers to assess the impact of climate change on cloud cover in the region covered by the Border Ranges Rainforest Biodiversity Management Plan.The case study will be carried out in 2019–20.

The Gondwana Rainforests Management Committee will continue to investigate adaptation planning for the World Heritage area within their jurisdictions. Opportunities to coordinate and share information and learnings between jurisdictions will be investigated and optimised. Input and advice from the Gondwana Rainforests advisory committees shall be sought as projects and programs are developed, including identifying knowledge gaps along the way.

The full report from this workshop is available on the Earth Systems and Climate Change Hub website at www.nespclimate.com.au.

For more information on the ESCC Hub's work in Gondwana Rainforests WHA, please contact Hub Knowledge Broker, Mandy Hopkins on 03 9239 4649 or mandy.hopkins@csiro.au.

WORKSHOP SUMMARY

Earth Systems and Climate Change Hub

National Environmental Science Programme

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Climate projections for the broarder Gondwana Rainforests region include:

- increased average temperatures in all seasons (very high confidence)
- more hot days and warm spells with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (very high confidence)
- a possible modest decrease in rainfall that is strongest in winter and modest incease in summer rainfall in the northern part of the region – but there is low confidence in these projections due to a very large spread of increases to decreases across climate models.
- increased severity of extreme rainfall events
- higher surface solar radiation (i.e. decreased overall cloud cover)
- decreased relative humidity (although modest in winter)
- higher evapotranspiration.

Changes projected generally increase for higher emissions scenarios and for further out in the century.

Detailed climate change projections are available at climatechangeinaustralia.gov.au – Gondwana Rainforests are in the East Coast cluster (both North and South sub-clusters).

The importance of cloud for the Gondwana Rainforests WHA

In high elevation forests, water from cloud and fog provides up to half of the annual vegetation water requirements.

The shifting of the cloud base up or down the mountains associated with climate change will have important implications for the management of these forests and the fauna that lives in them.

For this reason, cloud projections are of particular interest to managers.

Next steps

The Hub will is working with Gondwana Rainforests WHA managers to assess the impact of climate change on cloud cover in the region covered by the Border Ranges Rainforest Biodiversity Management Plan.The case study will be carried out in 2019–20.

The Gondwana Rainforests Management Committee will continue to investigate adaptation planning for the World Heritage area within their jurisdictions. Opportunities to coordinate and share information and learnings between jurisdictions will be investigated and optimised. Input and advice from the Gondwana Rainforests advisory committees shall be sought as projects and programs are developed, including identifying knowledge gaps along the way.

The full report from this workshop is available on the Earth Systems and Climate Change Hub website at www.nespclimate.com.au.

For more information on the ESCC Hub's work in Gondwana Rainforests WHA, please contact Hub Knowledge Broker, Mandy Hopkins on 03 9239 4649 or mandy.hopkins@csiro.au.

FOI 190505
Document 14

From: s47F
Subject: A statement from the Board of the Wet Tropics Management Authority
Date: Monday, 29 April 2019 4:48:37 PM
Attachments: image001.png
A statement from the Board regarding climate change - signed.pdf

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Dear all,

Please see attached, a statement from the Wet Tropics Management Authority Board which will be distributed this afternoon highlighting the threat that climate change poses to the World Heritage Area. The Board will also be releasing a media statement to accompany this material for tomorrows media. Please see below the full message from our Chair, Leslie Shirreffs (my apologies for earlier posting):

> The Board of the Wet Tropics Management Authority has released the attached Statement to bring to attention new evidence of escalating impacts on the Wet Tropics of Queensland World Heritage Area from climate change.
>
> Climate change adaptation and mitigation to protect the Wet Tropics World Heritage Area is a top priority of the Board and, consequently, the Authority is well advanced in the development of a Climate Adaptation Plan. However, after the hottest summer ever, new evidence has indicated that the trends are worsening and that there is likely to be extinctions of some species from their known strongholds in the very near future.
>
> The Wet Tropics World Heritage Area is very well researched and monitored which allows this assessment to be presented. It can be assumed that tropical forests and ecosystems around the world are similarly impacted or worse.
>
> The Board has agreed that, with new evidence showing the accelerated decline of key species, the situation is dire and action must be urgently taken to build the resilience of the Area, as well as strong action on reducing emissions globally.
>
> It is recognised that, based on current emissions, we are effectively 'locked' into 20 years of increasing temperatures. Urgent action to minimise threats locally will ensure the Wet Tropics World Heritage Area is as robust as possible to withstand increasing temperatures.
>
> At a special out-of-session meeting the Board decided to bring the challenges facing the property to a wider audience. The Board is optimistic that urgent collaboration and investment in a range of activities and actions will assist in building the resilience of the world's oldest living rainforest. Australia has the resources and expertise to be a leader in responding local climate change challenges.
>
> Please feel free to circulate this to your networks. Should you require any further information, please contact s47F, and a member of the Board will be in touch.
>
> Yours sincerely,
>
> Leslie Shirreffs PSM
>
> Chair, Wet Tropics Management Authority

Please note that the above message and attachment will also be distributed to the relevant Queensland and Australian Environment Ministers.

Regards

s47F

| Executive Director

Wet Tropics Management Authority

s47F

wettropics.gov.au | PO Box 2050, CAIRNS, QLD 4870

Ground floor, Cairns Port Authority, cnr Grafton & Hartley streets

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A statement from the Board of the Wet Tropics Management Authority regarding serious climate change impacts on the Wet Tropics of Queensland World Heritage Area

Concerning new evidence has shown an accelerating decline in the Wet Tropics of Queensland World Heritage Area's unique rainforest animals as a result of climate change.

The Board of the Wet Tropics Management Authority (the Board) has now become aware that, following the hottest summer ever recorded, some of the key species for which the Wet Tropics World Heritage Area was listed are at imminent risk of extinction.

The Wet Tropics World Heritage Area is the world's oldest rainforest and land of the world's oldest living culture. It is ranked by the International Union on the Conservation of Nature as the second most irreplaceable World Heritage Area on earth, and the sixth most irreplaceable protected area, largely because of its endemic species. It provides economic benefits to the region of more than $5.2 billion per annum, significantly through visitation and tourism which enables people to experience and understand this important tropical wonder.

Climate change was identified as the most significant threat to the Wet Tropics in the *2015-16 State of the Wet Tropics Report on ancient, endemic, rare and threatened vertebrates of the Wet Tropics* (the Report). Based on long term monitoring, the Report identified that the biodiversity of the Wet Tropics World Heritage Area was declining with many rainforest species already reduced in both distribution and population size, largely as a result of climate change.

Professor Steve Williams from the Centre for Tropical Environment and Sustainability Science at James Cook University, and co-author of the Report, has been monitoring rainforest biodiversity for over 20 years across the whole Wet Tropics region. The long-term monitoring of the rainforest vertebrates conducted by Prof Williams has observed a systematic decrease in the abundance and distribution of many Wet Tropics endemic species. Normally found at elevations over 600 metres, these cool adapted species have progressively moved to higher elevations, leaving alarming population declines at the lower elevation areas of their distribution.

The lemuroid ringtail possum, a species for which the Wet Tropics World Heritage Area is renowned, has been steadily declining now for more than a decade. Prof Williams' recent monitoring has identified that the declines in possum and bird species have continued at a rate similar to the predictions made more than a decade ago and are now reaching alarming levels. If the trends continue, populations at sites that previously had the highest density of lemuroid ringtail possums in the region could become locally extinct as early as 2022. This species is currently not even classified as endangered.

There are similar trends for species such as the Herbert River ringtail possum and green ringtail possum, as well as bird species such as the tooth-billed bowerbird—species which only occur in the Wet Tropics World Heritage and for which it was World Heritage listed.

A model, using 400,000 data points collected over the past 10 years, predicted that the World Heritage Area could be facing the extinction of more than half of its endemic species by the end of this century. The latest rates of decline suggest that these extinctions are happening even sooner.

Since its appointment in 2015, the Board made it a key priority to pursue climate change adaptation and mitigation strategies to protect the Wet Tropics World Heritage Area. In June this year it will release a draft Climate Adaptation Plan, informed by the best available science. However, given the gravity of the new evidence, the Board feels that decisive action is needed now.

The 2017 International Union on the Conservation of Nature Outlook Report on the Wet Tropics also cautioned that "The Wet Tropics of Queensland World Heritage Area is particularly vulnerable to the impacts of climate

change. Climate change threatens to disrupt the finely balanced ecological and climatic conditions that support the distinctive assemblage of plants and animals and may result in rapid and catastrophic changes."

These scenarios are increasingly proving true, not only here but around the world, with measurable and rapidly growing impacts from climate change being experienced. In the Wet Tropics World Heritage Area this is exacerbated by introduced pests like pigs and myrtle rust also gaining access to higher altitudes due to a warming climate. Strong intervention is required immediately to secure the future of the Wet Tropics World Heritage Area.

While, understandably, the Great Barrier Reef has received significant funding to address climate change impacts in recent years, investment in terrestrial World Heritage Areas has not been commensurate with the urgency for mitigating climate impacts on their World Heritage values.

Extreme heat is the Wet Tropics World Heritage Area's coral bleaching event equivalent, with some mountain adapted species, like the lemuroid ringtail possum, unable to survive even a day of temperatures above 29 degrees Celsius. Mount Bartle Frere, (the highest mountain in the Wet Tropics), recorded an unprecedented 39 degrees Celsius at its peak on six days this past summer.

The Board is convinced that, given the evidence, these key species endemic to the Wet Tropics World Heritage Area are under severe and immediate threat from climate change. This is occurring now, not in the future, and requires an immediate response. With current trends, the world is locked into 20 years of increasing temperatures. Action and significant investment is needed to reduce other threats now to ensure these areas are as robust as possible to withstand those increasing temperatures.

Australia has the resources and expertise to be a leader in responding to local climate change challenges. The Board is optimistic that the measures listed below will improve the resilience of the Wet Tropics World Heritage Area's internationally significant values, together with strong global action to reduce emissions.

The World Heritage Convention is about protection, conservation and presentation of World Heritage areas—but it is also about transmission of these values to future generations. The Board is determined to meet this obligation but it will take considerable effort, across all sectors, all governments and all people who cherish the best of the best natural and cultural significant areas Australia has to offer.

Action is needed now, before it is too late.

Signed:

Ms Leslie Shirreffs PSM, Chair

Prof Iain Gordon, Director

Dr Leah Talbot, Director

Mr Phil Rist, Director

Mr John Courtenay, Director

Ms Anne Clarke, Director

Climate change in the Wet Tropics: a 10-point plan

A statement from the Board of the Wet Tropics Management Authority regarding serious climate change impacts on the Wet Tropics of Queensland World Heritage Area

Urgent action and investment from governments is needed to improve the resilience and protection of the Wet Tropics of Queensland World Heritage Area. Such actions include

1. **Land restoration**. Enhance resilience through restoration and enhancement of wildlife corridors and buffering of refugia.
2. **Monitoring.** Re-initiate and expand monitoring to increase information of the impacts on World Heritage Values / Outstanding Universal Value and identify potential refugia.
3. **Pest management**. Immediate and aggressive control of feral pigs and myrtle rust to prevent spread into the higher altitude refugia.
4. **Research and innovation**. In-depth assessment of possible measures, examples could include biobanking, genetic editing or potential for *ex-situ* conservation (e.g. captive breeding) and assisted migration in collaboration with Rainforest Aboriginal Peoples.
5. **Threatened species listing**. Urgent discussions with relevant agencies to nominate at risk species and ecosystems for listing under the Australian threat lists (Nature Conservation Act, Environmental Protection and Biodiversity Conservation Act, IUCN).
6. **Fire**. Assess vulnerability and reduce threats from increased risk to rainforests from fire.
7. **Partnerships and engagement**. Rainforest Aboriginal peoples, the tourism industry and the community to collaborate in the response.
8. **Cooperation**. Work with the Australian World Heritage Advisory Committee (AWHAC) and other Queensland terrestrial world heritage properties on cooperative research and responses.
9. **Climate Adaptation Plan.** Finalise the Wet Tropics Climate Change Adaptation Plan as a matter of urgency.
10. **Mitigation**. Call for urgent action on reducing global emissions.

Climate change in the Wet Tropics: a 10-point plan

Key Elements of the 10-point Plan

1. **Land restoration**. Although the Wet Tropics World Heritage Area is largely intact, there remain some areas of fragmentation, degradation and competing land uses that limit the connectivity of habitat and prevent transition of species to suitable areas. Species habitat mapping also identified significant areas, external but adjacent to the World Heritage Area, that are critical to species movement and require rehabilitation to operate effectively as corridors. A Wet Tropics World Heritage Restoration Program will deliver a cross tenure program of on-ground actions to increase resilience, reduce emissions, reconnect habitat and provide social, environmental, cultural and economic co-benefits, particularly for World Heritage values, environmental services, adjacent landholders and Traditional Custodians.

   Action: Establish a landscape level restoration program to be delivered primarily by on-country Indigenous Land and Sea Rangers and in partnerships with land managers. Conservation agreements and strategic acquisition may be pursued to enhance resilience, augment wildlife corridors, buffer refugia and secure carbon abatement. ***Est. Cost $15,000,000 over 3 years.***

2. **Monitoring**. The Wet Tropics World Heritage Area has been fortunate over its 30 years to have a highly professional scientific community conduct wide ranging research and monitoring activities. This has assisted in preparing regular State of the Wet Tropics reports and supported management activities. However, funding for monitoring effectively ended in 2016, although some opportunistic monitoring by committed scientists and students has continued sporadically. While there is information known about a small selection of well-researched sites, the overall state of the Wet Tropics environment and the effects of changing climactic conditions is not well known. An effective response requires comprehensive monitoring of key values across at-risk areas to better understand and effectively address impacts.

   Action: Re-initiate and expand monitoring to increase information of the broader impacts of climate change on World Heritage Values and identify potential refugia. ***Est. Cost: $750,000 over 3 years***.

3. **Pest management**. Recent consultation with a wide community of interest has exposed growing concern about the threat and damage being observed by a growing feral pig problem across the Wet Tropics World Heritage Area. This is not the only introduced pest likely to become more widespread as temperatures warm – weeds like miconia and Koster's curse, diseases like myrtle rust and invasive species like Yellow Crazy Ant, affect the lifestyle, productivity and natural values of the Area, and reduce the resilience of species to withstand the effects of a changing climate. Fortunately the Queensland and Australian governments have funded a strong response to the scourge of Yellow Crazy Ants. This program is a model for a science –based, collaborative response to pest management.

   With warming temperatures, montane areas become more accessible to pests such as pigs and myrtle rust, putting additional pressures on at-risk native species. An integrated pest management program would initiate immediate and aggressive control of feral pigs, myrtle rust and other exotic pests to prevent spread into the higher altitude refugia. The Authority continues to lead the successful Yellow Crazy Ant program which has significantly reduced threats to the World Heritage values.

   Action: Collaborate with land managers, the agricultural industry, Rainforest Aboriginal People and Local Governments to develop and implement an integrated pest management program. **Est. Cost:** ***$2.25million over 3 years.***

4. **Research and innovation**. Whilst there are a number of known methods for improving the resilience of degraded landscapes, there is little information on how to support heat-exposed species to withstand temperature impacts. Innovation is needed to explore the viability and design of artificial (cooled) habitats and in-depth assessment of feasible species conservation measures. Examples could include biobanking, genetic

editing or potential for ex-situ conservation (e.g. captive breeding) and assisted migration in collaboration with Rainforest Aboriginal Peoples.

Action: In partnership with RRRC and academic institutions, develop a comprehensive Science and Innovation Research Plan and implement. ***Est. Cost: $900,000 over 3 years.***

5. **Threatened species listing**. With long term monitoring data collected over 10 years, there is sufficient information to list a selection of at risk species (in particular possum and bird species) and ecosystems (such as cloud forests) as vulnerable or endangered under the *Nature Conservation Act 1992*, *Environmental Protection and Biodiversity Conservation Act 1999* and the IUCN Red List. Urgent discussions are required with relevant agencies to commence this process.

   Action: Compile and submit data to support the proposed listing and appropriate categories. ***Est. Cost $30,000***

6. **Fire Management**. In 2018, for the first time ever, Queensland issued a 'catastrophic' fire danger warning. Areas not historically vulnerable to fire became part of the inferno, including Eungella National Park, 90 kilometres west of Mackay, where 110,000 hectares burned, with subtropical rainforest reportedly reduced to cinders. Ecologists estimate it may take hundreds of years to recover. At the same time, there were spot fires igniting across the Wet Tropics region but the onset of Tropical Cyclone Owen brought cooler temperatures and rain that, fortunately, stopped fire spreading. Under a changing climate, the risk of fire in the Wet Tropics has increased - there is a new vulnerability for rainforest areas; fire season is becoming longer; fires are fuelled by record conditions and the number of high-risk days are increasing. The Authority, land managers and communities need to reduce threats from increased risk and prepare for increasingly severe fires and impacts on the values of the World Heritage Area. A whole new approach to fire management, in consideration of both traditional Indigenous practice and emerging science needs to be developed.

   Action: In collaboration with Traditional Custodians, land managers, fire ecologists and local governments, assess vulnerability, plan and implement a rainforest fire management strategy to reduce threats from increased risk to rainforest from fire. ***Est. Cost: $1.2million over 3 years.***

7. **Partnerships and engagement**. To ensure success, strong collaboration with Rainforest Aboriginal peoples, the tourism industry and the community is vital.

   Action: The Authority will implement a range of initiatives to grow strong partnerships focused on environmental and social resilience. Initiatives will include the formation of a Climate Change Task Force, culturally appropriate engagement with Rainforest Aboriginal organisations, sector-based engagement with conservation, agriculture and community groups and the development of a tourism destination strategy (separately funded) that considers impacts climate change***. Est. Cost $240,000 over 3 years.***

8. **Cooperation**. Climate impacts are being experienced across all of Queensland's and Australia's World Heritage Properties. The Authority, and the Board, will work with the Australian World Heritage Advisory Committee (AWHAC) and other Queensland world heritage properties on cooperative research and responses, sharing information, research findings and resilience measures to ensure cooperative responses.

9. **Climate Adaptation Plan**. Currently in development in collaboration with scientists, community and Rainforest Aboriginal people, the Wet Tropics Climate Adaptation Plan will set a response framework over the next ten years. Due for completion in August/September 2019, with additional resources could be finalised by July.

   Action: Finalise the Wet Tropics Climate Change Adaptation Plan as a matter of urgency. ***Est additional cost: $24,000 (one year only)***

10. **Mitigation**. This 10-point plan will help to improve the resilience of the Wet Tropics World Heritage Area, enabling the best possible chance for the Area to withstand temperature increases pending a reduction in global emissions. **Action:** Call for urgent action on reducing global emissions.

WET TROPICS
MANAGEMENT AUTHORITY

WORLD HERITAGE • PATRIMOINE MONDIAL

ANNUAL REPORT 2017-2018

WET TROPICS
MANAGEMENT AUTHORITY

ANNUAL REPORT
2017-2018

Purpose of the report

This annual report details the financial and non-financial performance of the Wet Tropics Management Authority from 1 July 2017 to 30 June 2018. It highlights the work, achievements, activities and strategic initiatives of the Authority, and satisfies the requirements of Queensland's *Wet Tropics World Heritage Protection and Management Act 1993* and *Financial Accountability Act 2009*; and the Commonwealth's *Wet Tropics of Queensland World Heritage Conservation Act 1994*.

Feedback

The annual report is an important document representing communication and accountability. The Authority values comments and welcomes feedback from readers.

Public availability

This publication can be accessed from our website at www.wettropics.gov.au. Alternatively, hard copies can be obtained by emailing wettropics@wtma.qld.gov.au.

Interpreter service statement

The Wet Tropics Management Authority is committed to providing accessible services to people from all culturally and linguistically diverse backgrounds. If you have difficulty in understanding the annual report and need to access this document in a language other than English, please call the Translating and Interpreting Service (TIS National) on 131 450 and ask them to telephone the Queensland Government Library Services on +61 7 3224 8412.

Attribution

Content from this annual report should be attributed as: *Wet Tropics Management Authority Annual Report 2017-18*.

Disclaimer

This document has been prepared with all due diligence and care, based on the best available information at the time of publication. The Wet Tropics Management Authority holds no responsibility for any errors or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties.

Further information

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WET TROPICS MANAGEMENT AUTHORITY

30 September 2018

The Hon Melissa Price MP
Minister for the Environment
Parliament House
Canberra ACT 2600

Dear Minister

I am pleased to present the Annual Report 2017-2018 for the Wet Tropics Management Authority.

Under the *Wet Tropics World Heritage Conservation Act 1994*, section 10 (1) 'annual report' means a report given to the Australian Government under section 63 of the *Wet Tropics World Heritage Protection and Management Act 1993* (Qld).

Section 10 (2) requires you, as the Minister, to cause a copy of the annual report to be laid before each House of Parliament within 15 sitting days after the report is given to the Australian Government.

In submitting this report to you today the Authority is fulfilling its responsibilities under Australian Government legislation.

I would like to thank the Australian Government for its support of the Authority in delivering the achievements outlined in this report.

Yours sincerely

Leslie Shirreffs

Leslie Shirreffs, PSM
Chair
Wet Tropics Management Authority

2017-18 at a glance

PHASE 1 - MANAGEMENT PLAN REVIEW : ***COMPLETED***

2500 INVITATIONS TO SUBMIT

30 WORKSHOPS

PHASE 2 TO CONTINUE IN 2019

Supported development of a

BIODIVERSITY PLANNING assessment tool

for Wet Tropics bioregion.

6 DAYS OF WORKSHOPS

40+ EXPERT CONTRIBUTIONS

The Weekend Post, 16 Dec 2017

2 LOCAL ERADICATIONS OF **YELLOW CRAZY ANT** INFESTATIONS DECLARED

Crazy ant colony is wiped out

A YELLOW crazy ant infestation that was first discovered three years ago south of Cairns has been successfully eradicated.

The Wet Tropics Management Authority has announced the first successful eradication of an infestation of the invasive ants, south of Bentley Park.

The 10ha infestation of a development site near Wiseman Road West was sparked by the illegal dumping of garden waste, discovered in February 2014.

It took four helicopter baiting treatments by WTMA"s yellow crazy ant eradication program, as well as the inspection and hand installation of lures at almost 14,000 points across the area, before eradication was confirmed earlier this week.

To confirm yellow crazy ants have been eradicated from a site after treatment, four surveys are undertaken at least six months apart. All of these surveys must show there is no yellow crazy ant activity at the site.

The authority's executive director, Scott Buchanan, said it was the first successful eradication in what is expected to be a 10-year path to complete eradication of the pest from the Wet Tropics region.

HOSTED THE *Cassowary Awards*

11 AWARD RECIPIENTS

47 NOMINEES

9 CATEGORIES

250 GUESTS

30 YEARS OF WET TROPICS WORLD HERITAGE

Wet Tropics' **30th anniversary** celebrations @ **ECOfiesta**

Joined by **9** partner agencies and community groups

15,000 VISITORS

300 TREES provided free to the community

Produced

3 EDITIONS

of the Rainforest Aboriginal News with Terrain NRM

6,000 copies

PUBLIC EDUCATION EVENTS

Sharing the natural and cultural values of the Wet Tropics World Heritage Area with the regional community.

MORE THAN **50,000** AUDIENCE

INVESTED $40,000

IN ABORIGINAL ORGANISATIONS to support traditional and cultural land management.

WET TROPICS MANAGEMENT AUTHORITY

RESPECT PAST : PRESENT : FUTURE

HOSTED A **2 DAY** Rainforest Aboriginal people's **regional workshop**

to discuss the review of the statutory Wet Tropics Management Plan 1998 and the Wet Tropics of Queensland Regional Agreement.

ATTENDED BY **>40** RECOGNISED LEADERS

Supported Wet Tropics research programs by investing over **$30,000**

to 10 Wet Tropics postgraduate students

Photo: northern bettong (Stephanie Todd)

$1.8 million

in funds provided to Queensland Parks and Wildlife Service for on-ground park management.

Photo: Qld Government

Message from the chair

The Wet Tropics rainforests comprise diverse and remarkable ecosystems that are home to an incredible range of rare and endemic plants, animals and habitats. This landscape's biological significance is such that it was inscribed on the World Heritage List on 9 December 1988 as the Wet Tropics of Queensland World Heritage Area.

Rainforest Aboriginal people—some 20 Traditional Owner groups—have been connected to and managed the Wet Tropics country for many thousands of years.

This irreplaceable natural and biocultural wonder boasts breathtaking scenery and striking landscapes, abundant with fast-flowing rivers, prodigious gorges and spectacular waterfalls. Mountain summits provide extensive vistas of the world's oldest continually persisting tropical rainforest. Presenting these remarkable values to the world through tourism and recreation is an important and positive part of the Authority's World Heritage commitment. Indeed, together with the neighbouring Great Barrier Reef, we are uniquely positioned to present two World Heritage Areas, from the rainforest to the reef, as an internationally renowned tourism hotspot.

As manager of the Wet Tropics World Heritage Area, the Wet Tropics Management Authority has an obligation to 'protect, conserve, present, rehabilitate and transmit the Wet Tropics of Queensland World Heritage Area to future generations.' We are responsible to both the Australian and Queensland governments, and work together with the Traditional Owners of the land, our many partners and communities who live and work in the Wet Tropics region.

We actively work with these communities to ensure protection of the Area's outstanding universal value whilst enabling appropriate community and visitor infrastructure; involving Rainforest Aboriginal people in management and supporting aspirations to live and work on country; and facilitating commercial and non-commercial land uses and activities within the Area.

The Authority achieved and progressed many positive outcomes during 2017-18. This annual report provides a number of rich examples of such progress, including:

- completed the first phase of a comprehensive review of the Wet Tropics Management Plan 1998, involving extensive engagement and collaboration with Rainforest Aboriginal people, industry, government and community sectors
- improved engagement with Rainforest Aboriginal people to support self-determination including hosting a two-day regional workshop towards refreshing the historic 2005 Wet Tropics of Queensland Regional Agreement and investing $40,000 in grants to support traditional and cultural land management
- commenced implementation of 'Share, Connect, Protect – best practice World Heritage Presentation in the Wet Tropics', a comprehensive presentation strategy and work plan to enhance appreciation and enjoyment of the Area's values
- hosted the 16th Cassowary Awards at Tjapukai Aboriginal Cultural Park, which was attended by 250 guests and recognised 11 worthy recipients for their outstanding contributions to protecting and presenting the World Heritage Area
- continued the fight to eradicate the highly invasive yellow crazy ant from and adjacent to the World Heritage Area, achieving two areas of total eradication made possible from the generous support of the Queensland and Australian governments and a highly active community.

Many of these activities stand the Authority in good stead for the coming year and the challenges ahead.

Since the Wet Tropics was inscribed on the World Heritage List almost 30 years ago, the number of people living and working in the region has increased markedly. By 2031, the resident population is predicted to surpass 700,000 people. Domestic and international tourism has also increased at least fourfold over the past 20 years, placing expectations of increased access to the Area and pressure on popular visitor sites.

Despite its protection, long-term monitoring indicates the biodiversity of the World Heritage Area is declining, with many species reduced in both distribution and population size. This has been caused by habitat fragmentation—often outside the boundaries of the Area—and invasive pests such as diseases, plants and animals, which are more prevalent and pervasive now than 30 years ago.

The most serious risk to the outstanding universal value of the rainforest, however, is posed by current trends in global warming, which is already impacting on higher altitude species in particular. Whilst the Authority cannot address the overall issue of global climate change by itself, it can take steps to improve the resilience of the Area's World Heritage values through a range of actions and collaborations with other organisations. To this end, the Authority has been working towards an integrated resilience plan. In the next year we aim to develop a 'compact' with regional organisations to focus collaborative efforts on resilience actions like improving connectivity, feral plant and animal control and identifying transition pathways for species.

Yellow crazy ant eradication will continue to be a top priority for the next seven years, when total eradication targets are expected to be met. This will address the potential horrific impact this invasive pest would have on World Heritage values, but will also go a long way towards supporting a resilient landscape. The current yellow crazy ant funding agreement comes to an end in 2019 and, at the time of writing, discussions are underway for the next round of ongoing funding to support this highly successful program.

As a board we will continue to push for adequate funding for World Heritage management, based on the recognition that the Area is not only a world-class conservation asset of outstanding importance, but also an economic asset to the regional community.

This year saw the conclusion of the five-year funding agreement with the Australian Government. We were very pleased that a further five-year commitment for 2018-2023 was made during the year to continue the good work of the Authority.

We cannot succeed without supportive partnerships, so I take this opportunity to collectively thank the many, many people and organisations that assisted in the conservation and management of the Wet Tropics World Heritage Area during 2017-18. Prominent among these are the members of our Community Consultative Committee, Scientific Advisory Committee, and Yellow Crazy Ant Steering and Reference committees; Rainforest Aboriginal people and organisations working to preserve and pass on their cultural heritage and traditional knowledge; the many hundreds of volunteers in community conservation organisations; the tourism industry; the guides who present the Area to thousands of visitors each year; and researchers building knowledge.

The Authority is also grateful for the support and guidance of its partners in the Australian, Queensland and local government agencies, in particular, the Commonwealth Department of Environment and Energy, the Queensland Department of Environment and Science and the hard-working rangers on the ground who manage the Area on a day-to-day basis.

Finally, I would like to acknowledge and thank my fellow board directors, executive director Scott Buchanan and Authority staff for another year of dedicated service, all of whom go above and beyond to achieve the highest standards of management and enthusiastic collaboration with all of our communities, as is appropriate for the second-most irreplaceable World Heritage Area on Earth.

Leslie Shirreffs, PSM
Chair
Wet Tropics Management Authority

About the Wet Tropics

The Wet Tropics World Heritage Area

World Heritage listing is recognition by the international community that a place is such an outstanding example of the world's natural or cultural heritage that its conservation is of value to all people. The World Heritage List includes 1,092 properties which the World Heritage Committee considers to have outstanding universal value—this includes 19 Australian properties.

The Wet Tropics of Queensland World Heritage Area was inscribed onto the World Heritage list in 1988 for its natural values, meeting all four natural criteria for World Heritage listing and fulfilling the necessary conditions of integrity[1]. The Area was also listed on Australia's National Heritage List in 2007 for its natural values[2].

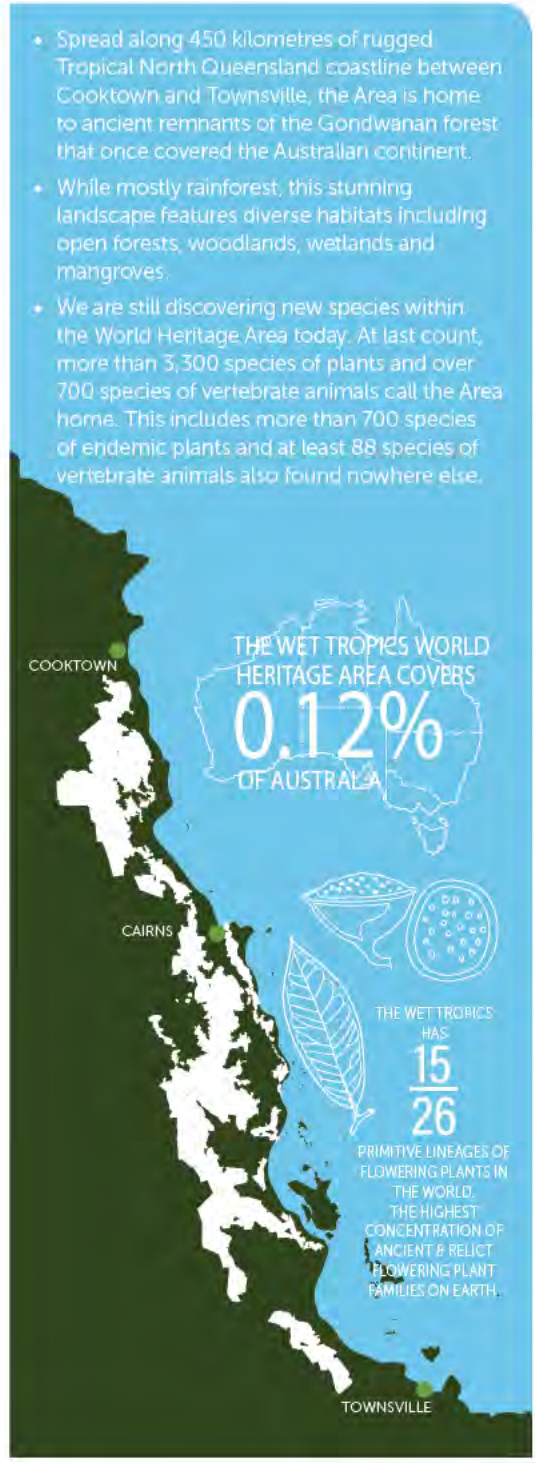
In addition to its outstanding natural values, the Area is a rich cultural landscape for Rainforest Aboriginal people, who have lived continuously in the rainforest environment for thousands of years. Indeed, it is the only Australian site where Aboriginal people have permanently inhabited a tropical rainforest environment.

The Area's Indigenous heritage values were included in its National Heritage listing in 2012.

Relevant legislation

The Wet Tropics of Queensland World Heritage Area (the Area) is managed under the *Wet Tropics World Heritage Protection and Management Act 1993* (the Queensland Act) and the *Wet Tropics of Queensland World Heritage Area Conservation Act 1994* (the Commonwealth Act). These acts implement Australia's international duty for the protection, conservation, presentation, rehabilitation and transmission of the World Heritage Area to future generations.

The Queensland Act establishes the Wet Tropics Management Authority (the Authority) and provides the legal basis for the *Wet Tropics Management Plan 1998* (the Plan), which regulates land use activities in the Area through a zoning and permit system. The *Wet Tropics World Heritage Area Management Scheme* is an intergovernmental agreement signed by the Prime Minister of Australia and the Premier of Queensland in 1990. It sets out broad structural and funding arrangements for the management of the Area. The agreement is incorporated as Schedule 1 to the Queensland Act and given effect by section 3 of the Commonwealth Act. An amended version of this intergovernmental agreement was adopted in 2011.



[1] http://whc.unesco.org/en/list/486
[2] http://www.environment.gov.au/heritage/places/world/wet-tropics

Our organisation

Who we are

The Wet Tropics Management Authority (the Authority) was established to ensure Australia's obligation under the World Heritage Convention is met in relation to the Wet Tropics of Queensland World Heritage Area. The Authority is a body corporate, with statutory powers defined under the Queensland Act. The Authority's functions (fully defined under section 10 of the Queensland Act) are to:

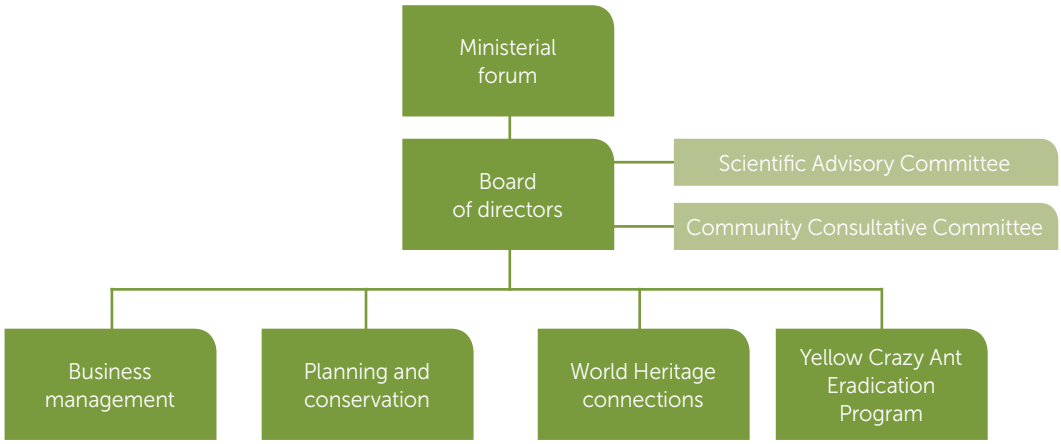
- develop and implement policies and programs for management of the Area
- formulate performance indicators for the implementation of approved policies and programs
- advise and make recommendations to the Minister and the Ministerial Forum
- prepare and implement management plans for the Area
- administer funding arrangements
- facilitate and enter into cooperative management agreements
- rehabilitate and restore the Area
- gather, research, analyse and disseminate information on the Area
- develop public and community education programs
- promote the Area locally, nationally and internationally
- liaise with State and Commonwealth governments, agencies and international organisations
- monitor the state of the Area
- advise and report to the Minister and the Ministerial Forum on the state of the Area.

The Authority performs its functions in a way which is conducive to the protection of the Area's natural heritage values and consistent with the World Heritage Convention and relevant legislation.

Our structure

As a body corporate operating under the requirements of both the Queensland and Commonwealth acts, the Wet Tropics Management Authority structure enshrines its engagement with the State and Commonwealth governments and a range of industry and community stakeholders throughout the Wet Tropics region.

The Authority operates as an administrative unit within the Queensland Government's Department of Environment and Science. As part of the Queensland public sector, the Authority is subject to public sector legislation, regulations, standards and guidelines governing administrative functions and arrangements. The Director-General of the Department of Environment and Science is the accountable officer for the Authority under the *Financial and Performance Management Standard 2009*. The Authority is responsible to the Director-General regarding compliance with State Government administrative and financial standards.



Wet Tropics Ministerial Forum

The Wet Tropics Ministerial Forum consists of relevant Commonwealth and State Ministers with environment portfolio responsibilities. The agreement recognises that both the Australian Government and Queensland Government have joint interests in and responsibilities for the Wet Tropics of Queensland World Heritage Area.

The Forum meets annually to provide oversight to the strategic operations of the Authority, approve annual budgets and consider future directions for meeting the property's World Heritage obligations. As at 30 June 2018, it comprised:

- The Hon Leeanne Enoch MP, Queensland Minister for Environment and the Great Barrier Reef, Minister for Science and Minister for the Arts
- The Hon Josh Frydenberg MP, Australian Minister for the Environment and Energy.

The Forum met on 7 July 2017. At that time, and prior to the Queensland State election in October 2017, the Hon Dr Steven Miles was Chair of the Wet Tropics Ministerial Forum in his capacity as Minister for the Environment and Heritage Protection.

Board of directors

A board of directors is set up under the Queensland Act and consists of seven directors, six of whom serve in a part-time capacity. Two directors are nominated by the Australian Government and two by the Queensland Government. The chair and a designated Aboriginal director are nominated by the Wet Tropics Ministerial Forum. The executive director of the Authority is a non-voting board director. The board's key function is to implement programs to meet Australia's international obligations for the Area under the World Heritage Convention. Details on the operations of the board and their achievements are at *Appendix 1*.

Statutory committees

The Authority has two statutory advisory committees appointed by its board under section 40 (1) of the Queensland Act: the Community Consultative Committee and the Scientific Advisory Committee. These committees meet before board meetings and advise the Authority on programs and research for the management of the Area. The board has appointed a director to chair each committee, providing a direct line of communication between the committees and the Authority. Additional details can be found at *Appendix 2*.

Our contribution to government objectives

The Authority's mission is to 'lead, inspire, advise and support the Australian and global community to protect and share the Wet Tropics World Heritage Area in perpetuity'.

Consistent with its legislative roles and functions, the Wet Tropics Management Authority endeavours to ensure that its service delivery initiatives contribute to State and Commonwealth government objectives for the Wet Tropics community.

Statutory reporting obligations

Each year the Wet Tropics Management Authority prepares a report on the financial statements and administration of the acts, and a report on the state of the Area, as required under section 63(1) of the Queensland Act and section 10 of the Commonwealth Act.

Our performance

The Wet Tropics Management Authority Strategic Plan set out the Authority's directions from 2013-2018, outlining how the Authority will achieve goals including protection of heritage values, community appreciation of the World Heritage Area, active participation of Rainforest Aboriginal people and a positive working relationship with the Queensland and Australian governments.

The Wet Tropics Management Authority's performance is measured against its seven strategic goals.

1. The outstanding universal value of the Wet Tropics World Heritage Area is protected and maintained consistent with Australia's obligation under the World Heritage Convention. See page 15.
2. Communities derive benefit and value from the World Heritage Area, are effectively involved in planning and management, and their stewardship of the World Heritage Area is recognised and supported. See page 18.
3. Rainforest Aboriginal people are supported in expressing their knowledge, culture and management practices on country. See page 20.
4. The Wet Tropics World Heritage Area is used, enjoyed and celebrated as the world's finest learning landscape for tropical rainforest and its sustainable management. See page 22.
5. World Heritage Area values are supported and presented through sustainable tourism. See page 24.
6. Enduring partnerships enhance the integrity of the Wet Tropics World Heritage Area, its presentation and its function in the life of the community. See page 26.
7. The Wet Tropics Management Authority is an accountable and capable organisation. See page 28.

Following completion of the first review phase of the Wet Tropics Management Plan in early 2018, the Authority's board approved preparation of a new Wet Tropics World Heritage Plan in two parts, the first of which will inform the Authority's strategic goals for the next 10 years.

1. The outstanding universal value of the Wet Tropics World Heritage Area is protected and maintained consistent with Australia's obligation under the World Heritage Convention

Protecting and managing the outstanding universal value of the Wet Tropics World Heritage Area lies at the heart of the Wet Tropics Management Authority's governance and management regime.

2017-18 highlights:

- Phase one of Wet Tropics Management Plan review completed.
- Supported development of a biodiversity planning assessment tool for Wet Tropics bioregion.
- Two local eradications of yellow crazy ant infestations declared.

Administration of the Wet Tropics Management Plan

The Wet Tropics Management Plan 1998 (the Plan) regulates land use activities in the Wet Tropics World Heritage Area (the Area) that have the potential to impact on its integrity. The Plan includes criteria to assess permit applications for construction and maintenance of roads, electricity transmission lines, water supplies and communication facilities. The Authority also develops policies and guidelines about how best to manage the use of the Area. Codes of practice and environmental management plans are often included as part of permit conditions.

The Authority continued to strengthen its partnerships with community service infrastructure providers and local, state and Commonwealth agencies throughout 2017-18. Officers provided pre-lodgement advice on over 20 different matters, and assessed and issued three new permits under the Plan. Authority staff regularly liaise with contractors and officers responsible for the planning, building and maintenance of community services infrastructure inside and adjoining the World Heritage Area. They advise on avoiding or mitigating impacts on the Area and training local councils on infrastructure maintenance.

More details on the Authority's Plan administration activities can be found at ***Appendix 3***.

Review of the operation of the Wet Tropics Management Plan

Under section 53 of the *Wet Tropics World Heritage Protection and Management Act 1993*, the Authority is required to review the operation of the Plan every 10 years. The review is undertaken over two phases, both of which require public notification.

Phase one of the review (May 2017—February 2018) invited public comment on issues such as zoning, visitor sites and facilities, roads and access, recognition of Rainforest Aboriginal tradition and activities allowed under a permit.

The consultation included more than 2,500 letters to landowners, neighbours and stakeholders inviting submissions, as well as stakeholder workshops, meetings and media promotions.

Thirty workshops, numerous face-to-face meetings and information sessions were held with Rainforest Aboriginal registered native title bodies corporate, prescribed bodies corporate, boards and communities. The Authority invited Rainforest Aboriginal representatives to a regional workshop in October 2017 to discuss the Plan review, ensuring that native title representative groups were informed and engaged in developing the amended Plan. Aboriginal leaders from the 20 tribal groups of the Wet Tropics Area as well as Queensland and Australian government officials, the North Queensland Land Council and Terrain NRM participated.

Mapping products prepared for the review were critical to communicate proposed changes to zones and roads. An interactive mapping application was produced in partnership with Terrain NRM to allow the public to explore proposed changes. The boundary was aligned with the State of Queensland Digital Cadastre Database, and this work continues into 2018-19 to ensure current and future community needs are reflected in the management zones.

In January 2018, the Authority considered all properly made submissions from the phase one consultation and released a consultation report. Following consideration of the report, the board approved preparation of a Wet Tropics World Heritage Plan in two parts:

- Part A: to outline the strategic and broader management functions of the Wet Tropics Management Authority
- Part B: to form the amended statutory plan

A second formal consultation phase will commence in January 2019.

Wet Tropics biodiversity planning assessment

In April 2018 the Authority supported the Queensland Department of Environment and Science to complete a biodiversity planning assessment for the Wet Tropics bioregion using the Department's biodiversity assessment and mapping methodology.

The Authority organised six days of expert workshops covering flora, fauna and landscape ecology. More than 40 experts were involved in the workshops from a wide range of government and non-government organisations including the Authority, CSIRO, James Cook University, Queensland Parks and Wildlife Service, Queensland Herbarium, Australian Tropical Herbarium, Australian Wildlife Conservancy, BirdLife Australia and private individuals.

The information gathered is being processed and will be publically available in the form of datasets and mapping layers in 2019. This information will help inform administration of the Plan, particularly in the consideration of any actions that may impact upon the values of the Area.

Wildlife recovery teams

The Authority continues to support threatened species recovery teams in the World Heritage Area, chairing and providing secretariat support to the Cassowary Recovery Team and attending Northern Bettong Recovery Team meetings.

With assistance from key partner Terrain NRM, the Cassowary Recovery Team is developing car strike mitigation measures, liaising with Transport and Main Roads and working with CSIRO to develop technologies that can alert drivers at cassowary crossing hot spots. Landscape connectivity continues to be progressed in the coastal lowlands south of Cairns and in the Atherton Tablelands.

The Authority co-facilitated with Terrain NRM a workshop for recovery teams focussed on threatened species including the cassowary, northern bettong, Kuranda treefrog, spotted-tailed quoll, mahogany glider and a threatened ecological community: Mabi Forest. One of the outcomes of the workshop was a grant from Terrain NRM to develop a short film and fact sheets on the plight of endangered species—and the hard work of these recovery teams—in the Wet Tropics.

Wildlife connectivity

Mount Lewis National Park is one of seven vital upland refugia in the Wet Tropics World Heritage Area, containing very high levels of endemic plants and animals, most with ancient and relict lineages. Recently the Authority worked with Queensland Parks and Wildlife Service to install two rope bridges across the thirty-two kilometre Mount Lewis Road, to assist the dispersal of endemic lemuroid ringtail possums. This species spends its entire life in trees and is unable to cross gaps in the forests created by roads.

Camera traps were installed on these bridges to monitor their use. An interpretive sign was also developed and installed at the beginning of the road, to highlight the importance of the area and the high biodiversity values of Mount Lewis National Park.

Climate resilience planning

Climate change poses one of the most significant threats to the Wet Tropics region, and will likely result in widespread, unavoidable and substantial ecological change. Climate change threatens the outstanding universal value and integrity that underpins the World Heritage Area, as well as the natural assets that are critical to the region's tourism industry that provide direct and indirect economic benefits worth more than $5.2 billion annually.

As such, the Authority commenced work on a climate change adaptation plan in collaboration with key stakeholders for release by June 2019.

Yellow Crazy Ant Eradication Program

The Authority's Yellow Crazy Ant Eradication Program is funded by the Australian Government's National Landcare Program and the Queensland Department of Environment and Science.

The Program's effort to eradicate yellow crazy ants intensified over the past year to provide full-time employment for 26 staff and operational contract work for another 36 field workers. Local Traditional Owner groups, Gimuy Walubara Yindinji and Djabugay, are actively participating in operational contracts and training programs.

The eradication program undertook three further successful rounds of treatment in July and December 2017 and June 2018, with research and monitoring indicating dramatic reductions in yellow crazy ant numbers across the majority of the infestation areas. Eradication was declared at two infestation sites and a third is due in the second half of 2018. 160ha of the 344ha Bentley Park infestation (adjacent to the World Heritage Area and Copperlode Dam) has transitioned from full broadcast treatment to intensive surveys and spot treatments as required.

The program has worked closely with the sugar industry to identify additional infestations and vectors for movement of yellow crazy ants in adjacent areas south of Cairns. The total infestation area currently covers about 1,600ha (93ha within the World Heritage Area), but the Authority is confident that eradication can be achieved with sufficient resources for treatments and research. An independent review and a cost-benefit analysis of the eradication program have been commissioned to recommend strategies for feasible eradication and to evaluate the cost of the program against the environmental and socioeconomic impacts of yellow crazy ants.

The success of the eradication program to date has relied heavily on a cooperative research partnership with James Cook University and liaison with other yellow crazy ant eradication programs in Australia and overseas. Research has focused on treatment techniques and effectiveness and the biology and life cycles of the ants. The lessons learned in the Wet Tropics have the potential to be applied in numerous other infestations throughout the world.

2. Communities derive benefit and value from the World Heritage Area, are effectively involved in planning and management, and their stewardship of the World Heritage Area is recognised and supported

The Authority maintains strong community networks and collaborates with land managers including Rainforest Aboriginal people and the conservation, research, tourism and community sectors. These partners play an important role in monitoring threats and helping to protect this special place for future generations.

2017-18 highlights:

- Hosted the 16th Cassowary Awards, attended by 250 guests with 11 Award recipients.
- E-newsletter distributed to more than 700 email subscribers supported by web page and social media promotion.
- 2018 ECOfiesta, sponsored by the Authority, launched the start of the 30th anniversary celebrations to approximately 15,000 visitors.

Working with the Wet Tropics community

The Authority is committed to developing and strengthening partnerships and encouraging meaningful community participation in World Heritage Area protection, conservation and enjoyment by raising awareness, educating and facilitating experiential learning.

The Authority embraces opportunities to share information and promote joint activities and projects undertaken across the Wet Tropics. The Authority communicates freely through distribution of e-newsletters, media releases, participation in community events and the dissemination of communiqués and minutes from each quarterly board meeting and Ministerial Forum to over 300 stakeholders.

Community Consultative Committee

The Authority's commitment to community engagement is embedded within its structure and governance, with the Community Consultative Committee (CCC) providing advice on a range of issues direct to the board to ensure the community's views are considered in the Authority's policies and programs.

During 2017-18, the CCC met four times, providing feedback and advice on a range of issues including the Cassowary Awards, the Area's 30th anniversary celebrations and several strategic documents. Further details on the CCC's work are available in ***Appendix 2***.

Cassowary Awards

The Cassowary Awards are the premier engagement event on the Authority's calendar, bringing together members of the community, industry as well as local, state and federal government representatives to celebrate the strong camaraderie and numerous achievements within the Wet Tropics community.

The 16th Cassowary Awards ceremony in March 2018 hosted more than 250 people, with addresses by Queensland Environment Minister Hon Leeanne Enoch and Federal Member for Leichhardt Hon Warren Entsch, as well as a special video presentation featuring David Attenborough, in honour of the late wildlife illustrator Bill Cooper.

Cassowary Award recipients were honoured across nine categories, including the special Chair's Award, presented to community organisation Trees for the Evelyn and Atherton Tablelands (TREAT), for its work over 35 years to conserving and improving the integrity of the Wet Tropics environment.

Award recipients were:

- **Asha Mayberry** – Young Cassowary
- **Rainforest Rescue and Dr Karen Coombes** – Thorsborne Award for Community Conservation & Rehabilitation
- **Cairns Regional Council's Sustainability Team** – Local Government & Industry Initiatives
- **Small World Journeys** – Tourism and Presentation
- **Gavin Singleton and Liz Gallie** – Community Champions
- **Distinguished Professor William F Laurance** – Innovation
- **Djunbunji Land & Sea Program** – People. Country. Culture
- **Holloways Beach Environmental Education Centre & Tinaroo Environmental Education Centre** – Education
- **Trees for the Evelyn and Atherton Tablelands (TREAT)** – Chair's Award.

The Cassowary Awards were leveraged as an opportunity to provide members of the Wet Tropics community throughout the Area with media opportunities, resulting in 28 separate media stories across local print, television and radio.

30th anniversary celebrations

The Authority contributed to Cairns Regional Council's 2018 Cairns ECOfiesta on 3 June, leveraging the event to launch the Wet Tropics World Heritage Area's 30th anniversary celebrations to more than 15,000 attendees.

Nine partner agencies and community groups joined a Wet Tropics-themed outdoor space. A series of public conversations on the main stage in conjunction with a formal launch to the 30th anniversary by the chair, Leslie Shirreffs, set the scene for a larger planned schedule of activities and promotions up to and including the 9 December 30th anniversary date.

Other community events

The Authority's presence at festivals and events around the Wet Tropics region is a high priority, ensuring meaningful engagement with the broader community throughout the Wet Tropics. During the 2017-18 period, the Authority attended six events, showcasing the Area and supporting partner activities to an audience of more than 50,000 people across the region.

Snap the Tropics

The Snap the Tropics photographic competition was initiated to provide an avenue for the public to share their experiences in the Wet Tropics World Heritage Area, attracting more than 150 entries from local photographers across the Wet Tropics region. Winners were announced at a local event and several of the submitted photographs have subsequently been utilised in Authority publications.

Website

Following a major refurbishment in June/July 2017, the Authority's website (www.wettropics.gov.au) continues to provide a contemporary and engaging platform for 100,000 users per annum to delve into information about the Wet Tropics World Heritage Area, the Authority's work programs and priorities, as well as emerging news and events from around the Wet Tropics.

News and media

The Wet Tropics Management Authority engages in media liaison activities to ensure it maintains a public profile to promote the Area's outstanding universal value and advocate for its management and protection.

The Authority maintains close working relationships with key members of local media, ensuring the Authority's events and milestones are communicated to the general public while news media regularly consult the Authority on key issues around the Wet Tropics.

In addition to significant coverage of the 16th Cassowary Awards, key media events to attract coverage in 2017-18 included the first local yellow crazy ant eradication announcement, commencement of 30th anniversary celebrations of the Area's World Heritage listing and regular updates on the Yellow Crazy Ant Eradication Program.

The quarterly Wet Tropics eNews remained a valuable source of stakeholder engagement, providing detailed updates on the Authority's work to a core, engaged stakeholder contingent of more than 700 contacts in the Wet Tropics community.

Social media

The Authority's social media presence on Facebook, Twitter and Instagram continues to grow, with Facebook (@WetTropicsWorldHeritageArea) remaining its primary platform. For the year ending 30 June 2018, this Facebook page grew to 2,822 'likes' (+23%), while expanding its organic reach per post by more than 20%. In addition, the Yellow Crazy Ant Eradication Program's Facebook group (with 255 members) provides a platform for the team to answer questions from landholders, staff and the general community. The Wet Tropics Tour Guide Program also hosts a sister page sharing current and relevant information on Wet Tropics World Heritage Area biodiversity values and major environmental issues within Australia. Membership of this page is made up of predominantly accredited nature-based tour guides who have undertaken the Wet Tropics Tour Guide Program.

Across all its social media platforms, the Authority's followers are predominantly Australian (from Queensland), with the United States and United Kingdom leading its international following.

Corporate branding and products

In 2018 the Authority developed a new corporate style guide, ensuring the Authority and its partners have the tools to engage in consistent use of its various brand elements to support its communications activities. Following the completion of the style guide, the Authority continues to refresh its communications products to achieve a consistent and contemporary brand which connects with the community.

3. Rainforest Aboriginal people are supported in expressing their knowledge, culture and management practices on country

Empowering Rainforest Aboriginal people as the traditional custodians of the Wet Tropics World Heritage Area—primarily via meaningful engagement in management—is vital for protecting and promoting the Area's natural and cultural values.

2017-18 highlights:

- Produced three editions of the Rainforest Aboriginal News and the 2018 People Country Culture Calendar in collaboration with Rainforest Aboriginal people and Terrain NRM.
- Hosted a two-day Rainforest Aboriginal people's regional workshop to discuss review of the statutory Wet Tropics Management Plan 1998 and the Wet Tropics of Queensland Regional Agreement.
- Supported a Traditional Owner Leadership Group to refresh the Regional Agreement.
- Invested $40,000 in Aboriginal organisations to support traditional and cultural land management.
- Increased employment opportunities with the Authority for Aboriginal people, from one person to six people since 2016, and awarding two contracts to Aboriginal organisations to assist in the eradication of yellow crazy ants.

Rainforest Aboriginal engagement

The Authority is focused on ensuring that Rainforest Aboriginal people are empowered to participate in the management of the Area. The Authority's board, Community Consultative Committee and Scientific Advisory Committee each have two Rainforest Aboriginal people as members. The Indigenous members from the board and committees are supported to meet to discuss Rainforest Aboriginal people's aspirations and engagement in the management of the Wet Tropics World Heritage Area. These Indigenous Advisory Members provide advice and direction to the Authority to improve strategic engagement and Rainforest Aboriginal governance matters.

In collaboration with Rainforest Aboriginal people and Terrain NRM, three issues of Rainforest Aboriginal News (RAN) were published and distributed across the region to Aboriginal and other organisations in July 2017, March 2018 and June 2018. The RAN is a tool to disseminate relevant and interesting information to Rainforest Aboriginal people and to tell the good news stories highlighting their many achievements. The June issue celebrated Rainforest Aboriginal women aligning with the NAIDOC theme 'Because of her, we can'.

A 2018 'People Country Culture' Calendar was also published and distributed to promote Rainforest Aboriginal people and highlight their application of traditional knowledge and cultural practices in the management of the Wet Tropics.

In 2017-18, the Authority also supported and/or participated in nine Traditional Owner-led public events.

Involvement in World Heritage Area management

The Authority has utilised a *free, prior and informed consent approach*[3] for engaging Rainforest Aboriginal people in the review of the Wet Tropics Management Plan 1998 (the Plan), to improve the recognition of, and develop management actions in support of, Rainforest Aboriginal tradition.

The Authority's Rainforest Aboriginal people's regional workshop was held to discuss not only a particular need to provide greater recognition of Aboriginal tradition in the Plan review, but a desire to refresh the Regional Agreement (2005) to reflect the contemporary environment and a more comprehensive involvement of Aboriginal people in World Heritage Area management.

In addition to ensuring involvement in the Plan review, the Authority has proactively increased employment opportunities for Aboriginal people, from just one person in 2016 to six in 2018. Two Aboriginal organisations have also been contracted to assist in the eradication of yellow crazy ants.

The Authority has worked closely with community service infrastructure providers and Traditional Owner groups to provide advance notice regarding upcoming permit renewals. This provides ample opportunity for Rainforest Aboriginal people to consider the permits in advance of formal notification.

Land tenure resolution negotiation processes have commenced between Eastern Kuku Yalanji Traditional Owners, the Queensland Government and the Authority. This will result in the transfer of national park ownership to Aboriginal freehold and jointly managed national parks in the future. The Authority will continue to attend negotiation meetings and support this process.

[3] United Nations Free, Prior and Informed Consent – An indigenous right and a good practice for local communities http://www.fao.org/3/a-i6190e.pdf

Traditional Owner Leadership Group

The regional workshop passed a resolution establishing a Traditional Owner Leadership Group (TOLG) to lead the process of refreshing the Regional Agreement with relevant partners. The Authority, North Queensland Land Council and Terrain NRM have supported the formation of the TOLG and facilitated its deliberations. The group provided a statement for the Authority and the Queensland and Australian governments to use in internal briefings, reaffirming commitment to the Regional Agreement and the ongoing involvement of Rainforest Aboriginal people in the management of the Wet Tropics World Heritage Area.

Following the regional workshop, the Authority liaised with Australian and Queensland government agencies to undertake an internal review of the Regional Agreement. The Authority is working with the Rainforest Aboriginal leaders, the North Queensland Land Council and other partners to identify priority outstanding actions from the Regional Agreement and the 1998 report "Which Way Our Cultural Survival".

Collaborative projects

In 2017-18, the Authority invested $40,000 of Rainforest Aboriginal Grants into four Aboriginal organisations in support of the following projects:

- Western Yalanji Aboriginal Corporation RNTBC – Cooperative Management of Mt Windsor Area
- Bana Yarralji Bubu Bayan Kabanji Inc – Ngananga Ngamunka – Kuku Nyungkal ecological language project
- Djunbunji Ltd – Hosting Wet Tropics Tour Guide School
- Mandingalbay Yidinji Aboriginal Corporation PBC – Interpretative Signage Project.

The Authority and Department of Environment and Science – Queensland Parks and Wildlife Service provided financial and other support to the Girringun Aboriginal Corporation to replace Edmund Kennedy National Park signage with Girramay National Park signs.

4. The Wet Tropics World Heritage Area is used, enjoyed and celebrated as the world's finest learning landscape for tropical rainforest and its sustainable management

Scientific research is critical to informed, evidence-based decision-making and community appreciation of the World Heritage Area's global significance. The Authority seeks to support continued research, build on the legacy of past research investment, and ensure knowledge generated in the Wet Tropics is accessible to rainforest and protected area managers elsewhere.

The outstanding universal value of the Area, together with the favourable research environment found within the region, provides great opportunities for collaborative research across a range of disciplines such as ecology, climatology, tourism, sociology and economics based on tropical ecosystems.

2017-18 highlights:

- More than $30,000 in grants provided to ten Wet Tropics postgraduate students.
- Partnered with Australian Tropical Herbarium to deliver three plant identification workshops.
- Developed a protocol for engagement between researchers and Rainforest Aboriginal people.

Scientific Advisory Committee

The Scientific Advisory Committee (SAC) advises the Authority's board on scientific research and developments that will contribute to the protection and conservation of the Area. In 2017-18, the SAC's work included input into climate change adaptation and mitigation strategies for the Area and drafted research protocols for engagement with Rainforest Aboriginal people. More details on the SAC's achievements are in ***Appendix 2***.

World Heritage Family project

The Authority has developed a collection of stories detailing the common evolutionary lineages of Queensland and some other states' World Heritage properties, collectively known as the World Heritage Family.

Despite their many differences, these sites share a common heritage–including geological and evolutionary history–which underlies their outstanding universal value. The 'Family' concept strategy highlights these links and gives the Authority a new and interesting way of telling stories highlighting and enriching the Wet Tropic's outstanding universal value message.

Early interest from other World Heritage property managers and industry is strong and, with the use of an animation currently under development, will provide another platform to share the value of these sites. In particular, the story has inspired the tourism industry to learn more about the Area and support the Authority's efforts to spread this message to the world.

Student Research Grant Scheme

The Authority's Student Research Grant Scheme encourages and supports post-graduate research in the Wet Tropics World Heritage Area, which is then used to directly inform management of the World Heritage site and awareness of the Area's values.

The Authority funds up to $4,000 for PhD and masters research projects and up to $1,500 for Honours projects. These 12-month grants support postgraduate students' costs associated with field work, purchase of equipment, field data collection, laboratory research and analysis of data.

In 2017-18 the Authority funded ten post-graduate students from three Australian universities:

- **Jennifer Cocciardi**, PhD candidate James Cook University (JCU) - Can species interactions cause rapid niche adaptation?
- **Alison Hoeger**, PhD candidate University of Queensland - Australian Bat Lyssavirus in Flying Foxes in Far North Queensland, 2017-2019
- **Elizabeth Joyce**, PhD candidate JCU - Origins of the northern Australian flora: role of the Sunda-Sahul floristic exchange
- **Lily Leahy**, PhD candidate JCU - Life in the canopy in a changing climate: The spatio-temporal distribution of rainforest ants along climate gradients in the Australian Wet Tropics
- **Donald McKnight**, PhD candidate JCU - Surviving disease outbreaks: Population genetics of a rainforest frog following a chytridiomycosis outbreak
- **James Milner**, Honours student JCU - Predicting drought response in lowland tropical rainforest: two models at two sites

- **Jesse Rowland**, Masters student University of Sunshine Coast - Distribution, abundance and demographics of the northern spotted-tail quoll (*Dasyurus maculatus gracilis*)
- **Stephanie Todd**, PhD candidate JCU - Connectivity, landscape genetics and genetic diversity of the endangered northern bettong (*Bettongia tropica*)
- **Nara Vogado**, PhD candidate JCU - The effects of drought on the phenology and eco-physiology of tree species in a tropical rainforest
- **Stuart Biggs**, Honours student JCU - Understanding yellow crazy ant/mammal interactions in Queensland's Wet Tropics.

Tropical rainforest plant identification

In a partnership with the Australian Tropical Herbarium, the Authority delivered three plant identification workshops that provide hands-on training for land managers and the public, to teach and develop skills in identifying the flora of the Wet Tropics. The workshops taught the use of interactive plant identification keys and improved participants' understanding of identification, distribution, and ecology of Wet Tropics native and invasive plant species.

The workshops were based on the Australian Tropical Rainforest Plants Key, the largest interactive key in the world covering 10% of the Australian vascular flora (over 2,530 species).

CASE STUDY

The Wet Tropics – a learning landscape

2017-18 is the seventh year that the Authority has offered competitive small grants to Australian post-graduate students.

The Authority funded ten students in 2018 including Elizabeth Joyce, a PhD candidate at the Australian Tropical Herbarium at James Cook University, Cairns, who is investigating the exchange of flora between Australia and Southeast Asia.

This exchange represents a key process which has shaped the evolution of Australia's Wet Tropics. Such research helps to set conservation strategies and priorities for managing Wet Tropics flora.

The floristic exchange began as the Sahul Shelf (a continental shelf extending from modern day Australia to New Guinea) moved closer to, and finally collided with, the Sunda Shelf (modern day Peninsular Malaysia, Borneo and other parts of the Indonesian archipelago) in the Cenozoic era about 15-30 million years ago.

The patterns and dynamics of the floristic exchange between Southeast Asia and Australia through time remain poorly understood.

The Authority's research grant will support the field work necessary to collect and sequence the Australian species of the 25 plant genera targeted for this study.

Understanding whether Australian wet tropical plants have transitioned into the savannah of Sunda regularly throughout history may give an indication of Wet Tropics flora's adaptability to a warming and drying climate.

Australian Tropical Herbarium JCU PhD candidate Elizabeth Joyce collecting plant material for her study at Nandroya Falls in the Wet Tropics World Heritage Area. Photo: Elizabeth Joyce / Australian Tropical Herbarium

5. World Heritage Area values are supported and presented through sustainable tourism

The Wet Tropics World Heritage Area—identified by the IUCN as the second-most irreplaceable natural World Heritage site in the world—warrants concerted efforts to provide the highest quality standards in presentation. Tourism Tropical North Queensland (TTNQ) markets the wider region as the world's best destination to experience nature, and although the Wet Tropics rainforests' profile is not as established as other global rainforest destinations, industry research lists rainforest experiences as a major drawcard for visitors to the region.

The Authority is taking a leading role, working with our partners in government, tourism agencies, local businesses and Traditional Owners to achieve excellence in World Heritage presentation. This includes a focus on education, information, interpretation and story-telling and World Heritage branding and messaging. Target audiences include local residents, visitors, schools and national and international communities and stakeholders.

2017-18 highlights:

- Finalised the Authority's presentation strategy.
- Progressed World Heritage Family animation product.
- Delivered two Wet Tropics Tour Guide Schools, one in partnership with the Mandingalbay Yidinji people and Queensland Parks and Wildlife Service.

Presentation strategy

In August 2017, the board endorsed the Authority's presentation strategy: 'Share, Connect, Protect – best practice World Heritage Presentation in the Wet Tropics'.

The strategy was developed in consultation with the Queensland Government, the tourism industry, local councils, visitor information centres and the Authority's Community Consultative Committee. This collaborative approach will assist to:

- identify new ways to ensure that people have the opportunity to better appreciate and understand the special values and attributes of the Wet Tropics World Heritage Area
- motivate and inspire people and agencies to make a deeper connection with the Area and take an ongoing interest in its care and protection
- create pathways for Rainforest Aboriginal people to participate more in tourism and presentation activities in the Area.

Key actions from these goals have been identified and are under implementation.

World Heritage Area brand

The Authority identified a need to generate awareness of the varied landscapes and special areas across the Wet Tropics. Following indications of support from the industry, the Authority partnered with TTNQ to develop a region-wide approach to brand development for the Wet Tropics based on its World Heritage values and attributes.

TTNQ has subsequently facilitated a number of workshops with the wider tourism industry to solicit input and support for a new rainforest brand.

Tourism partnerships

Working closely with the Department of Environment and Science – Queensland Parks and Wildlife Service, Department of Transport and Main Roads and local governments, the Authority has undertaken an audit of signage and presentation issues in the World Heritage Area to identify new signage opportunities and constraints.

A preliminary report recommended further work to consult with Rainforest Aboriginal people and explore options to standardise application of the World Heritage brand; this continues into 2018-19.

The Authority has continued to investigate opportunities to strengthen the Wet Tropics Tour Guide Program through accreditation, in order to re-establish the program as fully certified and to strengthen industry engagement and support. A Partnership with Queensland Tourism Industry Council will assist in this endeavour and support Traditional Owner participation and career pathways in tourism.

New partnerships have been developed with Arts Nexus, Queensland Water and Land Carers and the Department of Aboriginal and Torres Strait Islander Partnerships to support emerging eco-cultural tourism products and networking. Following consultations, Arts Nexus with the Authority's support held an Eco-Cultural Tourism workshop in October 2017 with Aboriginal participants.

Interpretive resources

An animation collaboration with the Department of Environment and Science is under development

to tell the World Heritage Family story in a creative and engaging way. The animation will incorporate key evolutionary and geological components that connect the five World Heritage Areas in Queensland, and will be available to other World Heritage sites to assist in their presentation activities.

The Authority also updated its World Heritage Area brochure, the primary promotional tool used to support the Wet Tropics Management Authority's activities, including attendance at community events, school visits and information packs. The new brochure features updated editorial and contemporary design, and features a taste of the many aspects of what makes the Area important, encouraging further investigation and exploration.

Following the brochure update, a series of bookmarks focussed on the Area's World Heritage values and Rainforest Aboriginal culture were published for distribution at community events.

Supporting visitor information centres

The Authority has been working closely with Skyrail Rainforest Cableway, Jungle Surfing Canopy Tours, Daintree Discovery Centre and Tablelands Regional Council (Malanda Visitor Information Centre) to help strengthen rainforest interpretation. Assistance provided includes input into visitor guide books, site-based presentations as well the delivery of information sessions on the World Heritage Family project.

In collaboration with TTNQ and Tourism and Events Queensland, the Authority has developed a World Heritage Gateway prospectus for potential investors in the Cairns Global Tourism Hub project. The concept promotes a world-class centre in the proposed hub that will celebrate Aboriginal culture, World Heritage and the reef and rainforest World Heritage areas at our doorstep.

Tour guides and hosts

The Authority partnered with professional tour guide body Savannah Guides to deliver two Wet Tropics Tour Guide Schools in 2017-18, including workshops and an on-country field school in partnership with Mandingalbay Yidinji with the support of the Department of Environment and Science – Queensland Parks and Wildlife Service. The workshop component of the second school will be delivered in the next financial year.

The Authority has supported other World Heritage sites to develop their own tour guide training programs, hosting Peter Cochrane, chair of Blue Mountains Institute, to discuss possible collaboration and alignment of respective tour guide programs.

Savannah Guides was successful in a funding submission to the Australian Government's Community Heritage Icons Grants to develop the Tourism Hosts Program (now called the Ambassador Program). The Authority will assist Savannah Guides with the delivery of training and support to volunteers and visitor information staff to tell the World Heritage story.

6. Enduring partnerships enhance the integrity of the Wet Tropics World Heritage Area, its presentation and its function in the life of the community

The Authority recognises the need to actively engage local businesses, Aboriginal organisations and communities, tourism operators, community groups, landholders and industry for the development and implementation of its programs.

The Authority reaches out to stakeholders through many means, including its statutory advisory committees, public forums, community events, working groups, strategic alliances and exchanges.

2017-18 highlights:

- Established partnerships with the sugarcane industry to help with the Yellow Crazy Ant Eradication Program to find infestations and develop industry protocols.
- $1.8 million in funds provided to Queensland Parks and Wildlife Service for on-ground park management.

The Authority's partnerships are evident in almost all elements of its work so feature in other parts of this annual report. Partnership activities that are not otherwise reported are summarised below.

Regional Managers Coordination Network

The Authority is an active participant in the Far North Queensland Regional Managers Coordination Network. This network, comprising senior public sector leaders in Commonwealth, State and local governments in the region plays an important role in supporting collaboration between government agencies by sharing information relevant to implementation of government programs. A major deliverable for 2017-18 was the development of a new engagement plan to encourage government champions to engage and work with the group.

Queensland Parks and Wildlife Service

Around 85% of the Wet Tropics World Heritage Area is protected area estate (national parks, conservation reserves and other areas of public land) which is managed by the Queensland Parks and Wildlife Service (QPWS). Day-to-day activities such as infrastructure maintenance, fire, pest and weed control are their responsibility. A partnership agreement has been developed between the Authority and QPWS to prioritise and coordinate management activities in the protected area estate within the World Heritage Area. This partnership agreement outlines products and services to be delivered by QPWS under funding provided by the Queensland Government for World Heritage management.

In 2017-18, the Authority provided QPWS with $1.8M of Queensland State Government funding to enhance World Heritage management on national parks. This arrangement provides capacity for QPWS to address priorities of the Authority in relation to the World Heritage status of the Wet Tropics landscape.

Australian World Heritage Advisory Committee

The Authority collaborated with other Australian World Heritage property managers through the Australian World Heritage Advisory Committee, which advises the Commonwealth Minister for the Environment on policies and programs which benefit World Heritage properties on national or crosscutting issues. During 2017-18, the Authority contributed on a subcommittee working group to develop a draft national policy discussion paper on World Heritage cultural values and engagement. These will be progressed during 2018-19, along with case studies that provide examples of meaningful involvement of Indigenous communities in World Heritage management.

CASE STUDY

Yellow crazy ant eradication via partnerships

The Authority's Yellow Crazy Ant Eradication Program demonstrates the benefits of effective partnerships with a wide range of landholders, Traditional Owners, community groups, researchers, local industries, and state and local government agencies.

The partnerships formed through the Yellow Crazy Ant Eradication Program have raised the profile and broadened the community engagement of the Wet Tropics Management Authority. It has enabled the Authority to play an active on-ground conservation role, bringing together a diverse mix of stakeholders who might otherwise have little in common.

The success of the annual Yellow Crazy Ant Taskforce embodies this spirit of partnerships. In July 2017, more than 50 participants from local councils, natural resource management groups and traditional owners collaborated to hand-treat 125 hectares along creeks and residential areas in Cairns' southern suburbs over just one week.

The Authority has also developed strong partnerships within the sugarcane industry, working closely with sugarcane farmers, contractors and mills to develop machinery movement protocols and providing field training sessions to assist farmers to identify and report the pest, and share techniques to prevent its spread.

The program will continue its work with local industries to identify further infestations and vectors for movement of yellow crazy ants south of Cairns, engaging community groups, landholders, local industries, schools and state and local governments to assist with community education and behaviour change.

Photos: **Top**: *Yellow crazy ant nest. (Wet Tropics Images / Biosecurity QLD)* **Inset**: *Yellow crazy ants milking aphids for honeydew. (Wet Tropics Images/ Rhys Sharry)* **Bottom**: *Operations team examining cane for evidence of white fly. (Wet Tropics Images/Rhys Sharry)*

7. The Wet Tropics Management Authority is an accountable and capable organisation

The Wet Tropics Management Authority is committed to excellence in corporate governance and management. It continues to pursue high standards of business planning to ensure adequate resources are allocated to achieving its strategic goals, while regularly monitoring progress and outcomes.

2017-18 highlights:

- Leadership and governance training provide to to board directors and senior management.
- Increased investment into strategic workforce capability, including staff attendance at 38 training programs covering technical, leadership and management modules.

Financial management

As a statutory authority, general-purpose financial statements and details for 2017-2018 are incorporated in the overall Department of Environment and Science financial statements. Total funding of $8.2 million for 2017-2018 was provided to the Authority principally by the Australian and Queensland governments, and supplemented by other forms of income.

A summary of the Authority's operating statement for 2017-2018 is shown in Table 1. The Authority realised an operating deficit of $527,000 (refer to note 1 below).

The Australian Government's allocation to the Authority for 2017-18 was $5.8 million; these funds were allocated to the Authority's programs. The Queensland Government, through the Department of Environment and Science, contributed $2.8 million

TABLE 1. WET TROPICS MANAGEMENT AUTHORITY OPERATING STATEMENT

CONTROLLED REVENUE AND EXPENSES	Notes	2017-2018	2016-2017
REVENUE		**$'000**	**$'000**
Revenue from government			
Payments for outputs		2,360	2,826
Asset assumed/liabilities transferred			
SUB-TOTAL GOVERNMENT REVENUE		**2,360**	**2,826**
Own source revenue			
User charges			
Grants and other contributions		5,801	4,747
Taxes fees and fines			
Gain on disposal of fixed assets			
Other revenue		57	34
Interest			
SUB-TOTAL OWN SOURCE REVENUE		**5,858**	**4,781**
TOTAL REVENUE		**8,218**	**7,607**
EXPENSES		**$'000**	**$'000**
Operating expenses			
Org. unit			
BBA WTMA		8,740	6,269
SUB-TOTAL OPERATING EXPENSES		**8,740**	**6,269**
Non-operating expenses			
Depreciation		5	5
Asset write-downs/loss on disposal			
SUB-TOTAL NON-OPERATING EXPENSES		**5**	**5**
TOTAL EXPENSES		**8,745**	**6,275**
OPERATING RESULT	**1**	**-527**	**1,332**

Notes:

1. 2017-18 reported operating deficit is due to utilisation of unspent Commonwealth grant funding carried forward from prior years.

to the Authority to support management of the Wet Tropics World Heritage Area.

The Authority allocated $1.8 million of these funds to Queensland Parks and Wildlife Service for on-ground and field management services. Further, protracted procurement and contract management timelines for the Yellow Crazy Ant Eradication Program required a deferral of $452,000; the carryover is reflected in the 2018-19 budget.

Audits

Three operational audits were conducted by PGL Financial Services in 2017–2018 for Commonwealth grants received.

Overseas travel

No overseas travel was undertaken by Authority staff in 2017-18.

Engaging contractors

The Authority expended $3.019 million on contractors to provide specific services during 2017-18, including Traditional Owners services, information technology support, invasive species treatment, business administration support and protection and conservation activities. Table 2 shows expenditure on contractors for 2017-2018 compared to the previous financial year.

Workplace health and safety

Employees who suffer from a work-related injury or illness are entitled to apply for workers compensation. The Wet Tropics Management Authority is committed to ensuring that all workers compensation claims are appropriately managed. In 2017-18, the total number of accepted claims increased by two from the previous reporting period. The average amount paid was $16,988 per claim.

The Authority adheres to the Queensland Government's health and safety management systems and procedures for all employees, contractors and volunteers. The Authority recorded 37 workplace incidents for 2017-18. All were minor, and none resulted in lost work days. Around 50% of the reported incidents were tick bites, three were brushes with stinging trees and eight were slips, falls or strains. Each of the reported incidents were reviewed to ensure all procedures were adhered to.

As required officers attended regular education, awareness and training sessions to ensure accreditations are maintained and current.

Regular workplace health and safety inspections are conducted with no significant issues arising.

Permanent separation rate

As at 30 June 2018, the Authority's permanent separation rate was zero.

TABLE 2. EXPENDITURE FOR CONTRACTORS

	2017-2018	2016-2017
EXPENDITURE	$'000	$'000
Contractors by program		
WTMA Base	1,800	1,800
Business Management	78	42
World Heritage Connections	53	22
Planning and Conservation	14	13
Yellow Crazy Ant Eradication Program	1,074	222
TOTAL	3,019	2,099

Workforce planning and performance

The Authority is committed to developing the capability of its employees and recognises that training and development is critical for meeting government objectives. In 2017-18, expenditure for delivering planned training and development was $49,800. All training needs were identified through individual performance and development plans.

In 2017-18, the Authority engaged in workforce capability planning in conjunction with the Department of Environment and Heritage Protection, ensuring the Authority remains competitive when it comes to workforce attraction and retention. Implementation of the strategic workforce plan enables the Authority to build an overall workforce strategy, tailor strategies for particular roles of interest and identify and fill skills gaps. During the year, board directors and senior officers within the Authority were provided with Australian Institute of Community Director training to ensure the leadership team has a clear understanding of its governance roles and responsibilities and practical applications.

Equal employment opportunity

All recruitment and selection recommendations are monitored and reviewed to ensure compliance with Queensland Government policies and procedures, including current human resources directives. All appointments during 2017-2018 complied with directives and no equal employment opportunity complaints were received.

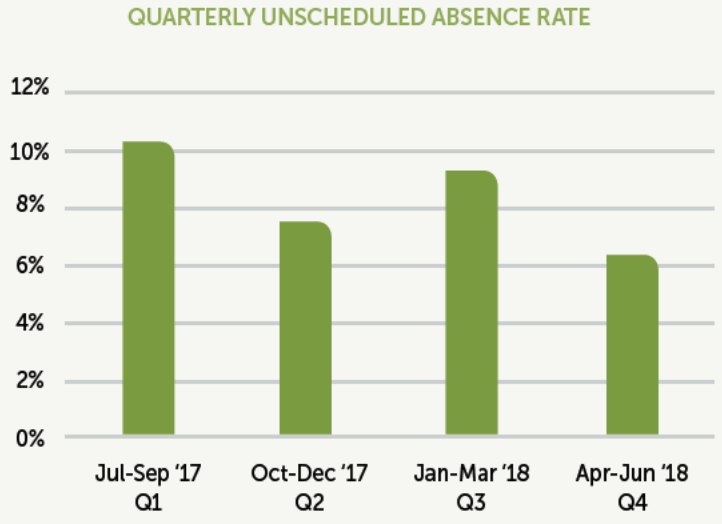
At 30 June 2018, the Authority employed 18 females and 30 males, a skew caused by a field of predominantly male applicants for field officer positions in the Yellow Crazy Ant Eradication Program.

Employee opinion survey

Since 2013 the Authority has been measured annually in the state government-wide *Working for Queensland* survey. The 2017 report highlighted a number of positive changes within the organisation, including a 25% improvement in leadership behaviour and engagement and a 30% increase in performance and development opportunities. In January 2018, an all staff workshop was held to discuss the survey results and to develop a staff-led action plan to maintain the positive momentum in the organisation's overall position.

Absenteeism

The following graph shows the quarterly rates for unscheduled absences as at 30 June 2018. Unscheduled absences include sick, carers' and special leave as well as leave for workers' compensation. The average quarterly unscheduled absence rate for 2017-2018 was 8.25%.



Workforce profile

As at 30 June 2018, the Authority employed 46.3 full-time equivalent (FTE) employees, of which 29% were employed on a permanent basis. The Authority employs a higher proportion of temporary staff due to the nature of funding cycles, especially the Yellow Crazy Ant Eradication Program, for which funding is due to cease on 30th June 2019.

At 30 June 2018, the staff establishment of the Authority totalled 61 positions of which 11 were vacant.

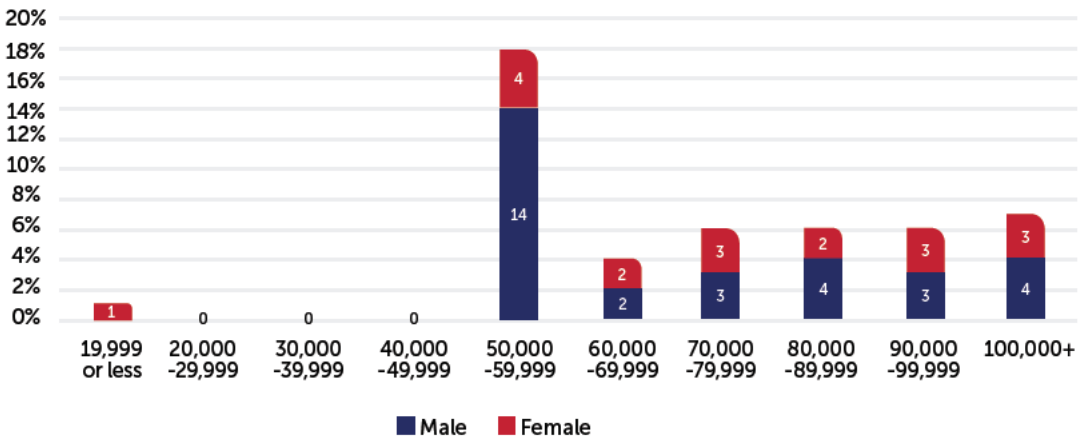
STAFFING FULL-TIME EQUIVALENT (FTE) BY OCCUPATION TYPE AND GENDER (AS AT 30 JUNE 2018)

Occupational stream	Female	Male	Total
Administration	11.2	6.8	18
Operational	3	15.9	18.9
Professional	2.6	4.8	7.4
Technical		1	1
Senior Executive Service		1	1
TOTAL	16.8	29.5	46.3

STAFFING FULL-TIME EQUIVALENT (FTE) BY EMPLOYMENT TYPE AND GENDER (AS AT 30 JUNE 2018)

Employment type	FTE		FTE		Total FTE	Total FTE%
	Female	Male	Female	Male		
Permanent	8.2	5	62.12%	37.88%	13.2	28.51%
Temporary	8.6	24.5	25.98%	74.02%	33.1	71.49%
TOTAL	16.8	29.5	36.29%	63.71%	46.3	100.00%

ANNUAL EARNINGS BY GENDER



Volunteers and internships

The Authority recognises that volunteers make a valuable contribution to the organisation, and is committed to planned, supported and appropriately managed volunteer arrangements. During 2017-18 the Authority hosted four graduate placements via formal arrangements through the Aurora (Native Title Internship) Program and the Department of Environment and Science.

Appendix 1. Wet Tropics Management Authority board of directors

Wet Tropics Management Authority board	
Act or instrument	*Wet Tropics World Heritage Protection and Management Act 1993*
Functions	Under section 10(1) *Wet Tropics World Heritage Protection and Management Act 1993* (the Act), the functions of the Wet Tropics Management Authority board are to: • develop and implement policies and programs in relation to the management of the Wet Tropics area • formulate performance indicators for the implementation of policies and programs approved by the Ministerial Forum • advise and make recommendations to the Minister and the Ministerial Forum in relation to: – the management of the Wet Tropics area – Australia's obligation under the World Heritage Convention in relation to the Wet Tropics area • prepare, and ensure the implementation of, management plans for the Wet Tropics area • administer funding arrangements in relation to the Wet Tropics area • enter into, and facilitate the entering into of, cooperative management agreements (including joint management agreements) with landholders, Aboriginal people particularly concerned with land in the Wet Tropics area and other people • enter into arrangements for the provision of rehabilitation and restoration works in relation to any land in the Wet Tropics area • gather, research, analyse and disseminate information on the Wet Tropics area • develop public and community education programs in relation to the Wet Tropics area • promote the Wet Tropics area locally, nationally and internationally • liaise with the governments and authorities of the state, the Commonwealth, other states and the territories, and international and foreign organisations and agencies • monitor the state of the Wet Tropics World Heritage area • advise and report to the Minister and the Ministerial Forum.
Achievements	In 2017–18, the board: • analysed the full range of issues raised during phase one consultation of the statutory Wet Tropics Management Plan review. As a result, the board provided direction on the Plan review process and proposed that a revised plan include an additional section to detail the vision and policy directions of the Authority to meet its World Heritage obligations • undertook a successful Wet Tropics Rainforest Aboriginal peoples workshop, which was attended by some 60 representatives of native title bodies, senior government officials, the North Queensland Land Council and Terrain Natural Resource Management. This regional gathering of Traditional Owners discussed issues relating to Aboriginal land and cultural management in the Wet Tropics. As a result, the board has resolved to refresh the regional agreement signed by state and Commonwealth governments and Rainforest Aboriginal Elders in 2005 • held the Wet Tropics Ministerial Forum on 28 July 2017. The forum, comprising Australian and Queensland Environment Ministers, meets annually to provide oversight to the strategic operation of the Wet Tropics Management Authority, approve annual budgets and consider future directions for meeting the property's World Heritage obligations • tabled the Authority's 2017–18 *State of Wet Tropics Report* in the Queensland and Australian parliaments • hosted the Cassowary Awards on 10 March 2018. This event celebrated the contributions made by the wider community into the protection and presentation of the World Heritage Area • approved scientific research protocols which will facilitate management of natural resources and bio-cultural collaborative exchange between traditional landowners and researchers who are performing low impact research in the Wet Tropics World Heritage Area • approved the *Wet Tropics Presentation Strategy,* which aims to focus Authority efforts to present the Wet Tropics World Heritage Area and canvass options for new private and public contributions to achieve higher standards of interpretation.

Wet Tropics Management Authority board (cont.)

Financial reporting	The Authority provides audited financial statements as required by the *Financial Accountability Regulation 2009*.

REMUNERATION

Position	Name	Meetings/sessions attendance	Approved annual, sessional or daily fee	Approved sub-committee fees if applicable	Actual fees received
Chair	Leslie Shirreffs	4	$520 daily fee		$5,460 $16,120*
Member	John Courtenay	4	$400 daily fee		$4,200
Member	Anne Clarke	4	$400 daily fee	$400 daily fee (Chair Wet Tropics Community Consultative Committee)	$4,800
Member	Iain Gordon	3	$400 daily fee	$400 daily fee (Chair Wet Tropics Scientific Advisory Committee)	$2,400
Member	Leah Talbot	2	$400 daily fee		$1,600
Member	Phillip Rist	4	$400 daily fee		$3,200
Executive director	Scott Buchanan	4	N/A	N/A	N/A

No. scheduled meetings/ sessions	The board met four times in 2017-18: 17 -18 August 2017, 15 January 2018, 8-9 March 2018 and 21-22 June 2018.
Total out of pocket expenses	The board cost $88,454 to operate, mostly for sitting fees, reimbursement of out of pocket expenses, travel expenses, governance training, ITC support, site inspections and catering. The board is funded by the Australian Government—the Queensland Government does not contribute to its operational cost.

* In addition to sitting fees for board meetings, directors are entitled to be remunerated for the additional work time required to carry out the role, as specified in *Remuneration Procedures for Part-time Chairs and Members of Queensland Government Bodies* (the Remuneration Procedures). Refer category – Regulation, Administration and Advice Level 2.

Appendix 2. Statutory committees

Wet Tropics Community Consultative Committee

Act or instrument	*Wet Tropics World Heritage Protection and Management Act 1993*
Functions	The Wet Tropics Community Consultative Committee (the Committee) advises the Wet Tropics Management Authority (the Authority) about community views on its policies and programs in relation to the Wet Tropics World Heritage Area.
Achievements	In 2017–18, the Committee: • provided advice and direction on a number of strategic documents, including the Authority's World Heritage Presentation Strategy, the review of the Wet Tropics Management Plan, and the 2016 Australia State of the Environment Report • provided advice and support on the planning for the Authority's 2017 Cassowary Awards and the 2018 Climate Change Workshop • participated in a workshop to provide a series of potential themes, activities and products to assist in celebrating 30 years of the Wet Tropics World Heritage Area • provided advice on the Authority's engagement, strategies and branding • provided input into the review of the Wet Tropics Tour Guide School and program • supported members to play a leadership role in the development of the Gillies Range illegal dumping clean-up project (with the Department of Environment and Science and regional councils).
Financial reporting	The Authority provides audited financial statements as required by the *Financial Accountability Act 2009*.

REMUNERATION

Position	Name	Meetings/sessions attendance	Approved annual, sessional or daily fee	Approved sub-committee fees if applicable	Actual fees received
Member	Anne Clarke	4	$400 daily fee	N/A	$2,400
Member	Dennis Ah-Kee	1	N/A	*N/A*	N/A
Member	Ellie Bock	2	N/A	N/A	N/A
Member	Allan Gillanders	1	N/A	*N/A*	N/A
Member	Sigrid Heise-Pavlov	3	N/A	N/A	N/A
Member	Bess Murphy	2	N/A	*N/A*	N/A
Member	Craig Pocock	4	N/A	N/A	N/A
Member	Gerard Puglisi	1	N/A	*N/A*	N/A
Member	Peter Rowles	4	N/A	N/A	N/A
Member	Angela Toppin	3	N/A	*N/A*	N/A
Member	Linda Venn	3	N/A	N/A	N/A
Ex-Member	Seraeah Wyles	2	N/A	*N/A*	N/A
Executive director	Scott Buchanan	0	N/A	N/A	N/A

No. scheduled meetings/ sessions	The Committee met four times in 2017-18: 27 July 2017, 2 November 2017, 1 March 2018 and 7 June 2018
Total out of pocket expenses	The Committee cost $7,476 to operate, mostly for sitting fees (chair), advertising, reimbursement of out of pocket expenses, travel expenses and catering. Members do not receive sitting fees. The Committee is funded by the Australian Government—the Queensland Government does not contribute to its operational cost.

Wet Tropics Scientific Advisory Committee

Act or instrument	*Wet Tropics World Heritage Protection and Management Act 1993*
Functions	The Wet Tropics Scientific Advisory Committee (the Committee) advises the Wet Tropics Management Authority on: • scientific research that will contribute to the protection and conservation of the Wet Tropics World Heritage Area • scientific developments relevant to the protection or conservation of the area.
Achievements	The Committee met three times during 2017–18 and provided advice to the Authority board regarding: • issues specific to the Wet Tropics Management Plan review • developing climate change adaption and mitigation strategies to protect World Heritage values. A climate change working group of the Committee was established to progress an initial multidisciplinary workshop to identify priority adaption and mitigation adaption actions • a draft guideline to formalise research protocols for engagement between Rainforest Aboriginal people and researchers. This document has gone through an extensive process of stakeholder engagement with Rainforest Aboriginal people • attributes and ecological function of Wet Tropics species, including the spectacled flying-fox and the southern cassowary.
Financial reporting	The Authority provides audited financial statements as required by the *Financial Accountability Act 2009*.

REMUNERATION

Position	Name	Meetings/sessions attendance	Approved annual, sessional or daily fee	Approved sub-committee fees if applicable	Actual fees received
Member	Professor Iain Gordon	3	$400 daily fee	N/A	$2,400
Member	Professor John Herbohn	1	N/A	*N/A*	N/A
Member	Mr John Locke	3	N/A	N/A	N/A
Member	Associate Professor Susan Laurance	3	N/A	*N/A*	N/A
Member	Dr Suzanne Long	2	N/A	N/A	N/A
Member	Professor Bruce Richard Prideaux	3	N/A	*N/A*	N/A
Member	Dr Lea Scherl	3	N/A	N/A	N/A
Member	Mrs Joann Schmider	3	N/A	*N/A*	N/A
Member	Dr David Westcott	1	N/A	N/A	N/A

No. scheduled meetings/ sessions	The Committee met three times in 2017-18: 25 July 2017, 23 October 2017 and 1 May 2018.
Total out of pocket expenses	The Committee cost $11,421 to operate, mostly for sitting fees (Chair), advertising, reimbursement of out of pocket expenses, travel expenses and catering. Members do not receive sitting fees. The Committee is funded by the Australian Government—the Queensland Government does not contribute to its operational cost.

Appendix 3. Annual report on the administration of the Wet Tropics Management Plan 1998

The Wet Tropics Management Plan 1998 **(the Plan) regulates land use activities inside the Wet Tropics World Heritage Area (the Area) that have the potential to impact on the integrity of the Area. In 2017-18, Authority staff audited and advised a number of agencies or organisations undertaking activities in the World Heritage Area under existing permits.**

Authority staff assessed a permit application by Tablelands Regional Council to undertake slip stabilisation works on the access track to the Upper Barron water intake. To streamline this process, the Authority collaborated with Queensland Parks and Wildlife Service (QPWS) enabling the issue of a letter of authority for these works to proceed within Mount Hypipamee National Park which was also deemed a permit in accordance with the Plan. Staff also provided input to the assessment of a permit application to QPWS to allow helicopter flights for filming at Wallaman Falls.

Authority staff assessed and issued two other permits under the Plan to:

- Department of Transport and Main Roads for curve widening on the Kuranda Range section of the Kennedy Highway
- Douglas Shire Council for road works at the intersection and access to Kulki at Cape Tribulation

Pre-lodgement advice on permit applications was provided to:

- Queensland Rail to construct new rock netting in Barron Gorge
- Tableland Regional Council for the construction of a new raw water pipeline from Herberton Dam to Herberton
- Cassowary Coast Regional Council regarding the urgent re-establishment of a section of the Tully Gorge Road
- Cairns Regional Council regarding the re-establishment of Lake Morris Road
- Powerlink regarding proposed refurbishment of tower footings in the Barron Falls National Park.

In accordance with section 28 of the Plan, staff assessed a number of proposals as having only minor and inconsequential impacts on the World Heritage Area, including:

- upgrading raw water pipelines at Rex Creek by Douglas Shire Council
- flying a drone to film a mass evacuation exercise in Tully Gorge involving QPWS, the SES and Raging Thunder
- flying helicopters to Skyrail Rainforest Cableway facilities for construction and maintenance purposes
- drilling for geotechnical analysis by the Department of Transport and Main Roads
- drainage works by Cook Shire Council on the Bloomfield to Rossville Road
- tree removal to facilitate bridge works on Black Mountain Road by Mareeba Shire Council
- re-aligning an Ergon electricity power line adjacent to Tully Gorge Road
- re-construction of bridges on the Tully Falls Road by Tablelands Regional Council
- installing a pedestrian bridge to span the railway line near Stoney Creek by Queensland Rail.

Authority staff consulted with registered native title bodies corporate regarding their views on assessment of Wet Tropics permit renewals by community services infrastructure providers for ongoing maintenance of their infrastructure inside the Area. Staff advised several community service providers of extensions to permits authorising the maintenance of their infrastructure including Stanwell Corporation, Ergon, Department of Transport and Main Roads, Skyrail Rainforest Cableway and Townsville Water to allow further time to consult with relevant Aboriginal People regarding the issuing of new maintenance permits.

Authority staff also provided advice to:

- Telstra, regarding on track maintenance at telecommunication facilities at Mt Misery and Wangetti
- Department of Transport and Main Roads, regarding landscaping at the Henry Ross lookout
- Ergon, regarding the upgrade of access tracks associated with a power line at Wangetti
- Department of Defence, regarding bridge construction and track maintenance at Tully Training Area
- Broadcast Australia, regarding the refurbishment of infrastructure and the construction of erosion control structures at their Bellenden Ker telecommunication facility
- Stanwell Corporation, regarding the removal and rehabilitation of a disused telecommunications site near Tully Falls
- Stanwell Corporation, regarding potential helicopter evacuation from a remote saddle dam at Koombooloomba.
- Consultants, regarding a proposed wind farm south of Ravenshoe
- Douglas Shire Council, on the likely cause of on-going siltation from Turpentine Road, Diwan.

Staff reviewed environmental management plans (EMPs) for the roads managed by the Department of Transport and Main Roads within the Area. Staff also reviewed the Stanwell Corporation EMP.

The Authority provided training to Tablelands Regional Council on community services infrastructure maintenance as it relates to permit conditions under the Plan.

Staff provided advice on the Draft Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (Commonwealth of Australia, 2017) and facilitated the eradication of invasive weeds at several locations within and adjacent to the World Heritage Area. In conjunction with Department of Transport and Main Roads and the Douglas Shire Council, the Authority facilitated closures of unauthorised tracks at Wangetti Reserve.

Investigation and enforcement

Staff investigated the removal of a red cedar (*Toona ciliata*) from a property near Shiptons Flat. The land owners were cautioned and no prosecution was pursued as the matter involved a single tree that had died and fallen naturally within a cleared paddock and the activity could be considered as having no more than minor and inconsequential impacts on World Heritage values.

Staff investigated a report of the destruction of a number of rare and threatened native plants by surveyors undertaking a boundary survey at Cooper Creek. Following a review of the matter it was agreed the methodology employed resulted in minimal destruction of vegetation and it was agreed the surveyors would seek input from qualified botanists before undertaking any further work in the vicinity.

Land dealings

The Authority advised on seven enquiries regarding development proposals, including those outside the Area that may affect World Heritage values. Advice was also provided to the Department of Natural Resources and Mines regarding proposed road closures, a proposed conversion of a lease to freehold, potential development sites near Shiptons Flat, the inclusion of a former lease into the adjoining national park and the potential acquisition of properties adjoining national parks at Cow Bay and Mount Lewis.

Staff provided information to various persons on the location of the boundary of the World Heritage Area and the effect of the Plan on properties within the Area. Advice was provided to landholders on the potential for future development at properties within the Area at Home Rule and Bramston Beach. Staff inspected the state of a freehold property at Woopen Creek that was for sale to ascertain what activities may be able to be carried out by any potential new owner.

Staff also provided advice to a new landholder about their obligations under a cooperative management agreement in regard to their property. Letters of support were provided to the South Endeavour Trust supporting the purchase of two properties important to enhancing the ecological connectivity of upland rainforests.

Abbreviations

CCC	Community Consultative Committee
Commonwealth Act	*Wet Tropics of Queensland World Heritage Area Conservation Act 1994*
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EMP	Environmental management plan
IUCN	International Union for Conservation of Nature
JCU	James Cook University
OUV	Outstanding universal value
QPWS	Queensland Parks and Wildlife Service
Queensland Act	*Wet Tropics World Heritage Protection and Management Act 1993*
The Area	Wet Tropics of Queensland World Heritage Area
The Authority	Wet Tropics Management Authority
The Plan	Wet Tropics Management Plan 1998
RMCN	Regional Managers Coordination Network
SAC	Scientific Advisory Committee
TOLG	Traditional Owner Leadership Group
TTNQ	Tourism Tropical North Queensland
WTMA	Wet Tropics Management Authority

WET TROPICS
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FRONT COVER IMAGE: Stoney Creek (Wet Tropics Images / Charlotte Hellings)

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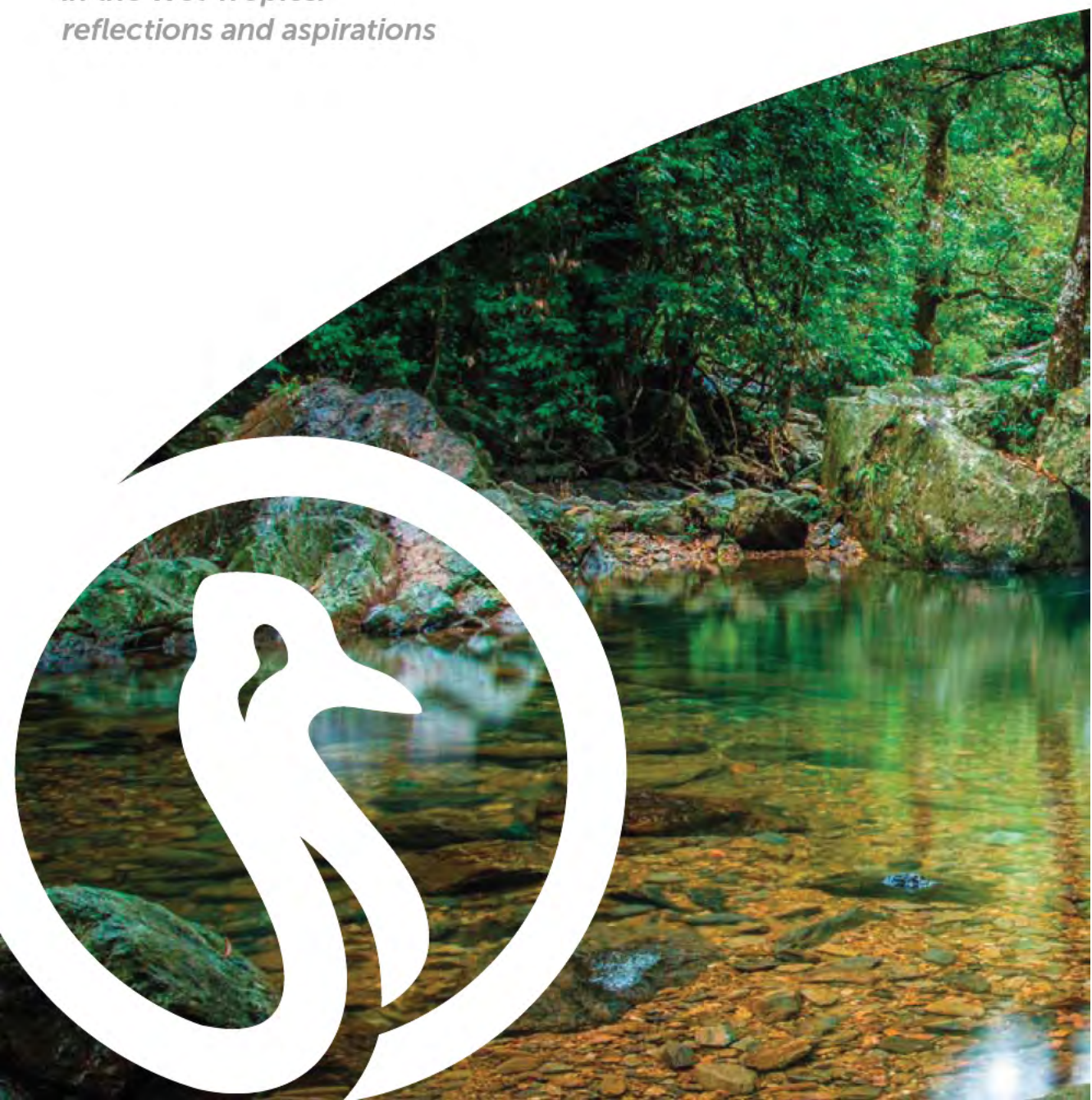
STATE OF WET TROPICS 2017-2018

30 years of World Heritage in the Wet Tropics: reflections and aspirations

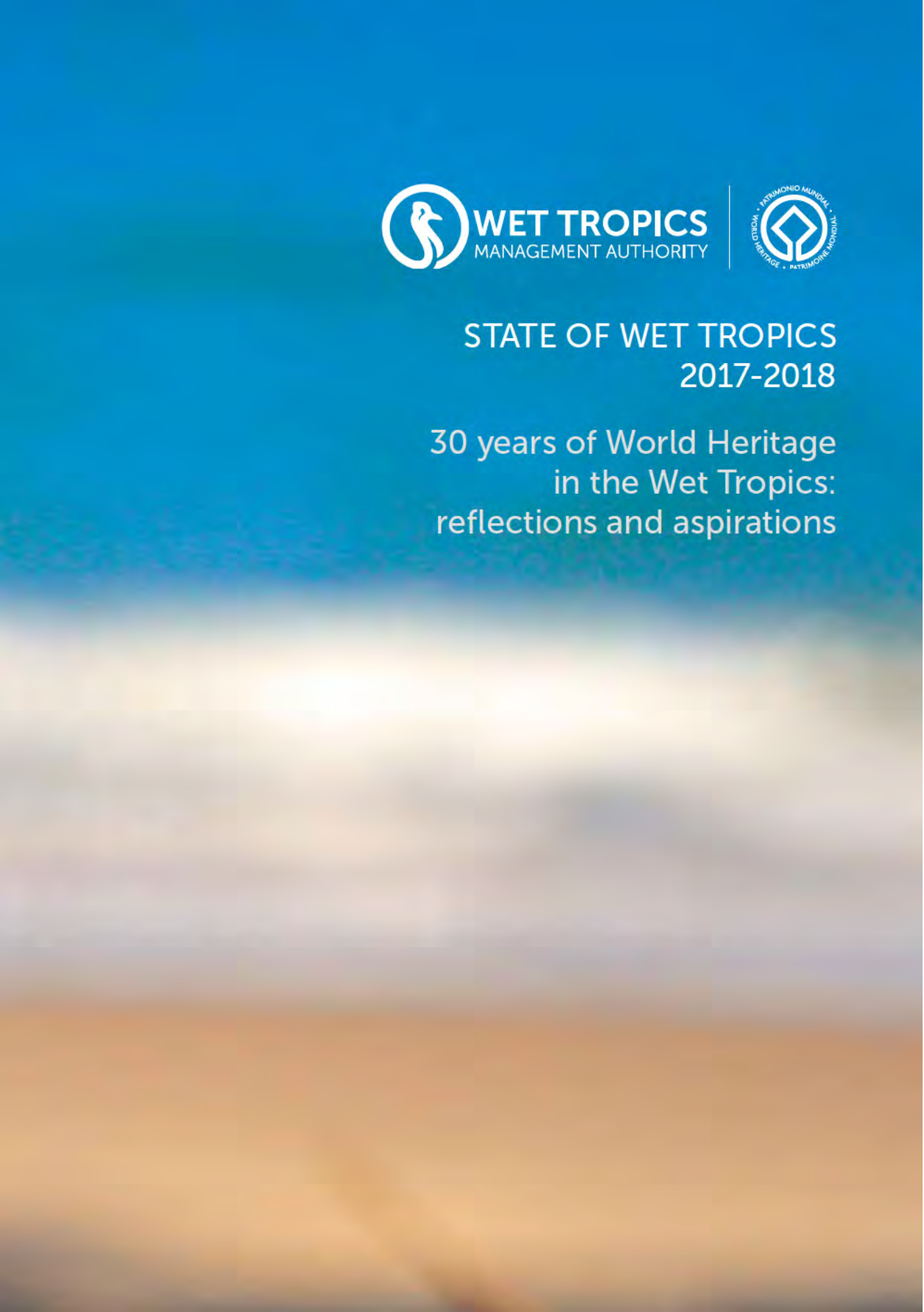


Southern cassowary
(Wet Tropics Images / Matt Cornish)

WET TROPICS
MANAGEMENT AUTHORITY

STATE OF WET TROPICS 2017-2018

30 years of World Heritage in the Wet Tropics: reflections and aspirations



Purpose of the report

This State of Wet Tropics report satisfies the requirements of Queensland's *Wet Tropics World Heritage Protection and Management Act 1993* and *Financial Accountability Act 2009*; and the Commonwealth's *Wet Tropics of Queensland World Heritage Conservation Act 1994*.

Public availability

This publication can be accessed from our website at www.wettropics.gov.au. Alternatively, hard copies can be obtained by emailing wettropics@wtma.qld.gov.au.

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Disclaimer

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Davies Creek (Wet Tropics Images / Charlotte Hellings)

Executive summary

In the 30 years since the Wet Tropics of Queensland was inscribed on the World Heritage list, much has changed in terms of attitudes towards its listing and broader natural resource management issues such as climate change.

World Heritage listing of the Wet Tropics

The World Heritage Convention aims to protect places that are so significant—of such outstanding universal value—that their permanent protection is of the highest importance to humanity.

The Wet Tropics of Queensland World Heritage Area was inscribed on the World Heritage list on 9 December 1988. It is one of an elite group of World Heritage properties listed for all four natural criteria (UNESCO, 1988).

Some 32% of Australia's terrestrial fauna species (many of which occur nowhere else) are found in the Area, which comprises less than 0.2% of the continent. These rainforests are globally significant relics of the great Gondwanan forests that covered Australia 50 to 100 million years ago.

While there was little doubt about the natural values of the Area, the journey towards World Heritage listing was complex, controversial and had strong involvement of communities—both in support of and against the proposed listing. Particularly, the permanent protection of the forests signalled an end to logging, giving rise to concerns about economic decline in regional areas. Political division, protests, blockades and even civil disobedience characterised a decade-long struggle that resulted in significant social, economic and environmental effects across the region.

For Rainforest Aboriginal people, there was apprehension about the impacts of World Heritage on their rights of self-determination, with no tangible benefits evident. While the cultural and spiritual values of the land are inextricably linked with its natural values, the listing did not recognise the cultural landscape and biocultural values they had managed for generations.

Once the World Heritage Area was declared, the Wet Tropics Management Authority was established to ensure Australia meets its obligation to the World Heritage Convention. The Queensland and Australian governments entered into a Wet Tropics Management Scheme in 1990, agreeing to joint funding and management arrangements. They established the Authority to work in partnership with the community as a means of building a sense of ownership and sharing both the benefits and burdens of sound management.

30 years on: a place worth celebrating

Much has changed and been achieved over the last 30 years, but importantly the outstanding universal values that inspired the World Heritage listing in the first place have been conserved (IUCN,2017). The Area offers breathtaking beauty, incredible species endemism and diversity, along with biocultural and spiritual values.

While first viewed as overly bureaucratic and, at times, unresponsive to demands, the Authority has grown to become an integral part of the community it serves, working across the spectrum of interests towards community and World Heritage goals.

Since the signing of an historic Regional Agreement in 2005, relationships between Rainforest Aboriginal people and the Authority have matured, although a number of the commitments under the Agreement have yet to be fully implemented.

The World Heritage Area plays an important role in the life of the community, whether through culture, recreation, employment or simply the quality of life that comes from living in such an aesthetically enjoyable place.

Securing the future—the next 30 years

Whilst managing the World Heritage Area has always been complex, the Authority must address the social, economic and environmental issues and challenges anticipated for the next 30 years—of which there are many.

Perhaps the biggest challenge is climate change. With changes to species distribution and density having already been recorded—and some somber predictions of modelled effects—there will be a critical need for science-based solutions, advocacy by informed communities and substantial resources to improve the resilience of the Area.

Invasive species will continue to cause impact. Existing problems, like feral pigs, and emerging new ones, like myrtle rust, will require collaborative effort and resources to manage impacts. Multi-faceted strategies like the highly effective Yellow Crazy Ant Eradication Program will form the basis of whole of community, rapid-response approaches to pest management.

Urban growth in the region is expected to double to more than 700,000 people in the next 20 years, putting further pressure on the natural environment and increasing demand for infrastructure like roads, dams and energy supply. This growth could potentially sever wildlife corridors, causing species isolation and limiting their ability to respond to change.

Tourism plays an increasingly important role in presenting the Area to visitors and it will evolve to provide even more diverse experiences, distributing visitation across a wider area and extending the length of stay in the region. This will bring economic and employment growth, but also increase the need for infrastructure.

The challenge is to plan for future changes without endangering World Heritage values. Ensuring these values, our economy and the wider community are protected from negative effects will need considered planning and regulation as well as the support, and partnership, of the Wet Tropics community. The people of the Wet Tropics are one of the Area's greatest assets, with a strong record of stewardship, which, in the case of Rainforest Aboriginal people, stems back thousands of years.

With native title either resolved, or in the process of being resolved, across 87.5% of the Area and the first Wet Tropics land tenure resolution process underway, it is foreseeable that in the next 30 years, large parts of the Wet Tropics World Heritage Area will be either solely or jointly managed by Traditional Owners. From this will come increased economic opportunities—through tourism, ranger programs and use of cultural resources—and the official recognition of responsibility for country, consistent with traditional practices over thousands of years.

Our committed Wet Tropics community, together with collaborative government support and a dedicated management authority, unite to give optimism for the coming 30 years.

Fan palms at Cooper Creek Wilderness (TTNQ Images)

Introduction

Each year, the Wet Tropics Management Authority (the Authority) produces a report to inform the community and stakeholders on the integrity and state of the Wet Tropics World Heritage Area (the Area).

This report reflects on the events leading up to the listing, provides insight into the changes in our Wet Tropics community since that time, and looks to the next 30 years. We are grateful to be able to share the recollections of a number of people from the years immediately following the listing, as well as some future aspirations of the Wet Tropics community.

9 December 2018 marks 30 years since the inscription of the Wet Tropics of Queensland on the World Heritage list. Now is an opportune time to reflect on the events that led to the listing and the changes since, and to consider aspirations for the Area over the next 30 years.

The road to World Heritage listing was complex and controversial. Proponents and opponents were numerous, and passionately vocal. Some who opposed the World Heritage listing now acknowledge what World Heritage status has brought to the region, while others remain sceptical of its worth and the means by which it was achieved. Importantly, 30 years later the outstanding universal values that supported World Heritage listing of the Wet Tropics have been conserved and are deeply entrenched in the lives and lifestyles of residents.

For the Authority in particular, a focus will be to strengthen community relations and empower Wet Tropics stakeholders to work together for the 'protection, conservation, presentation, rehabilitation and transmission to future generations' of the World Heritage Area (*Wet Tropics World Heritage Protection and Management Act 1993*).

After all, World Heritage is our promise to the future.

Mossman Gorge day use area (Paul Curtis Images)

The history of settlement in the Wet Tropics World Heritage Area

Rainforest Aboriginal people

Rainforest Aboriginal people have been living in the rainforests of the Wet Tropics region for many thousands of years. Prior to European settlement, the Wet Tropics rainforests were one of the most populated areas of Australia, and the only area where Indigenous Australians lived permanently in the rainforest. Rainforest Aboriginal people's environment provided everything— spirituality, identity, social order, shelter, food and medicine. Their cultural and spiritual beliefs are intertwined with the natural features of their country. Those values, and their importance to the management of the World Heritage Area, persist today.

On 9 November 2012, the property was included on the National Heritage listing for its Indigenous values. The listing recognised that "Rainforest Aboriginal people were able to permanently occupy the Wet Tropics because they had developed techniques which allowed them to exploit toxic plants throughout the year. The majority of calories consumed by Rainforest Aboriginal people came from toxic plants. They processed and ate at least 14 native toxic plants—a greater use than anywhere else in Australia—and developed more complex techniques for processing toxic plants than anywhere elsewhere in Australia. Remains of toxic plants eaten by Rainforest Aboriginal people have been recovered from excavations of rockshelters and date to about 3,500 years ago.

Rainforest Aboriginal people developed a unique material culture that enabled them to utilise the plant and other resources on which they relied. This includes a set of distinctive stone tools including: an ovate or rectangular grooved slab associated with a crushing stone; an anvil stone pitted with small hollows and accompanied by a hammer stone; polished waisted stone axes called *ooyurkas*, and bicornual baskets. In addition to the use of this unique material culture, fire management was essential for Rainforest Aboriginal people's permanent occupation of the rainforest in the Wet Tropics region. This includes the use of fire to convert patches of rainforest into open forest and the placing of hot coals at the base of lawyer vines to kill them so walking tracks and camp sites are kept clear. Both of these techniques are unique to the Wet Tropics region." (Australian Government, 2012).

European settlement

The first European explorers to the region, such as Edmund Kennedy and Christie Palmerston, characterised the Wet Tropics rainforests as jungle, bush or bastard scrub (Francis, 1929). For the colonisers, the rainforests of the region stood as uncultivated spaces, in contrast to the desired patchwork of settlements (Parnell, 2008).

George Dalrymple led the first comprehensive exploration of the coastal Wet Tropics in 1873. The primary purpose of the expedition was to discover agricultural lands. He reported on a 'Northern Eldorado' and a 'great coast basin' with 'soil unsurpassed by any in the world... all fitted for tropical agriculture' (Birtles, 1995). The area was subsequently colonised and large tracts of land were logged or cleared for maize, sugar, dairy, tea and cotton.

Following the separation of Queensland from New South Wales, land development in Queensland followed a policy of closer settlement (Cameron, 2005) to fill the lands of the newly founded state. Timber getters moved to the Atherton Tableland, aided by the building of roads and railways, which stimulated further settlement and land clearing.

During the 1950s, large-scale schemes to develop most of the north Queensland 'scrub lands' into small farms were proposed (Frawley, 1987; Gould 2000). The Queensland Forestry Department argued against such schemes, lobbying for the reservation of forested lands and their professional management for timber production and 'feature protection'. They were successful and most of the remaining forested lands were retained as Crown land.

A change in perception

Up to the late 1950s, while general botanical observations and limited collections had been made, the study of rainforest vegetation was largely neglected except for forestry and timber extraction purposes. Such forest was often seen as a barrier to progress, and in a number of states throughout Australia landholders could not receive government incentive funding until their land had been cleared of trees (Cassells *et al* 1988).

The 1960s saw significant change in rainforest management, planning and utilisation for two reasons: the expansion in effort and expenditure by the government into long-term management planning; and the evolution of the conservation movement, which successfully challenged the pre-1960 management of timber in favour of managing for rainforest preservation and conservation (Valentine and Hill, 2008). This radical change in the way society valued the region's rainforests was largely due to the changes in knowledge and appreciation of the international scientific significance of the rainforests.

The foundations for the study of the Wet Tropics rainforests were laid by Len Webb (1959, 1968), who published the first systematic classification of Australian rainforest vegetation from Tasmania to the monsoonal tropics. Until the 1970s, it was thought that rainforests were alien to the Australian landscape—eucalypts and acacias were considered the quintessential Australian vegetation. Rainforests were thought to be recent invaders from Asia via the land bridge that, in fairly recent geological times, connected Australia with New Guinea. Ecological and taxonomic research, however, gradually provided evidence that radically changed this view (Webb 1959; Webb *et al*. 1976, 1984; Webb and Tracey 1981).

IN THEIR OWN WORDS

Peter Valentine

Former chair of the Wet Tropics board

Scientists started to write articles about the rainforest—these were helping people to have a better understanding. When people walked in the rainforest, they did not see evidence of all the rich wildlife; they could not interpret it without tools and guidance.

There was a recognisable need to help people understand the true magnificence of the rainforest. It did not come naturally. They could look at the rainforest and say scrub! Barrier! Wait-a-while, lawyer vine, stinging plants: all the things they did not want to know about.

There was a recognisable need to help people understand the true magnificence of the rainforest.

The rise of rainforest conservation

The Australian Conservation Foundation and the Queensland Conservation Council launched the Rescue the Rainforest Campaign in 1981, followed by a blockade of logging operations on Mount Windsor Tableland later that year. Pressure was being mounted by conservation groups to protect the rainforests from logging operations, though the primary focus of early campaigns was on the Daintree area.

A significant event in the campaign for rainforest protection came in November 1983 when a developer, supported by the then Queensland Government, constructed the Cape Tribulation–Bloomfield Road (Wilkie, 2015). This resulted in a blockade by protestors which, although unsuccessful in stopping the construction of the road, focussed significant national and international attention to the area.

IN THEIR OWN WORDS

Ro Hill

Former Wet Tropics Management Authority board director and committee member

The Wet Tropics is an important part of the global history of people's growing concern about the destruction of rainforests. I remember being contacted by a National Geographic photographer in 1982 who was doing a story on the world's rainforests and we were the first people that he came across who were protesting against rainforest destruction. He came to Australia especially because of this.

Everyone now takes rainforest conservation for granted because of its obvious benefits. However, it wasn't back then and the movement that started in the Wet Tropics was world leading.

The movement that started in the Wet Tropics was world leading.

A bumpy road to listing

The Wet Tropics featured heavily in national environmental politics throughout the 1980s. The World Heritage listing of the Area was beset with political battles between the Queensland and Australian governments (Burg, 2007)—the former strongly opposed the idea, while the latter championed it.

The impetus for the Wet Tropics' eventual World Heritage listing was its inclusion on the World Conservation Union's list of places deserving World Heritage protection in 1982.

In 1984, the Australian Heritage Commission engaged the Rainforest Conservation Society of Queensland to evaluate the international conservation significance of the Wet Tropics. Their report stated: 'we conclude that the Wet Tropics region of north-east Queensland is one of the most significant regional ecosystems in the world. It is of outstanding scientific importance and natural beauty and adequately fulfils all four of the criteria defined by the World Heritage Convention for inclusion in the World Heritage List.' In September 1984, the Australian Heritage Commission officially recommended the Australian Government proceed to World Heritage nomination.

During 1985, the Australian Government developed the National Rainforest Conservation Program, which included $22.24 million for a review of the rainforest timber industry, acquisition of rainforest on private lands, preservation of virgin rainforest and the establishment of a national rainforest research institute. The Queensland Government rejected the program and refused to participate.

The 1987 federal election saw the Australian Government announce its commitment to the World Heritage listing of the rainforests of the Wet Tropics of Queensland, despite the objections of the Queensland Government, all of the region's shire councils and several Aboriginal representative groups.

The Australian Government formally presented the nomination of the Wet Tropics to the World Heritage Committee on 23 December 1987. The State Government immediately mounted a High Court challenge and established an anti-listing alliance.

In response to the concerns of local residents and communities about the social and economic consequences of listing, the Queensland Premier urged groups to 'set yourselves up like an army and fight' (Woodward 1987).

Horsfall and Fuary (1988) reported that Aboriginal groups were divided between those who supported the listing because cultural maintenance was strongly linked to rainforest protection, and those who opposed it as a limitation on their rights. Aboriginal leaders were among groups funded by the State Government to lobby the World Heritage Bureau against the listing.

In 1988, so as not to compromise the listing, the Australian Government passed a regulation under the *World Heritage Properties Conservation Act 1983* banning logging in the Wet Tropics. In April of that year they announced a $75.3 million Wet Tropics of Queensland Structural Adjustment Package (SAP) for job creation, labour adjustment and assistance and business compensation to offset the impacts of the cessation of logging.

At the *Twelfth Session of the World Heritage Committee* in Brasilia, Queensland's Wet Tropics nomination was endorsed and the Area was officially inscribed on the World Heritage list on 9 December 1988, but it would take a change of government in Queensland before there would be any support from the State.

Outstanding universal value of the Wet Tropics World Heritage Area

The concept of outstanding universal value underpins the whole World Heritage Convention and all activities associated with properties inscribed on the List.

The Wet Tropics of Queensland World Heritage Area fulfils all four natural criteria for World Heritage listing, and the necessary conditions of integrity. The Wet Tropics is considered to:

- contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance—*criterion (vii)*
- be an outstanding example representing the major stages of Earth's history, including the record of life, and significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features—*criterion (viii)*
- be an outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals—*criterion (ix)*
- contain the most important significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation—*criterion (x)*.

Responsibilities, governance and legislation

Under the World Heritage Convention, the Australian Government is required to provide:

- protection (legislative action)
- conservation (management action)
- presentation (sharing the outstanding universal value of the place with the community)
- transmission to future generations (ensuring the values of the area are protected so that they can be passed onto future generations)
- rehabilitation (repairing any damage to the integrity of the World Heritage Area).

The Wet Tropics of Queensland World Heritage Area remains unique for Australia, in that it is protected under a legislative regime established specifically to support its World Heritage status. Three documents govern the protection of the Area: the *Management Scheme Intergovernmental Agreement* (the Agreement) between the Australian and the Queensland government; the *Wet Tropics World Heritage Protection and Management Act 1993* (the Act); and the *Wet Tropics Management Plan 1998* (the Plan).

In November 1990, the Queensland and Australian governments established a Ministerial Council of relevant ministers, which was the executive policy and decision-making body. They formalised an

agreement for the funding and management of the Area by signing the Agreement—an important milestone, as it was the precursor to both the Act and the Plan. Indeed, from the time of its signing up until the Act was gazetted in November 1993, the Agreement provided the official power for managing the Area.

The Agreement originally set up two separate bodies which later merged to become the present Authority. The original Authority, which became the Wet Tropics Management Authority Board under the Act, consisted of five private citizens who reported directly to the Ministerial Council with the intent of guaranteeing independence in decision making. The second body set up under the Agreement was the Wet Tropics Management Agency.

Under the Act, the Queensland Parliament 'recognises that Australia's obligation under the World Heritage Convention is to ensure the protection, conservation, presentation, rehabilitation, and transmission to future generations of the natural heritage values of the Area'. It is 'the intention of the Parliament that the Area should be established and maintained as a World Heritage Area of the highest standard'.

The Plan is a regulation under the *Wet Tropics World Heritage Protection and Management Act 1993*; it regulates activities inside the Area that have the potential to adversely affect its integrity. It is currently under review to address issues such as zoning, visitor sites and facilities, roads and access, recognition of Rainforest Aboriginal tradition and activities allowed under a permit.

In the 30 years since the World Heritage listing of the Wet Tropics, the Authority has met Australia's obligation under the World Heritage Convention and will continue to do so into the future, enabled by strong governance and legislative frameworks.

IN THEIR OWN WORDS

Ro Hill

Former Wet Tropics Management Authority board director and committee member

Overall we've achieved a lot since establishing the Wet Tropics [World Heritage Area] in 1988. I think institutionalising protection of the rainforest into the mainstream of north Queensland society has been a key achievement. I remember when a National Party Minister spoke about the Tully Millstream Falls and building a dam inside the World Heritage Area in the 1990s. The Minister appeared on the front page of the newspaper stating "these are good ideas but the community won't wear them anymore". It's like the community developed informal institutions to protect the rainforest. This is part of the process of social normalisation that occurred over this time and it has helped ensure that the rainforest could survive in the long term.

I think in terms of environmental challenges it's less positive. We haven't dealt with climate change adequately. The threats are still very large, because of all the endemic mountain species here. I also worry about the level of recognition of just how special the Wet Tropics is. The IUCN recognises that the Wet Tropics as the second most irreplaceable World Heritage Area on Earth. I don't think that it figures in the reckoning of governments and people. Australians generally take seriously the importance of the reef but the rainforest doesn't seem to register, despite its exceptional values being recognised by the IUCN.

In terms of environmental challenges it's less positive. We haven't dealt with climate change adequately.

The value of the Wet Tropics to the regional community

Rainforest canopy, Daintree National Park (TTNQ Images)

Article 5(a) of the *Convention Concerning the Protection of the World Cultural and Natural Heritage* requires management to 'adopt a general policy which aims to give the cultural and natural heritage a function in the life of the community'.

A wide range of scientists, artists, conservation groups, and non-government organisations in the region provided the inspiration and drive for the World Heritage listing (Gunn and Brouwer, 2016). From its earliest days, the Authority realised that resolving ecological problems required authentic and meaningful engagement with communities, management agencies, industries and policymakers.

Cultural and social effects of listing on the regional community

The World Heritage listing of the Area occurred at a time of immense social change in the region, namely the collapse of the timber industry. It was expected that such a dramatic contraction of a core regional industry would result in marked negative economic and social impacts in those communities most heavily dependent upon it. All logging within the Area ceased in 1988 and by 1991 there were only two licensed timber mills still operating in the Atherton and Ingham forestry districts. Prior to listing there had been 12 mills in operation employing 486 timber workers. By 1991, 413 of these timber mill workers had been made redundant (Lynch 2000).

Timber extraction in the Wet Tropic rainforests

For around 50 years until 1980, the Wet Topics had been logged at a rate of around 200,000m^3 of timber per annum.

By 1980 it was already clear to forestry professionals that the allowable cut was far in excess of sustainable yields (Stocker *et al*. 1977). In 1981 the Crown quota of timber from northern Queensland rainforests was reduced to 152,000m^3 but this figure could not be achieved by the logging companies (Department of Forestry Queensland, 1981). In 1983 Crown quotas were set at 130,000m^3 but only 112,000m^3 could be found.

Although the Crown quota remained static, in 1985 the industry harvested only 88,000m^3. By 1987 the quota was reduced to 60,000m^3 and still could not be met when the Commonwealth Government introduced a unilateral decision to ban logging. In the decade leading up to World Heritage listing, the industry based on Crown timber had collapsed from 200,000m^3 per year to less than 60,000m^3. Associated with this demise was the loss of perhaps two-thirds of the workforce (from about 2,000 in 1981 to around 760 in 1987) and a reduction in logging contractors associated with the reduced yield.

The Commonwealth oversaw two social impact assessments (SIA): the first was conducted in 1987 prior to listing, with the other conducted four years later (Vanclay 1993). The initial SIA was used as the basis of a Structural Adjustment Package (SAP) designed to ensure retrenched timber workers would not be unfairly disadvantaged. A sum of $75.3 million was allocated for the SAP, comprising $50.9 million for employment-related programs and $24.4 million for business compensation. The job creation component comprised public works projects, tree planting projects, private sector initiatives and local community initiatives. Assistance for displaced workers included a number of allowances, training subsidies and an early retirement package.

While World Heritage listing certainly caused social impacts at the individual level, it was anticipated that at the community level any adverse impacts would eventually be overshadowed by changes in other areas of the regional economic base.

Logging versus tourism

The major argument put forward opposing the nomination and listing of the Wet Tropics World Heritage Area was that it would socially and economically cripple the region by destroying the rainforest logging industry. It was claimed that there would be major losses of employment and income. These arguments were fiercely debated despite the facts that sustainable timber yields were in rapid decline, costs of maintaining the industry was exceeding royalties, and research showed significant environmental impacts from logging (Cassells *et al.* 1988).

There is no doubt that the timber industry had been a major contributor to north Queensland's regional economy since European settlement, and the effects of this industry permeated many aspects of regional activity. Consequently, the end of the timber industry caused a major disruption to the economies of several communities reliant on this industry for their livelihoods. At the time of listing, the gross value of the region in timber sales was around $26 million. Driml (1997) converted this value to a 1994 equivalent of $34 million in order to make post-listing comparisons between tourism and logging to the regional economy. This figure of $34 million was directly comparable with the gross expenditure on tourism in 1994 of $443 million. These figures indicate that the gross expenditure on tourism seven years after the prohibition of logging was around ten times the gross value of logging and timber production in the year logging ceased in the Area.

As predicted by many of the supporters for World Heritage listing, the growth in tourism has more than offset negative economic impacts resulting from the cessation of logging (Driml 2000). It must be acknowledged, however, that tourism was not an alternative for many individuals and some communities previously dependent on the timber industry.

The value of tourism in the Wet Tropics

Almost two decades later, a nationwide analysis of the economic contribution of Australia's World Heritage properties found that in terms of national economic impact, the Wet Tropics was one of the most significant World Heritage areas in Australia.

It was estimated to contribute more than $2.6 billion in annual direct output and household income, as well as almost 13,600 direct and indirect jobs; demonstrating a very real and significant value of the Area to the regional, state and national economy (Gillespie Economics 2008). During the year ending 2010, the region had an estimated 5.7 million visitors and was the third most significant destination in Australia for international visitors.

IN THEIR OWN WORDS

Ro Hill

Former Wet Tropics Management Authority board director and committee member

When I first came to Cairns I used to imagine what it was like to see the reef and rainforest being promoted and accessible to visitors. But in those days there were no signs or businesses based on rainforest tourism. But now people move through Cairns airport and the images are everywhere and we have World Heritage signs on the roads. We know that people are coming from all over the world to see and enjoy these sites. This has exceeded my expectation.

We know that people are coming from all over the world to see and enjoy these sites.

Community attitudes

As previously recognised, conflict and disputation over the values and uses of the Wet Tropics rainforests characterised the nomination and listing of the World Heritage Area. In addition to the ban on logging, the progressive conversion of Wet Tropics lands to national parks also resulted in more restrictions on what the Area would be used for, and the gazettal of the Wet Tropics Management Plan added a further layer of prohibition and regulation. These actions polarised the community.

Recognising the need for broad community engagement, the Authority commissioned a number of community attitude surveys (AGB McNair 1992, 1993 and 1996). These surveys (Table 1) were designed to develop an understanding of how the local community uses the Wet Tropics World Heritage Area and engages with the Authority, and to assess community attitudes towards the management of the Wet Tropics (AC Nielsen, 1999). More detailed studies have attempted to capture a broad range of community views (Bentrupperbäumer and Reser 2003, 2006), including use, access and support for Rainforest Aboriginal cultural heritage in a future World Heritage listing.

What is apparent from the surveys is that, despite the challenging start, it is well-recognised that many other values have come to the community from World Heritage protection and management. In the 30 years since listing, community support for the Area has grown from 50% in 1996 to over 80% in 2007, and this improving trend is likely to have continued in the eleven years since the last survey was undertaken. Being a resident of the Wet Tropics region brings pride to communities and individuals and promotes an overarching sense of place, social identity and cohesion (Carmody and Prideaux, 2007).

TABLE 1. SUMMARY OF FINDINGS AND CHANGES IN ATTITUDES FROM COMMUNITY SURVEYS (1992 TO 2007)

Survey	Method	Key findings
Community Attitudes to the Wet Tropics World Heritage Area: A Benchmark Study (1992)	2,000 telephone interviews	• 52% were aware that the Wet Tropics was a World Heritage listed area • 51% strongly support World Heritage listing • 26% visit the Area once a month or more • 46% visit for picnicking, swimming and bushwalking/ hiking
Community Attitudes to the Wet Tropics World Heritage Area (1993)	2,000 telephone interviews	• 59% strongly support World Heritage listing • 54% visit for picnicking, taking scenic drives, swimming and bushwalking/ hiking.
Community Attitudes to the Wet Tropics World Heritage Area (1996)	1,900 telephone interviews	• 68% were aware that the Wet Tropics was a World Heritage listed area • 56% strongly support World Heritage listing • 60% visit for taking scenic drives and picnicking.
The Role of the Wet Tropics World Heritage Area in the Life of the Community: A Survey of the North Queensland Community (2002)	788 surveys returned from postal distribution and drop-off/pick-up survey methods	• 93% were aware that the Wet Tropics was a World Heritage listed area • 58% strongly support the World Heritage listing • 25% visit the Area once a month or more often • 56% visit for a recreational activity.
Community Attitudes, Knowledge, Perceptions and Use of the Wet Tropics World Heritage Area (2007)	853 surveys returned from postal distribution and drop-off/pick-up survey methods	• 92.6% of respondents supported the general level of protection that operates in the World Heritage Area • 71.8% support for the inclusion of Indigenous cultural heritage in a future World Heritage listing • 89% of respondents have visited the Area at least once • Recreational activity was the main reason for visiting the Area.

The community has a sense of attachment to the Wet Tropics World Heritage Area, and it plays an important role in their quality of life: providing scenic amenity and substantial areas of environmental significance for recreational activities, employment, personal wellbeing and educational purposes (Scherl, 2013). Residents view the Area as an integral part of their landscape, lifestyle and community, and feel a strong sense of collective ownership and responsibility. The Area is also valued by the broader regional North Queensland community and its outstanding universal value is widely recognised and supported in the Australian community and elsewhere.

IN THEIR OWN WORDS

Peter Hitchcock

Wet Tropics Management Authority executive director (1991-1997)

What I am quite proud of was the community attitude surveys. What comes out of the interviews was extremely valuable. We were able to assess what the overall level of support was for the World Heritage Area. We expected low levels of support from rural areas. Surveys showed that even in the most rural areas, there was still a majority of people who supported the World Heritage Area. That surprised everyone. It was thought in government circles that that there was no support in rural areas, however the surveys showed this to be wrong. If you do nothing to find out what is in people's minds then you will get nothing.

Even in the most rural areas, there was still a majority of people who supported the World Heritage Area

Community wellbeing

Management approaches adopted for the Wet Tropics World Heritage Area continue to be successful in recruiting people from different sectors of the community, through formal and informal processes. The Authority engages the community in management of the World Heritage Area in a variety of ways including partnerships, capacity building, visitor information and community education. Formal community involvement in the management of the Area is based on both statutory consultative and advisory groups and, when required, a range of sector or issue-focussed liaison groups which provide feedback, advice and recommendations to the Authority.

IN THEIR OWN WORDS

Peter Valentine

Former chair of the Wet Tropics board

The move to establish strong community engagement through committees was the foundation for the success of the Authority. In addition to the Community Consultative Committee (CCC), the tourism, conservation and Aboriginal liaison groups were added over time. They gave us the opportunity to develop deeper and richer relationships, and get a much stronger level of understanding of the different groups and interests.

There were always people on the CCC that came from parts of the community that opposed the idea of World Heritage listing to some extent but wanted to be part of it once it was established. They ultimately became good supporters of World Heritage. The Authority continued to work hard to engage more people.

The move to establish strong community engagement through committees was the foundation for the success of the Authority

The CCC was good because it brought people together to talk to each other. It was a forum for the community as much as the Wet Tropics Management Authority. All the ideas had to come out and all the concerns had to come out. However, I think having those extra liaison groups allowed for more of the 'nitty-gritty' to be taken up. All the time on the CCC, we discussed everything under the sun without any sense of bitterness or anger. There were different viewpoints but people were reasonably mature and they were all local people. The community was big enough, intelligent enough and passionate enough to do all these things and make it work.

Involving Rainforest Aboriginal people in World Heritage management

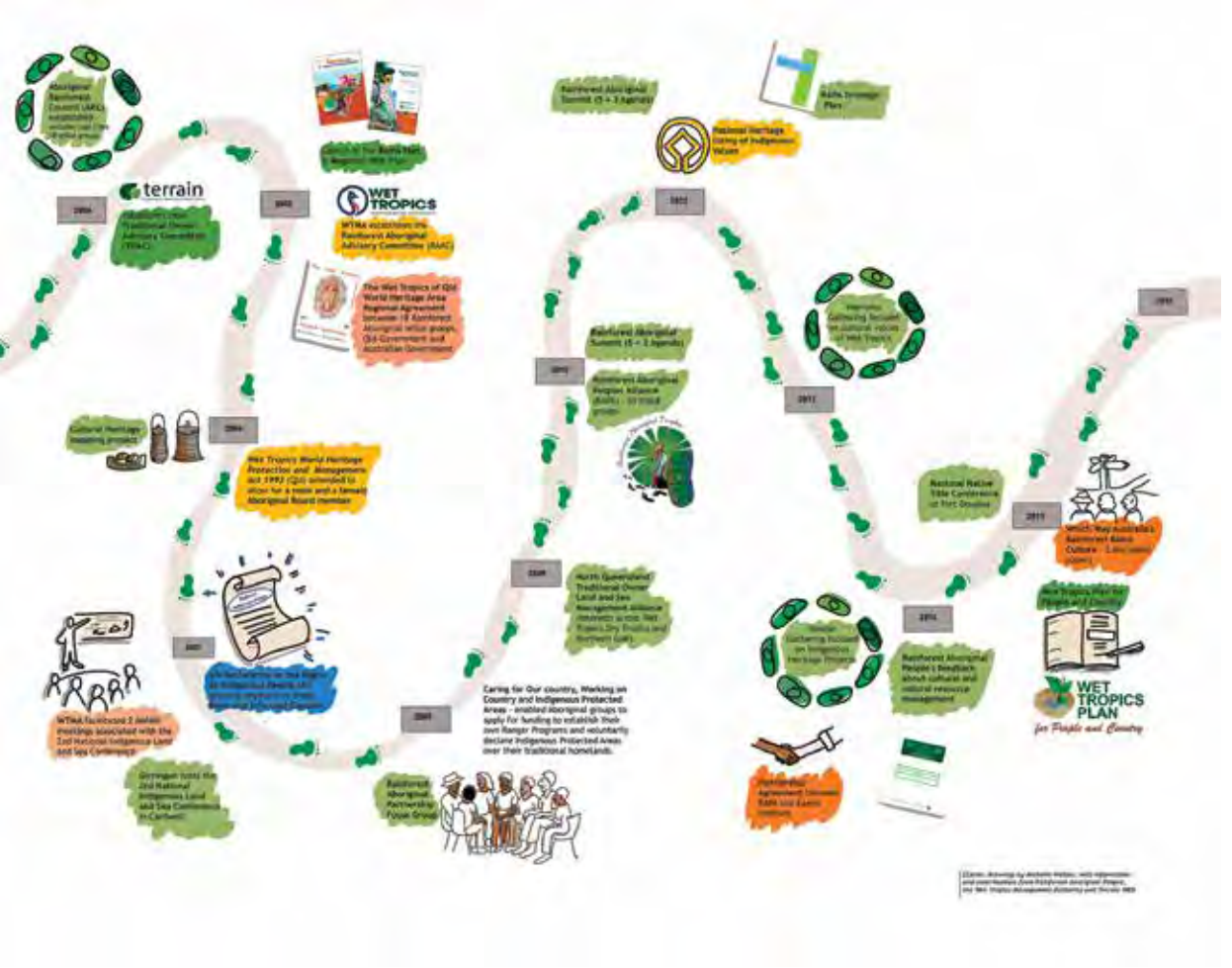
Historical context: dispossession of country

Rainforest Aboriginal people have adapted to a range of climatic, environmental, political and social changes – including a long, dark history of dispossession from the Wet Tropics region. While time has passed since then, Rainforest Aboriginal people continue to live through these past injustices and face consequent disadvantage and inequality in their lives. No other landowner surrendered so much land to World Heritage listing as did the Rainforest Aboriginal peoples (Bama Wabu, 1996).

Today, there are at least 20 Rainforest Aboriginal tribal groups, 120 clans and 8 language groups—currently over 20,000 people—with ongoing traditional connections to landscapes in the Wet Tropics World Heritage Area. Each group has customary obligations for management of their country under Aboriginal lore. Caring for country, sharing of stories, the use of language, and the performance of songs and dances are still very important. These activities play an important part in maintaining Rainforest Aboriginal people's unique evolving cultural identity and connection to country.

A Rainforest Aboriginal perspective

While there was general support from most Rainforest Aboriginal people to protect the values of the Wet Tropics, some Rainforest Aboriginal people objected to the World Heritage listing over their lands, in particular at Yarrabah and other former missions.



Two Rainforest Aboriginal representatives from Yarrabah travelled to Paris in June 1988 to voice their objections to the World Heritage Bureau about their land being included on the World Heritage List without their consent. Representatives also met with Commonwealth Ministers to try and re-negotiate World Heritage boundaries.

The World Heritage Bureau recommended the nominated wet tropical rainforests of north-east Australia be inscribed as a World Heritage Area. It requested the Commonwealth to provide clarification and further information on several points, particularly in relation to future management arrangements involving the State and Commonwealth governments, and a revision of the proposed boundaries to exclude areas which did not contribute significant values.

The Bureau, in considering the World Heritage nomination, also reacted to opposition of some Aboriginal groups to World Heritage listing by expressing their requirement for the Commonwealth to fully consider ways to accommodate Aboriginal concerns and interests once listed.

The Commonwealth Government developed a special review team which prepared a report addressing the recommendations of the Bureau to the World Heritage Committee Secretariat in September 1988. The report primarily addressed boundary concerns, but also clarified a number of other issues requested by the Bureau. In dealing with questions about Aboriginal opposition to inclusion of their land, the report stated "that for Aboriginal communities which have Deed of Grant

Preparing for traditional dancing (Wet Tropics Images / Brad Newton) Images)

in Trust (DOGIT) land within the nominated area, the Government has no intention of restricting traditional non-commercial activities. The proposed management arrangements are designed to ensure that Aboriginal communities play an important role in the future management of the nominated area" (IUCN, 1988). The Commonwealth re-submitted the World Heritage nomination to the World Heritage Committee in October 1988.

In November 1988, the Chairperson of the Yarrabah Aboriginal Community Council wrote to the Environment Minister in response to the Commonwealth's position on the inclusion of Aboriginal land in the nomination. "This potential interference with our rights to self-management and self-determination could not receive our agreement if there were no tangible benefits to be received by the community. If there be no tangible benefits and such interference with our land rights, we would have no option but to continue strenuous opposition to our lands being included in the listing..." (Brennan, 1992).

The letter continued, "Basically you have offered us nothing but the assurance we will still be able to use our land as we do presently, if all goes well. The cost to us will be the uncertainty and time involved in gaining approval from outside bodies for our land use including outstation development... We thought you would do more to consult with us. We thought you would have more regard to our land rights and self-management... If listed, it will be without our consent" (Brennan, 1992).

Despite this, the Wet Tropics of Queensland was inscribed on the World Heritage List on the 9 December 1988. To enshrine commitments to the World Heritage Committee, the *Wet Tropics World Heritage Protection and Management Act 1993* was prepared and legislated with:

- an acknowledgement of the significant contribution that Aboriginal people can make to the management of cultural and natural heritage within the World Heritage Area, particularly through joint management agreements
- a requirement for the Authority to have regard to the Aboriginal tradition and to liaise and cooperate with Aboriginal people particularly concerned with the land in the Wet Tropics
- a requirement for Ministerial Council to appoint one Aboriginal person particularly concerned with the land in the Wet Tropics to the Authority's board of directors.

Evolution of relationships and attitudes

When the Authority was established in 1992, it became a priority to improve Aboriginal engagement. There was not a well-developed or common understanding about joint management and or Aboriginal cultural values and what this might mean for World Heritage management. It was also before the Mabo decision and Commonwealth Native Title Act 1993 so Rainforest Aboriginal people's rights and interests were less in policymakers and politicians' minds.

A turning point occurred when the Authority acted on Rainforest Aboriginal people's concerns about the removal of stones from a sacred site in the Daintree. The Authority supported negotiations with the tourism industry and Douglas Shire Council to relocate the road, avoiding contact and disruption to this sacred site. By taking this issue up, the Authority signalled a more responsive and supportive approach to dealing with Rainforest Aboriginal people's concerns.

Native title and recognition of rights

Following the Mabo decision in 1991, Rainforest Aboriginal people's native title rights and interests were formally recognised through the *Commonwealth Native Title Act 1993*. This provided a national scheme for the recognition and protection of native title and for its coexistence with the existing land management system. Following a consent determination of native title, Indigenous Land Use Agreements (ILUAs) were negotiated between native title groups and others to suit particular circumstances. Although the ILUAs protected the interests of government agencies, they did not go far enough to capture basic engagement protocols or the rights and interests of Rainforest Aboriginal people in decision making for national parks and the Wet Tropics World Heritage Area.

Rainforest Aboriginal people successfully lobbied the Wet Tropics Ministerial Council to financially support Rainforest Aboriginal people to review the legislative, policy and protocol constraints to proper involvement in World Heritage Area management. The Ministerial Council also supported a negotiation process to improve Rainforest Aboriginal people's involvement in the management of the Wet Tropics World Heritage Area.

The United Nations Declaration on the Rights of Indigenous Peoples was adopted by the General Assembly in 2007. The growing emphasis on the principle of 'free, prior and informed consent' (FAO, 2016) of Indigenous people in the management of World Heritage Areas has given added impetus for more appropriate engagement by Indigenous Australians in such matters.

Bridging the gap or forging it wider

Participation in World Heritage Area management has the potential to contribute significantly to Closing the Gap targets (Department of Prime Minister and Cabinet, 2018). Links between environmental, cultural and socio-economic policies and programs must be strong to realise appropriate investment needs for Traditional Owner organisations involved with looking after country.

Millions of dollars are spent on negotiating native title determinations and making framework agreements. However, when it comes to the implementation of programs and projects that provide for equitable involvement of Rainforest Aboriginal people in decision making and on-ground management, there are very few resources or meaningful support to build Rainforest Aboriginal people's capabilities and capacities.

A cooperative named Bama Wabu was established in 1994 and led the development of a Rainforest Aboriginal people's submission called *Reasonable Expectations or Grand Delusions* (1996) which sought to persuade the Authority to consider Aboriginal issues in the development of the Wet Tropics Management Plan 1998. The submission provided background information about Rainforest Aboriginal history (since 1874) and provided recommendations to improve the draft plan and engagement with Rainforest Aboriginal people in the management of the World Heritage Area. Rainforest Aboriginal people held numerous workshops and came to a tacit agreement that the Plan failed to meet international, common law and statutory obligations to Aboriginal tradition and Aboriginal peoples. There was also frustration that the Plan exclusively focussed on natural values and did not include reference to Aboriginal culture and connection to country. Aboriginal leaders protested in front of the Authority's office and burnt a copy of the Plan to show that it was inadequate and unworkable in its current form.

When the first ten-year review of the Wet Tropics Management Plan commenced in 1998, Bama Wabu led another engagement process with Rainforest Aboriginal people to develop *"Which Way Our Cultural Survival"*. This report outlined 163 specific recommendations for how Aboriginal people should be involved in the management

Passing traditional knowledge, Yarrabah boardwalk (Wet Tropics Images / Brad Newton)

of the Wet Tropics World Heritage Area. As a result the Commonwealth Government responded by resourcing the establishment of the Interim Negotiating Forum (INF) to address these recommendations and resolve how to better involve Rainforest Aboriginal people in the management of the Wet Tropics World Heritage Area. The negotiations were between the government negotiating team, including representatives from the Authority and Queensland and Australian governments, and the Aboriginal Negotiating Team comprising mandated Rainforest Aboriginal representatives from across the region. The INF pulled out a series of recommendations from *"Which Way Our Cultural Survival"*, which became the focus of negotiations and formed the basis for a formal agreement. After three years of negotiations including several large Rainforest Aboriginal regional workshops, the process resulted in the Wet Tropics of Queensland World Heritage Area Regional Agreement (the Regional Agreement).

The Regional Agreement

On the 29 April 2005, the Wet Tropics of Queensland World Heritage Area Regional Agreement was signed to provide a framework for the cooperative management of the World Heritage Area by Rainforest Aboriginal people, the Australian and Queensland governments.

An Aboriginal Natural and Cultural Resource Management Plan (commonly known as the 'Bama Plan') was also launched at this time to promote natural and cultural resource management considerations and define the aspirations that Rainforest Aboriginal people have for country and culture, through 36 strategy areas and 108 specific actions. The Bama Plan was prepared and implemented with the support of Terrain NRM and a Traditional Owner Advisory Committee.

Allison Halliday

I first became involved with the Wet Tropics World Heritage Area in 1994, and that is when the late Vince Mundraby was heading up Bamu Wabu. Vince had a strong history of pushing for investment to flow from the 1992 High Court decision on Mabo and native title. Vince was always about the need to be tenure blind when managing country, regardless of what kind of tenure was overlaying country.

The underlying thing is that it is our country at the end of the day.

The underlying thing is that it is our country at the end of the day. The Rainforest Aboriginal Network initiated the review 'Which Way Our Cultural Survival' and Bama Wabu carried this work through to completion. There were 163 recommendations from this report targeting actions and responses from various tiers of government. This led to the funding to develop the Regional Agreement through the establishment of the Interim Negotiating Forum (INF). We went up to Wujal, Daintree, all the way inland west to Ravenshoe and Mount Garnet, the Tablelands, south to Paluma and on as far as Palm Island, doing a whole lot of consultation. This gave the opportunity for government people to talk to and understand local Aboriginal people and the way they see the world.

The signing of the Regional Agreement occurred on 29 April 2005, at Warrina Lakes in Innisfail. We had our Elders from each of the respective tribal groups sign off on the Regional Agreement in conjunction with the government Ministers – the Hon Greg Hunt MP from the Commonwealth and the Hon Desley Boyle MP from the state. It was an emotional day for many after a lot of hard work, talking and negotiating. Quite a few of our Elders who signed the Regional Agreement have sadly passed on since then.

We were still trying to do work, with no resources, very little support and we are still losing momentum.

I would characterise the mood of the time as one of hopefulness and with energy levels that were great. It was unbelievable. I think at every meeting we had, we had everyone attend. People believed and there was a lot of buy-in. I felt really hopeful and confident. The Wet Tropics executive director at the time of the signing of the Regional Agreement was supportive and active within the negotiating team. Some of the outcomes that the Authority achieved and that were important included the establishment of a formal Rainforest Aboriginal Advisory Committee (RAAC) under section 40 of the Wet Tropics World Heritage Protection and Management Act 1993, and the ongoing appointment of two Aboriginal board directors. Whoever sat on the Aboriginal Rainforest Council (ARC) as a director also sat on the RAAC and this ensured it had representation across the 18 groups that signed up to the Regional Agreement. The establishment of RAAC, and two Aboriginal board members, was seen by us as the Authority genuinely seeking to empower Rainforest Aboriginal people.

The ARC was given funding of $150,000 in the first year from the state and from the Commonwealth government's respectively. Therefore, we had $300,000 budget. The RAAC and ARC were a mirror image of each other (same individuals) but had different roles. After the ARC and RAAC were established, I went on to be acting director on the Authority's board and was later confirmed as an appointed director, with support and mandate from the RAAC and ARC. Russell Butler Senior became the male director at that time.

I started to become frustrated when there were changes in the state of play within government and change in managers who had been supporting the Regional Agreement. The ARC did not get all the funding agreed to, and that severely impeded our ability to achieve outcomes. The ARC was sadly dissolved in 2008, which meant that the protocols, processes and objectives in the Regional Agreement could not be implemented. It appeared as though some partner agencies pulled the rug from under our feet. They just didn't seem committed to supporting the Regional Agreement even though there were individuals in the agencies who were committed and working hard. We set up many of these things but once the ARC closed its doors, we felt like everything came to a screeching halt and nothing was followed through thereafter.

It left a bad taste and a sense of dissatisfaction and we responded by establishing the Rainforest Aboriginal Peoples' Alliance (RAPA) in 2010, as a less formal alliance to maintain momentum, rather than as a corporation. This was a hard period and it was difficult to get people to buy in when they had lost faith with the agencies and with the process. We were still trying to do work, with no resources, very little support and we are still losing momentum.

An independent voice for Rainforest Aboriginal people

2002-2008 was an extremely active and optimistic period with the focus on the Regional Agreement and a period of hope, optimism and innovation. Energy and enthusiasm was also bolstered by Commonwealth funding for Indigenous Protected Areas, Indigenous rangers, the establishment of prescribed bodies corporate and successful native title claims.

The early years of the Regional Agreement, with the Aboriginal Rainforest Council (ARC) providing leadership and governance, inspired a concept to share and support Traditional Owners of other Australian World Heritage Areas through a national network. The Australian Department of Environment and the Authority supported the establishment of the Australian World Heritage Indigenous Network (AWHIN) and the inaugural meeting occurred in 2002.

AWHIN connected and empowered grassroots Traditional Owners by giving them a voice at the highest levels of World Heritage governance in Australia. Allison Halliday and Ernie Raymont were the two Rainforest Aboriginal people represented on AHWIN. They could also be represented by proxies if needed. It provided equity with others who participated in decision making. The Rainforest Aboriginal representative and one other from AWHIN joined the Australian World Heritage Advisory Committee (AWHAC). This created greater opportunities to formulate options and reconcile nationwide issues. However, inadequate financial and political support has more recently led to a growing sense of powerlessness and scepticism about the future and the AHWIN has not met for several years or participated on the AWHAC. The other World Heritage areas represented on the committee followed the Wet Tropics' lead and took on the approach to on-ground Aboriginal management being implemented locally. Wet Tropics representatives on AHWIN were seen as leading the way and Allison Halliday was invited to speak at a UNESCO conference in Banff Canada on Mountains at Risk, addressing issues of on-ground management and self-determination for Aboriginal people.

The ARC also closed its doors in 2008, meaning the protocols, principles and objectives in the Regional Agreement could not be effectively implemented. A lot of momentum, trust and hope in the working relationship between the Authority and Rainforest Aboriginal people was lost at this time—a period of frustration for many. At the closure of ARC, there was pressure for the Board's Rainforest Aboriginal Advisory Committee (RAAC) to now be the voice for all Rainforest Aboriginal people's concerns, although they were not established to undertake this task. Frustration and a desire to be driving their own agendas led to the call by Rainforest Aboriginal members to disband the RAAC and Terrain NRM's Traditional Owner Advisory Committee. Both were dissolved at a joint meeting in 2011.

After many years of activism, advocacy and negotiation, the Rainforest Aboriginal tribal groups of the Wet Tropics were still waiting for equitable involvement in World Heritage Area management. Fewer of the younger generations appear to see real value in these processes, having seen their parents and grandparents try for many years with little or no return.

The reaffirmation that significant investment is required to support Rainforest Aboriginal people's capacity to engage equitably and to actively participate in the policy, planning and program development for managing Australia's World Heritage Areas was now exceedingly clear. In particular to support the capacity for leadership, institutional governance and operation, employment and business development, and joint management arrangements for protected areas.

A shift towards self determination

One of the most important developments over the history of the Area since listing has been the number of successful native title claims; at least 87.5% of the World Heritage Area has been native title determined or is currently under application. Rainforest Aboriginal organisations are strengthening their capacity to develop land management and economic development agendas. A number of Rainforest Aboriginal organisations have registered themselves as cultural heritage bodies.

The establishment of the Rainforest Aboriginal People's Alliance (RAPA) marked a turning point and the need to re-negotiate relationships. RAPA's focus was to provide Rainforest Aboriginal people with a more self-determining network for engaging on a broad range of interests within the region.

RAPA convened a Rainforest Aboriginal summit in 2011 to develop its strategic plan and agenda; the Warrama Summit in 2013 to discuss the key cultural values of the region; and the Booran gathering in 2014 to develop a partnership agreement with the Cairns Institute and CSIRO to deliver Indigenous

heritage projects. The partnership resulted in three discussion papers focusing on Indigenous-led management, re-listing the cultural values for World Heritage, economic development and sustainable livelihoods (Dale *et al* 2016; Hill *et al* 2016 and Turnour, 2016).

The focus was now about securing the place of Rainforest Aboriginal organisations and participating in the economy. In addition, many organisations struggling with short-term grant funding were starting to think in new ways, for example, charging fees for services and future act notices, and registering as public benevolent institutions and cultural heritage bodies. With more capacity, groups were now better placed to apply for grants and manage programs.

The Authority has further reaffirmed its rapport with Rainforest Aboriginal people and their organisations over recent years. There are some perceptions that the Authority deliberately moved its focus away from Rainforest Aboriginal issues particularly when the ARC closed its doors and the RAAC was dissolved. However, the Authority received less support to play a regional coordination role and local Rainforest Aboriginal organisations sought to lead their own conversations and agendas. This led to a period of review and reflection as the Authority sought to establish new relevance in this area.

Since the disbanding of the RAAC, the Authority's focus has been to engage with Rainforest Aboriginal people at the local level and through sub-regional organisations. A range of project-based outcomes has been achieved with this approach. Rainforest Aboriginal people are also included in the membership of the Authority's two statutory advisory committees (i.e. Community Consultative Committee and Scientific Advisory Committee) and two non-statutory committees (i.e. Cassowary Recovery Team and the Yellow Crazy Ant Project Reference Group), and as directors on the Authority Board.

National Heritage listing and prospects for World Heritage listing of cultural values

On 9 November 2012 the Wet Tropics World Heritage Area's Indigenous heritage values were included as part of the existing Wet Tropics of Queensland National Heritage listing. The listing recognises that Rainforest Aboriginal heritage is unique to the Wet Tropics and is a remarkable and continuous Indigenous connection with a tropical rainforest environment.

To quote the Australian government, "the Aboriginal Rainforest people of the Wet Tropics of Queensland have lived continuously in the rainforest environment for at least 5,000 years and this is the only place in Australia where Aboriginal people have permanently inhabited a tropical rainforest environment" (Australian Government, 2012).

Rainforest Aboriginal people developed distinctive cultures determined by their dreamtime and creation stories and their traditional food gathering, processing and land management techniques. Reliance on their traditions has helped Rainforest Aboriginal people to survive in this at times inhospitable environment. The distinctiveness of the traditions and technical innovation and expertise needed to process and prepare toxic plants as food and the use of fire are of outstanding heritage value to the nation and are now protected for future generations under national environmental law.

Traditional burning practices, Yarrabah community (Wet Tropics Images / Brad Newton)

Ongoing customary obligations for country (Wet Tropics Images / Brad Newton)

IN THEIR OWN WORDS

Allison Halliday

Former Wet Tropics Management Authority board director

The Wet Tropics was listed for its Aboriginal cultural values on the National Heritage List in November 2012. We are grateful for cultural heritage listing but are still waiting to see the results and benefits to fully understand what it means for us. We are still looking to government to take a lead. Given feelings of being disenfranchised and ignored at the time of the original World Heritage listing meant that the National Heritage Listing came as a great relief and sense of achievement. It represented the chance for something meaningful to happen. However, what does it mean now?

In November 2012, I told the Minister at the announcement of National Heritage listing of Indigenous values for the Wet Tropics that it was great that we now had those values recognised. However, it now had to turn into something meaningful for Traditional Owners. We have spent the best part of last five years to get here but for what? There is still a lot that needs to be done to realise benefits from the National Heritage Listing before we can really consider World Heritage listing. We are still waiting for a meaningful response.

We are grateful for cultural heritage listing but are still waiting to see the results and benefits to fully understand what it means for us.

What would help is if the mob could be better informed of what the differences are between National and World Heritage Listing in terms of our aspirations, and then it is more likely that they would undoubtedly support World Heritage re-listing for cultural values. There is an overall sense of being abandoned, let down. A good starting point would be an information campaign. For agencies to get out there and explain the difference and benefits. Now there are just a lot of misunderstandings and misconceptions. Community expectations have been consistently expressed but we are still waiting to see all agencies come into line to take up the challenges. Actions are being taken in communities including by prescribed bodies corporate, registered native title bodies corporate and other organisations to seek registration as cultural heritage bodies. We are also looking to access the Intellectual Cultural Property Kit, which was started a few years ago, so we can finish it and implement it. Overall, we are really seeking to get on the front foot by strengthening our own organisations to go forward and make things happen.

Reigniting the fire for the next 30 years

The principles that now guide the Authority's engagement with Rainforest Aboriginal people include:

- being a culturally responsible lead agency in collaboration with Rainforest Aboriginal people and the broader network, to ensure accountability to our commitments
- improving the way we do business by moving towards a better understanding of 'good practice' and strengthening enabling conditions for a rights-based approach to World Heritage conservation
- empowering Rainforest Aboriginal people to progress their agendas on their own terms
- showcasing good practice and success stories with a specific focus on different aspects of rights-based approaches.

The Authority has also continued to strengthen partnerships with Terrain NRM, the North Queensland Land Council, the Department of Aboriginal and Torres Strait Islander Partnerships and others to facilitate additional support for Rainforest Aboriginal people's interests and aspirations in relation to knowledge, culture and management practice in the Wet Tropics.

A regional workshop of Rainforest Aboriginal people in October 2017 has been instrumental in a process to commence reconciling outstanding differences from the past and to bridge the natural-cultural divide. A Traditional Owner-led terms of reference is currently guiding the free, prior and informed consent of Rainforest Aboriginal people in the current review of the Wet Tropics Management Plan and a Traditional Owner Leadership Group is driving a refresh of the Regional Agreement.

The Authority is committed to supporting Rainforest Aboriginal people into the future, by promoting and incorporating their rights, interests and aspirations in the management of the World Heritage Area. Future actions are to:

- implement a rights-based approach to World Heritage management in the Wet Tropics
- develop an Implementation Agreement to refresh the 2005 Regional Agreement
- empower Rainforest Aboriginal people's wellbeing and livelihoods
- support Rainforest Aboriginal people to exercise custodial relationships between their peoples and customary landscapes.

IN THEIR OWN WORDS

Allison Halliday

Former Wet Tropics Management Authority board director

The first phase review of the Wet Tropics Management Plan 1998 commenced in 2017. We started getting traction again and were more positive about our involvement in management again. The regional workshop on 21-22 October 2017 was a huge opportunity for Rainforest Aboriginal people to get together again and it became a real turning point, re-igniting the fire for many. I felt at that point of time a huge sigh of relief. I was asked to do a presentation at the workshop about the journey so far. Staff from the Authority and Terrain NRM are working closely together and supporting us to build momentum. Together we developed a pictorial timeline, a walking track, of our thirty-year journey which was easier for people to identify with rather than words. It was good to see some familiar and unfamiliar faces but I really wanted to take everyone at the workshop along on the thirty-year journey, so we can better shape our future hereafter. We can't have a successful future until we acknowledge the massively hard work done by so many in the past.

We can't have a successful future until we acknowledge the massively hard work done by so many in the past.

We are building the momentum to bring forward our aspirations into the now and to highlight them again so that they are achieved and implemented. There has been new optimism and direction established... there is a positive feeling about reviewing and refreshing the Regional Agreement and the commitment to action again.

Collaboration and participation of stakeholders in World Heritage management

Despite its challenging start, it is well recognised now that the protection and management of the Wet Tropics World Heritage Area has provided many benefits to the community. By its 20th anniversary, the World Heritage Area was totally entrenched in the community, with support for its listing growing from 50% in 1996 to over 80% in 2007.

There is strong recognition of the quality of life benefits derived by the community from the Wet Tropics World Heritage Area. There are many opportunities within the Area for adventure trips, hiking, observing wildlife or simply relaxing within serene surroundings. The amazing evolutionary, ecological and cultural values of the Area also make it an unsurpassed educational asset and a living research laboratory.

Recent research indicates that residents believe the region's non-market ecosystem services, including those associated with aesthetics, recreation and preservation of the region for future generations are important to their quality of life, and are key factors in their choice or area to live and work. The collective worth to the region's natural values is likely to exceed $5 billion annually (Esparon *et al* 2014), which includes the $2.6 billion income associated with the tourism industry, plus additional values generated by non-market values associated with the worth the community places on the natural values and on ecosystem services such as clean air and water.

TABLE 2. EXAMPLES OF SOME ENVIRONMENTAL GOODS AND SERVICES PROVIDED BY THE WET TROPICS WORLD HERITAGE AREA.

ENVIRONMENTAL VALUES AND SERVICES		HUMAN AND COMMUNITY WELLBEING	
Supporting/ Processes • biodiversity • habitats and refugia • soil formation and fertility • pollination • nutrient recycling • genetic resources • fire regimes • water cycles • biomass production	**Provisioning** • energy (hydro/solar/ wind) • water • clean air • carbon sequestration • cloud stripping • food	**Quality of Life/Health** • recreation • exercise in natural settings • water quality • access to clean air • historic values • art and craft materials • human-wildlife interaction • pharmaceutical and biological products	**Security** • secure resource access • security from disasters • maintaining options for the future • shade and shelter
Social/Economic/ Cultural • aesthetics • regional identity • social value to community • economic value to community • traditional connection to country and rights	**Regulating** • regional and micro climates • flood mitigation • water purification • erosion control • groundwater recharge • waste treatment • energy conversion • pest control	**Social Cooperation/ Cohesion/Identity** • sense of place • formation of new groups/networks • types of cooperation • governance arrangements • collective pride	**Tourism** • attraction to area • economic revenues • generation of employment • employment for Traditional Owners **Education/Research** • living laboratory • scientific discovery • knowledge generation • environmental awareness and education **Spiritual/Customary** • cultural values • customary practices • spiritual significance • conservation and management of important traditional areas

With more than 2,500 individual blocks of land neighbouring the World Heritage Area's 3,000km boundary, the active involvement of landholders and neighbours is crucial to the management of the Area. Wider representation for community engagement comes through a number of committees attached to management agencies and NRM organisations. In addition to its statutory functions, the Authority and its community and industry partners engage in a variety of activities in support of the World Heritage management.

One of the most important foundations for all of the Authority's work is its broad program of community engagement. The Authority works hard to ensure it remains connected with and responsive to community views about the World Heritage Area. The Authority places a particular priority on the rights and aspirations of Rainforest Aboriginal people, and the interests of the conservation and tourism sectors. To ensure decision-making is well grounded in evidence, the Authority also supports its Community Consultative Committee and Scientific Advisory Committee, comprising regional leaders and scientists from a wide range of disciplines.

IN THEIR OWN WORDS

Dr Lea M Scherl

Scientific Advisory Committee member

Harnessing Social Capital in the Wet Tropics

There is an incredible amount of social capital in the Wet Tropics region—it has people from all sections of the community that helped achieve World Heritage listing in 1988. Activists, scientists and community groups worked together to form the social capital that helped establish and sustain the Area. World Heritage listing was based on the outstanding universal values of the Area but achieving it in practice also needed people to fight for it. This social and community capital is also critically important for the future.

Since the establishment of the Wet Tropics Management Authority (the Authority), the place and role of social capital has been wound back. The Authority took up its legitimate and mandated role (based on legislation and policy) and the Area has been managed through the more traditional government perspective on engagement. In this approach, the government decides how and when the engagement takes place.

We are now at a point where we need to think of the role of the Authority and how it works with partners in a slightly different way. We need the Authority to be more of a facilitator, helping to establish collective roles and shared responsibility amongst many agencies, including Aboriginal organisations and the community sector. There is no one else that can really do this facilitation role successfully. The quantum leap is for the Authority to empower and support key stakeholder contributions to managing the Area, from scientists, conservationists, Traditional Owners, the tourism industry, neighbours and other government agencies. We do not have a clear vision of exactly how this might work but we have to put faith in the process and see where it can take us. In the end, it will help strengthen confidence and support for the Authority.

Looking to the future, the Authority will be stronger because it strengthens the relationships with the groups and interests that share concern and responsibility for the World Heritage Area. It is about acknowledging and respecting what a wider collective of agencies and partners can do together. That is the essence of harnessing social capital. It is not about following an existing model or comparative case. It's about following and believing in the process. By working together, the process will take the Authority into a much better space. It recognises the potential that other actors and agencies makes in successful World Heritage Area management and lets them all play their part to contribute.

We are now at a point where we need to think of the role of the Authority and how it works with partners in a slightly different way.

Partnerships

Because of the Authority's small size and its limited operational roles, it has always had to rely on the commitment and cooperation of its partners in government, the community and in industry to ensure that the goals of the World Heritage Convention are achieved. These partnerships have evolved over the past 30 years as land ownership and management responsibilities have changed, as government priorities and investments have changed and as environmental management issues and community and industry interests and concerns have changed. A recent example of this is work currently undertaken in the Authority's Yellow Crazy Ant Eradication Program, which has been in operation since 2013.

Yellow crazy ant eradication: Partnerships in adaptive management

From the beginning, the Authority's Yellow Crazy Ant Eradication Program has demonstrated the power of strong and adaptable collaborations with a diverse range of partners, including the three tiers of government, education institutions, industry and residents.

Partners in the Program have demonstrated a concerted will to seek the most effective ways to achieve eradication, often through innovation and experimentation. Some examples of innovative ongoing partnerships include:

- Community champions volunteered their services and mobilised their local communities to participate in the eradication program, particularly when it was first established with limited resources. For example, Kuranda Envirocare, a local community group, attracted funding and over 100 volunteers who participated in monitoring and treatment and developed property land management plans within their local infestation.
- Frank Teodo, a local landholder south of Cairns, raised public awareness through the media and lobbied politicians about the impacts of yellow crazy ants on his property, himself and the cane industry. He also provided his land and house as an operational base for the initial eradication program.
- MSF Sugar, the Mulgrave Mill and the sugar industry are now helping the eradication program to find infestations and develop industry protocols to prevent the further spread of yellow crazy ants by harvesting machinery and cane trains.
- James Cook University is contracted to assist the program with research and monitoring of yellow crazy ants and the effectiveness of eradication methods. Collaborating with experts around the world, scientists continue to research the biology, life cycle and genetic distribution of yellow crazy ants, and the success of various treatment regimes. This partnership also led to successful negotiation of more effective permit conditions for the use of fipronil products with the Australian Pesticides and Veterinary Medicines Authority APVMA and the Department of the Environment and Energy.
- Local Aboriginal ranger groups from Gimuy Walubara Yidinji and Djabugay actively participate in operational contracts and training programs.
- Local and state government representatives volunteer to undertake annual delimitation and treatment for a week each year.

Yellow crazy ant nest. (Wet Tropics Images/Biosecurity QLD)

The partnerships formed through the Program have raised the profile and broadened the community engagement of the Wet Tropics Management Authority. The eradication program has enabled the Authority to play an active on-ground conservation role, bringing together a diverse mix of stakeholders who might otherwise have little in common. Participants in the program feel inspired to work together to build a better tomorrow—protecting the biodiversity and enjoyment of the Wet Tropics World Heritage Area as well as protecting the prosperity of their industries and the integrity and enjoyment of their lands and lifestyles. The program also has provided further opportunities to educate the community about the unique biodiversity of the Area and the vital role that the Authority plays in protecting it.

Successes to date

The Yellow Crazy Ant Eradication Program has successfully:

- declared eradication at two infestation sites. A third is due to be declared in the second half of 2018
- halted the spread of ants on the western boundary within the World Heritage Area
- significantly reduced ant activity across the entire infestation area through broadscale treatments.

An independent review of the Yellow Crazy Ant Eradication Program in 2018 concluded that local eradication can still be achieved. It praised the adaptive management of the program to date.

Yellow crazy ants milking aphids for honeydew. (Wet Tropics Images/Rhys Sharry)

Operations team examining cane for evidence of white fly. (Wet Tropics Images/Rhys Sharry)

Another important partnership is how the Authority influences the practices of infrastructure agencies and land managers through the publication of best environmental practice guides. Examples include guides for road maintenance (Goosem *et al,* 2010), electricity infrastructure (QESI, 2008), and water infrastructure (Wet Tropics Management Authority, 2001). In some cases, initial work conducted by the Authority has influenced the development of codes of practice for road maintenance and electricity infrastructure now applied throughout Queensland.

IN THEIR OWN WORDS

Bruce Jennison

Principal conservation officer, Wet Tropics Management Authority

Skyrail Rainforest Cableway is a 7.5 km scenic cableway running above Barron Gorge National Park, in the Wet Tropics of Queensland World Heritage Area, north of Cairns. It has won more than 25 international and national tourism awards since its construction in 1994. While the Skyrail project certainly deserves all the accolades and recognition it has garnered, an important part of the back-story was the commitment of Authority staff to work with Skyrail to set these high standards of environmental practice. The Authority, and previously the Cairns Rainforest Unit, took a strong interest in the minutiae of the design.

The Authority was never anti-development. We rarely said no.

The Authority was never anti-development. We rarely said no. The only time we did say no, was to a proposed development of an old forestry road at the back of Russet Park, near Kuranda. The road traversed one of the narrowest vegetated corridors in the World Heritage Area in an area critical for ecological connectivity. This issue goes to the heart of how we are managing the World Heritage Area. The Black Mountain Corridor is one of the most important corridors for fauna movement in all of the World Heritage Area. It just had to be protected. The idea of opening an old forestry road through such a critical ecological corridor was unthinkable and we needed to say no because of almost certain long-term detrimental outcomes—regardless of the pressure we received from a small section of the community seeking a new road access to their properties.

I came to this principal conservation officer role with the Authority with a very open mind. I focused on being enthusiastic and tried to do things in innovative ways that would better protect the World Heritage Area. I was motivated to find ways and negotiate methodologies with developers that minimised the impact of infrastructure on World Heritage. I would describe the approach as just trying to do the best things possible to minimise adverse impacts and reduce harmful effects. The approach to developers has generally not been about saying no, but asking questions. For example, have you considered doing something different, something that better addresses good ecological and environmental outcomes and still provides for necessary infrastructure work? It is about encouraging innovation, education and setting the high standards you would expect for a World Heritage Area and doing so in a way that keeps people on side and cooperating.

It is about encouraging innovation, education and setting the high standards you would expect for a World Heritage Area

The work on the regulatory aspects of the Wet Tropics Management Plan 1998 deals with key sensitive areas such as where the boundaries of national parks and the edges of roads and electricity corridors meet. Council reserves, infrastructure easements, power lines, areas along the suburban edge. These are the key sensitive areas and where the important negotiations concerning edge effects and the impact of development on the management of protected areas meet.

Partners in science

The Authority promotes the Wet Tropics as a learning landscape to encourage the research and education communities to embrace the World Heritage Area as a living laboratory. Scientific research plays a critical role in providing the knowledge for informed decision-making and for the community to understand and appreciate the importance of the Area.

The Wet Tropics World Heritage Area is regarded as one of the best-studied patches of rainforest in the world (Laurance 2016). For this reason, and also for the calibre of work undertaken, research in the Area has raised global interest in similar tropical environments facing comparable problems like climate change and infrastructure impacts, fragmentation, and ecological restoration.

Research capacity and knowledge has developed rapidly in the Wet Tropics over the last 30 years through two rounds of Rainforest Cooperative Research Centre funding (Rainforest CRC, 1993-2006); the Marine and Tropical Sciences Research Facility (MTSRF, 2006-2010); and the National Environmental Research Program (NERP, 2010-2014). A supersite was also established under Australia's Terrestrial Ecosystem Research Network to capitalize on, and build upon, the environmental research legacy of the region.

One of the defining features of the Wet Tropics and the presence of its listing is its track record for environmental research excellence. A number of universities are active in research activities in the area, while James Cook University (JCU) and CQUniversity (CQUni) both have two campuses located near the Wet Tropics region (Cairns and Townsville). These are high performing research institutions; in 2016 JCU was ranked 22nd in the World for Environment and Ecology research (JCU, 2018), and among the top 12 tourism education institutions in the world, recognised for its special focus on ecotourism. CQUni is listed within the world's top two percent of universities due to its commitment to research, learning and teaching, internationalisation and student success. Without investment in these areas of research, the Wet Tropics will lose its scientific experts and global reputation, and lessen its influence and function in the life of both the regional and global communities.

The past research programs of the Rainforest CRC, MTSRF and NERP (which were supported and funded until 2014) all focussed on the environment and human interactions with it. These research programs involved Authority staff in various steering committee and advisory roles, and in the determination of research direction and projects consistent with the Authority's Research Strategy and its board's and partner organisations' priorities.

The Area was World Heritage listed on the basis of scientific understanding, and research in the 30 years since listing has reinforced the international significance and the irreplaceability of the Area.

Despite past government research investments, current levels of activity, unfortunately, are declining. The Wet Tropics, with its research infrastructure and committed scientists, has great potential to join other well-studied tropical forest areas, such as La Selva in Costa Rica, the island of Barro Colorado in the middle of the Panama Canal and Tambopata Research Centre in Peru (Laurance 2008), in providing essential information on how tropical forests function, how they are responding to changing conditions and importantly, how they can best be managed to maintain their functions in the face of these changes.

Mt Lewis road (Paul Curtis Images)

Partners in visitation and tourism

World Heritage is a very powerful brand for the tourism industry. The tourism industry is a key partner in delivering better understanding of the outstanding universal value of the Wet Tropics through interpretation and presentation. The role of visitor information centres, tour guides and volunteers are critical to the success of connecting visitors to the World Heritage Area. Tourism, visitation and the tangible benefits it provides are valuable in giving the Area a function in the life of the community and in strengthening appreciation and support for the World Heritage Area.

The Authority has entered into joint ventures with the tourism industry and local governments to improve visitor experiences through the establishment and support of professional and knowledgeable visitor information centres. Tourism Tropical North Queensland is actively exploring opportunities to improve the marketing and interpretation of the values of the World Heritage Area to a broad domestic and international market.

The Authority continues to provide support to local businesses through our renowned tour guide training, sharing of information about the World Heritage Area and in joint development of interpretive products. The Authority provides advice to major tourism projects to ensure that they can proceed in line with high standards.

Queensland Parks and Wildlife Service

National parks now make up 84% of the Wet Tropics World Heritage Area, a significant increase from the 14% of the area that existed in 1988. Due to this significant landholding within the region, the Authority maintains a strong partnership with the Queensland Parks and Wildlife Services (QPWS). The Authority has a formal partnership agreement with QPWS which ensures that national parks within the World Heritage Area are managed consistent with the World Heritage Convention. This means that the Authority and QPWS work collaboratively on pest and weed management strategies, fire management strategies, research, signage and interpretation, and on supporting Rainforest Aboriginal people in economic and land management activities on national parks.

QPWS officers actively participate in tour guide training (as experts and as participants) as well as the Community Consultative Committee, Scientific Advisory Committee, board meetings, and are active collaborators in the refresh of the Wet Tropics Regional Agreement.

Queensland Parks and Wildlife Service rangers. (Queensland Government)

World Heritage is our promise to the future – the next 30 years

With World Heritage listing comes an obligation to manage the Area "for the protection, conservation, presentation, rehabilitation and transmission to future generations of the World Heritage Area".

That obligation—and the property's enduring standing as the world's oldest living tropical rainforest and an exemplar of outstanding universal value—is our promise to the future.

The Wet Tropics World Heritage Area has a rich history steeped in commitment, passion and controversy. Its listing was the culmination of communities respecting, living in, utilising and valuing the rainforest, over millennia for Rainforest Aboriginal people, and, more recently, for a regional community of diverse interests and perspectives.

Science—shaping our knowledge

Science strengthens community advocacy, and an abundance of research, reports and symposia demonstrated the outstanding natural value that led to the World Heritage nomination of the Area. Since that listing, science has continued to play a strong role in education, planning, management and addressing emerging challenges (such as yellow crazy ant eradication). Science has also underpinned regulatory tools for the Wet Tropics Management Authority on activities and development on the Area.

It was science too, that identified the Area as the second-most irreplaceable World Heritage site on Earth. It is science that will also galvanize protection, management and resilience over the next 30 years.

Despite its World Heritage listing, strong science foundation and its own legislation, the Area faces significant challenges. The threats posed by climate change, declining biodiversity, increasing pest species, extreme weather events, altered water flows and fire regimes, together with population growth, infrastructure demands and economic imperatives, suggest that while the campaign for listing has been won, there is a continuing struggle emerging for the future.

The 2017 UNESCO Conservation Outlook report supports this, stating the Area is *"protected by a strong and updated legislative framework, a dedicated independent Management Authority which enjoys broad community support, and a comprehensive suite of management strategies. However, the insidious and damaging threat posed by invasive plants, animals and diseases, and the high risk posed by the predicted impacts of climate change present real danger to the continuing integrity of the site's biodiversity and associated endemic species."*

Science, and the Authority's Scientific Advisory Committee, will play a strong role in the response to these threats. These challenges are shared with World Heritage properties across Australia and globally, and collaboration and shared solutions will inform action locally.

Specific areas of science will become increasingly important, including technical approaches for preserving ecosystems and World Heritage values, such as regeneration, translocation, genetic engineering and biomimicry (Rosen, 2017).

Science requires resources, which, for the challenges being faced, will undoubtedly be insufficient to support all of the research and actions needed, and the Authority will need to prioritise the most critical science needs and investigate collaborative research partnerships.

A changing climate

Climate adaptation to maintain World Heritage values poses one of the most significant future threats to the World Heritage Area, and to World Heritage globally (Welbergen *et al* 2015). Whilst there is little the Authority can do to reduce global emissions and reverse climate trends, to meet its charter it must advocate for and take strong action to sustain the World Heritage values of the property, in collaboration with land managers, Rainforest Aboriginal people, industry and community.

At its 42nd meeting in Bahrain, the World Heritage Committee expressed "its continued concern about the impacts of climate change on the Outstanding Universal Value (OUV) of World Heritage properties and reiterated the importance of State Parties undertaking the most ambitious implementation of the Paris Agreement of the United Nations Framework Convention on Climate Change" (UNESCO, 2018).

Professor Steve Williams

Former Wet Tropics Management Authority committee member

Is anybody listing to the canaries?

I started out studying the Wet Tropics as a university student during the 1990s. My association with the Wet Tropics is because of the high endemism, significant biodiversity and so many unique species that are found here and nowhere else.

At that time, my interest was in understanding biodiversity, in particular vertebrates, birds, animals and frogs. But around 2003, we did some projects looking into what potential impacts climate change might have and that really shocked me. The results suggested that nearly half of the species of everything I worked on could actually go extinct this century. My research priority evolved to better understand the impacts of climate change and what can be done.

I came to the realisation that everything that my research focused on faced a potential threat of extinction in the current century. Unfortunately, with climate change, the very special are endemic species are the ones that are most at risk. They are at higher altitudes, above 600 metres. Increasing temperature pushes animals up the mountains in search of cooler air and because the mountains are not very high, the animals are running out of habitable space. They will eventually run out of altitude and have nowhere to go.

It is a bit depressing to find an area so well protected and managed like the Wet Tropics World Heritage Area, but find that it does not actually help with an issue like climate change. When we started, it was about the possibility of extinctions and when they might occur at a time in the future. Unfortunately, extinctions are already happening. As we have been monitoring and testing our models, the decline in species populations and their resilience has actually been occurring and faster than we originally predicted. Already, we can detect significant declines in abundance of animals as they have been pushed up the mountains. Ringtail possums and Herbert River possums were being found regularly at 600 metres in our studies during 2007-08. They have since disappeared at this level. They are currently still stable at 800 metres but who knows for how much longer?

To put a time on it, by the 60th anniversary of the World Heritage Area we may well be facing the prospect that there are not many endemic species left. If not extinct, many species face massive decline over the next three decades. It underlines the overwhelming urgency of a response to climate change. I use to say climate change was one of the critical issues for the Wet Tropics. Now I think it just blows everything else out of the water. I think all of those issues are still important (things like invasive species, fire and drought), but I think they have been rapidly overtaken by climate change. In addition, of course, they interact with climate change.

The Great Barrier Reef has had massive impacts, visually obvious impacts, and it has attracted a lot of attention. I actually think that the threat to the Wet Tropics is equally severe and we will probably face proportionally higher levels of extinction than the reef. However, because it is not as visually obvious it has not attracted attention. It is vitally important for the Authority to help bring the risks into focus and advocate for more action and investment.

... the animals are running out of habitable space. They will eventually run out of altitude and have nowhere to go.

Unavoidable and extensive ecological deterioration is likely as a result of climate change, which will impact on the property's World Heritage values, potentially putting its listing at risk. Similarly, the natural and built assets vital to the tourism industry and that provide benefits to the wider community are at risk.

There has been considerable research and modelling to support planning for climate change, with a range of potential actions to reduce loss and negative impacts on biodiversity values. However, specific responses to clearly defined impacts, particularly on OUV, are urgently needed.

The Authority is preparing a climate resilience plan that will include a range of practical and strategic measures to give confidence to the community that action is being taken to ensure the World Heritage values of the Area are maintained to the greatest extent possible.

Community-led science

Critically important to science, research and on-ground action is the continuing support and involvement of communities. The integration of the traditional knowledge of Rainforest Aboriginal people with Western science provides a wealth of understanding and knowledge about managing country over thousands of years, including previous periods of climate change. The Authority has already established traditional knowledge as part of its Scientific Advisory Committee structure, and progressed a research protocol for involving traditional custodians of the Area in research activities.

The regional community has also played an important role in the practical application of science. A large number of groups and organisations have implemented projects that contribute to achieving the World Heritage obligation—including plant propagation, revegetation, threatened species recovery, pest eradication, education, data collection and monitoring.

In the future, the Authority will encourage increased public participation in research and on-ground activities to assist in the collection of data, and will sponsor citizen science projects to address critical challenges. It will continue to target its successful student grants program to priority issues, and expand its partnerships with industry and philanthropic organisations, like the Skyrail Rainforest Foundation, to ensure priority research and on-ground actions are progressed.

It's all about people—engaging the community

Ensuring the Area has a role in the life of the community is a fundamental commitment to World Heritage management. There is substantial support for the World Heritage rainforest with research showing that residents view the Area as an integral part of their landscape, lifestyle and community and feel a strong sense of collective ownership and responsibility (Carmody and Prideaux, 2008).

However, there will be changing expectations as populations grow, amid projections that the regional population will grow to 700,000 by 2050 (Cairns Regional Council, 2015). This will likely lead to demand for increased recreational experiences and access to the Area. Regional pressures for housing and other land uses in the region will potentially fragment vegetated corridors, placing heavy reliance on protected areas for maintenance of biodiversity. Services to support growth will be needed both inside and outside the Area, including reliable energy, improved roads, access to technology, water and other resources and economic and employment opportunities.

Whilst the Area is protected under both the World Heritage Convention and legislation, impacts from changes in and outside the property, coupled with increased usage by residents and visitors, will place significant pressure on the Area's values.

As we face these challenges, and the compounding challenges associated with biodiversity decline and climate change, the participation of the community will be crucial to meeting the World Heritage obligation.

Contemporary communications techniques, using multiple channels, will distribute information, educate and invite participation. More collaborative engagement and partnerships will be pursued across the Authority, government organisations and communities, to share responsibility and make well-informed, sustainable solutions on challenging issues. Those involved will necessarily be representative of the community, in terms of age, gender, affiliation and cultural background. This will require resources to support participation and ensure the range of factors and perspectives are known, respected and understood, particularly the perspectives of traditional custodians, and that legislative obligations, data and information are considered, expectations managed and results documented.

Rainforest Aboriginal people of the Wet Tropics

Despite the Area currently only being World Heritage listed for its natural values, it is a nationally-listed cultural heritage landscape and the land of the world's oldest living culture. One of Authority's most critical partnerships, now and into the future, is with the traditional custodians of the land on which the Wet Tropics World Heritage Area is situated, the Rainforest Aboriginal people.

When the property was listed, there was little consideration of cultural values. The World Heritage listing was advanced before the Mabo decision, before native title legislation and when the World Heritage Convention had a strong distinction between natural and cultural heritage. The concept of free, prior, informed consent had not been fully considered.

Since then there has been substantial change, with stronger recognition of the biocultural values of the Area and acknowledgement that the land is and always has been the land of Rainforest Aboriginal people. Native title has been resolved or is continuing to be resolved, prescribed bodies corporate established, Indigenous Protected Areas dedicated, Indigenous Land Use Agreements (ILUAs) negotiated and the first Wet Tropics land tenure resolution process is underway to return national park land to the Eastern Kuku Yalanji people.

The Authority's approach to consultation with the traditional custodians has also evolved towards more purposeful and collaborative engagement, focused on closer working relationships and maximising opportunities. However, many commitments of the Regional Agreement are yet to be realised, a number of ILUAs have expired and there is still a considerable way to go for Rainforest Aboriginal people to meaningfully share in decision-making and the economic benefits of the Area as full partners.

Over the next 30 years, it is foreseeable that all areas subject to native title will be determined, and that land tenure resolution or similar programs will see more land returned to Traditional Owners. As a result, the Area will have strong input from Aboriginal organisations in the decision-making and day-to-day management. Free, prior and informed consent using culturally appropriate governance methods will be used to progress management decisions, based on a refreshed Regional Agreement and negotiated ILUAs.

IN THEIR OWN WORDS

Ro Hill

Former Wet Tropics Management Authority board director and committee member

The key challenges include accommodating Aboriginal traditional rights and especially how to bring Rainforest Aboriginal people's knowledge into management of the Area. Internationally, there now needs to be prior and informed consent for nomination of World Heritage areas.

I think there is an opportunity to go back and look for consent retrospectively. It's a different time now and that is reflected in the tenure changes.

Between 2008 and 2012 was big change in tenure. In 2008 we mapped that about 12% of the Wet Tropics had native title rights determined. By 2012 it's about 85%. That's is a huge change and all the local groups have been recognised, they have got their country.

Now we need to look again at what co-government looks like. There is also a need to look into greater regional economic opportunities, along the lines of what has occurred at Mossman Gorge as Aboriginal-owned and run enterprise.

...there now needs to be prior and informed consent for nomination of World Heritage Areas.

Rainforest Aboriginal people's Regional Forum, October 2017 (Wet Tropics Images)

Embracing sustainable tourism

Tourism is the single biggest contributor to achieving the World Heritage Convention's goal of "presentation" and the tourism industry is a key partner in presenting the Area to visitors.

In a region that boasts two World Heritage properties – the Wet Tropics and the Great Barrier Reef, ecotourism providers are well-versed in its international significance, attractiveness for visitors and the global mandate for protection and sensitive use.

The UNESCO World Heritage and Sustainable Tourism Program supports "sustainable tourism as an important vehicle for protecting and managing cultural and natural heritage of outstanding universal value" and sets out a cooperative framework "where planning for tourism and heritage management is integrated at a destination level, the natural and cultural assets are valued and protected, and appropriate tourism is developed" (UNESCO, 2018).

Whilst there are exceptional experiences now with over five million visits each year, the Area has an under-utilised potential for broadening the visitor experience and expanding the tourism product across its nearly 900,000 hectares.

Despite the many benefits, if poorly managed, tourism growth is not without risk. The World Heritage Committee has acknowledged the positive impact sustainable tourism can have on local communities and the protection of World Heritage properties. However, it has noted "concern that the number of properties negatively affected by inadequate visitor management and tourism infrastructure development continues to increase", requesting State Parties "to develop visitor management plans that assess appropriate carrying capacity of properties for visitors and address the issue of unregulated tourism" (UNESCO, 2018).

Planning a way forward – the Wet Tropics Management Plan

The Wet Tropics World Heritage Area is administered under the *Wet Tropics World Heritage Protection and Management Act 1993* (the Act), and through the *Wet Tropics Management Plan 1998* (the Plan), which is subordinate legislation under the Act. These set out a framework to protect the ecological, biological, evolutionary and scenic landscape attributes for which the Wet Tropics World Heritage Area was listed. In the 30th anniversary year, the Wet Tropics Management Authority is reviewing the Plan towards improved and less complex management, whilst maintaining the highest levels of protection.

The Australian World Heritage management principles establish that a management plan for a World Heritage property should, amongst other things, "state mechanisms to deal with the impacts of actions that individually or cumulatively degrade or threaten to degrade, the World Heritage values of the property; and provide that management actions for values that are not World Heritage values, are consistent with

IN THEIR OWN WORDS

Tim Nevard

Tourism advocate

The Authority presented the first iteration of the Wet Tropics Management Plan (1998) as quite broad and encompassing. It was understood that the Plan could have an ecotourism component and establish a framework in which the World Heritage Area could accommodate and support a strong tourism industry. The subsequent drafting process of the Wet Tropics Management Plan and regulations however set limits to this broader approach. That left the tourism industry somewhat disappointed. The feeling amongst the tourism industry was that the opportunity for genuine partnership was lost, which led to a curtailment of momentum in what had been a very promising, developing relationship.

The 2017-18 the Wet Tropics Management Plan review process has provided a new opportunity to revisit tourism issues and the wider relationship with the tourism industry.

I was engaged to assist in the industry consultation with the hope and expectation that it will provide an opportunity for the Plan to reinvigorate meaningful partnerships, fostering the needs and interests of both the tourism industry and values of the Wet Tropics World Heritage Area.

...the Wet Tropics Management Plan review process has provided a new opportunity to revisit tourism issues and the wider relationship with the tourism industry.

the management of the World Heritage values of the property" (EPBC Regulation 2000, schedule 5).

Therefore a robust framework for decision-making is required in consideration of the values, science, community feedback, traditional cultural practice and current and emerging uses.

Share, connect, protect – the Authority's role into the future

The Wet Tropics Management Authority was established under an Intergovernmental Agreement between the Australian and Queensland governments with a primary goal "to provide for the implementation of Australia's international duty for the protection, conservation, presentation, rehabilitation and transmission to future generations of the Wet Tropics of Queensland World Heritage Area within the meaning of the World Heritage Convention."

The size and complexity of the Area, the people that live in or near it, and the many people and groups that visit, as well as their potentially profound effect on its future, are acknowledged in the Agreement.

Having a statutory body with an independent board of directors dedicated to meeting Australia's World Heritage obligation for the Area has provided numerous advantages. It has been able to advise, report on, and make recommendations direct to Australian and Queensland government ministers about the Area. It has enabled the Authority to develop and implement policies, programs and statutory instruments for effective management of the property. Through those instruments, it has been able to consider, assess and influence the outcomes of proposals and activities within the Area. It has entered into partnerships and cooperative agreements with landholders, Rainforest Aboriginal people and industry sectors, for the sustainable use, enjoyment, advancement and rehabilitation of the Area, gathered research and information to support decisions and management options, and administered funding across a wide range of activities, grant programs and contracts.

However, those policies and plans have been viewed by some sectors as not strong enough, and by others as too strong and inflexible. At times, they have largely been achieved without the meaningful involvement of Rainforest Aboriginal people. The new statutory Wet Tropics Management Plan 2019-2029, developed in stronger collaboration with the community, will set a new framework for achieving the primary goal.

Education, awareness and advocacy, will be increasingly important for strengthening appreciation of the exceptional values and global significance of the Area. Sharing knowledge will be an important focus to garner support for a determined response to climate change impacts and other challenges.

Partnerships will be essential for improving protection and presentation of the Area. Science partnerships will ensure the right priorities and the right knowledge for protecting and managing the Area is available. Partnerships with the tourism sector will attract new investment, manage visitation and help to position the Wet Tropics as a world class destination for visitors. Partnerships with the Queensland Parks and Wildlife Service will be maintained to ensure that collaborative delivery of key strategies will continue to meet community expectations of World Heritage management. Partnerships with community groups will see a wide range of restoration, recovery, conservation and education projects delivered, along with continuing advocacy for the area. Increasingly, the Authority will need to identify the high priority interventions and connect communities, governments at all levels and other stakeholders with an interest to take action.

The declaration of the Wet Tropics as a World Heritage property has ensured the protection of its outstanding universal value for the past 30 years. In the coming years, to fulfill its primary goal and keep the World Heritage standing will require the meaningful participation of Rainforest Aboriginal people, communities, the tourism industry and the research community, together with robust science, strong management planning and a committed statutory authority under cooperative government leadership. The commitment, passion and advocacy of those communities will ensure its World Heritage standing over the next 30 years.

Headland between Myall Beach and Cape Tribulation Beach (TTNQ Images)

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Creek in the Daintree (TTNQ Images)

Abbreviations

ARC	Aboriginal Rainforest Council
AWHIN	Australian World Heritage Indigenous Network
CCC	Community Consultative Committee
CQU	Central Queensland University
CRC	Cooperative Research Centre
INF	Interim Negotiating Forum
DOGIT	Deed of Grant in Trust
ILUA	Indigenous Land Use Agreement
IUCN	International Union for the Conservation of Nature
JCU	James Cook University
MTSRF	Marine and Tropical Sciences Research Facility
NERP	National Environmental Research Program
NRM	Natural Resource Management
OUV	Outstanding Universal Value
QPWS	Queensland Parks and Wildlife Service
RAAC	Rainforest Aboriginal Advisory Committee
SAC	Scientific Advisory Committee
SAP	Structural Adjustment Package
The Area	Wet Tropics of Queensland World Heritage Area
The Authority	Wet Tropics Management Authority
UNESCO	The United Nations Educational, Scientific and Cultural Organisation.

Appendix 1. A chronology of the protection and management of the Wet Tropics of Queensland World Heritage Area

Pre-European Settlement	Aboriginal people occupied, used and enjoyed land in the Area prior to the arrival of Europeans.
Early 1870s to mid 1980s	Colonisation and dispossession of Aboriginal traditional lands. Traditional lands reduced to a few small Aboriginal reserves.
1791	Samples of red cedar were dispatched from Australia to London (November 1791). Admiralty ordered that convict ships on their return journey to England should carry as much red cedar as possible.
1842	Special decree by Governor Gipps (colony of NSW) that no timber licences were to be granted in any rainforest north of Brisbane containing Bunya Pine (in recognition of its importance to Aboriginal people).
1859	Separation of the colony of Queensland from New South Wales.
1860	First timber regulations proclaimed and licence system introduced in Queensland.
1873	Dalrymple explored coastal valleys and ranges between Cardwell and Cooktown assessing the potential of the land for development.
1874	Timber cutters commenced logging of red cedar and kauri pine.
1875	Government formed a select committee to report on forest conservancy in Queensland.
1877	Cedar of the Daintree and Mossman valleys reported as totally cut-out.
1881	Cedar cutters extended operations to western margin of Atherton Tableland.
1881	33 general timber licences issued at Herberton. By end of 1881 a total of 9 million superfeet of cedar logged.
1881	Sugar cane farms established on coastal lowlands.
1882	Christy Palmerston, a prominent bushman and pathfinder, explored ranges between Port Douglas and Cairns, then a stock route between Herberton and Innisfail (parts of the Palmerston Highway, K-tree Road and West Palmerston Road)
1882	Rainforests of the Atherton Tablelands opened up for selection – first dairying commenced on the Atherton Tableland to supply dairy products to miners on the goldfields (dairying accelerated rainforest selection and clearing).
1882	Export of red cedar through Port Douglas ends as all trees near streams had been removed.
1882	Carl Lumholtz (naturalist explorer) explored the Herbert River district.
1883-86	Palmerston discovered gold in Jordan Creek area and lower Russell River.
1886	George Russell discovered gold in upper terraces of Russell River.
1887	Palmerston, with a companion believed to be Wilkam Leighton, successfully located and blazed a route from the lowlands near Port Douglas to the Tablelands (the Bump Track) in April 1877. The route was later cleared in July 1877.
1889	By 1889 the following timbers were being milled in the Wet Tropics: red cedar, beech, kauri pines, black bean, silkwood, hickory, acacia cedar, satinwood and pencil cedar.
1891- 1893	Railway progressed from Cairns and Kuranda to Mareeba.
1897	Two small sawmills operating in Cairns.
1901	The Commonwealth of Australia came into being as a Federation of what had previously been six colonies which then became six states (1 January). Constitution came into force.
1902	Three sawmills operating in Atherton.
1906	*State Forests and National Parks Act of 1906* gazetted which included royalty-based sales instead of simple licensing.

1921	Bellenden Ker National Park gazetted.
1924	Cairns linked to Brisbane by rail.
1929	Publication of the illustrated field guide *Australian Rain Forest Trees* (Francis 1929).
1931	Edward Swain, Forestry Director, criticised land settlement policies. Led to a Royal Commission to investigate conflict between land settlement and forestry. Swain dismissed for his attempts to retain greater areas of rainforest.
1932	Hinchinbrook Island National Park gazetted.
1934	Lakes Barrine and Eacham national parks gazetted.
1936	Public Estate Improvement Scheme commenced as a measure to reduce post-depression unemployment and to open-up access to several timber reserves and state forests (1936-1943). Examples include construction of Black Mountain Road (Kuranda to Julatten), B Road (Danbulla), Kennedy-Kirrama Road.
1940	Barron Gorge National Park gazetted.
1947	Queensland Government decrees that all timber logged in the region had to be processed locally (previously much was exported as logs).
WW2	Construction of the Kuranda-Mareeba Road by American forces.
Post WW1	Soldier resettlement schemes – opening-up of Malaan, Mena Creek and Utchee Creek areas.
1952	Tree marking introduced (trees selected for cutting paint-marked with direction of fall indicated).
1958	Len Webb's (rainforest ecologist) classification of Australian rainforests.
1960	Forest Inventory System introduced (permanent monitoring plots).
1960s	Last massive clearing (42,900 ha) occurred in the lower Tully River valley (King Ranch).
1966	Len Webb put forward a series of national park proposals, designed to protect the full range of the remaining habitats of the Wet Tropics (first time in Australia). *The Identification and Conservation of Habitat Types in the Wet Tropic Lowlands of North Queensland*. This was also the first reference in the scientific literature to the international significance of the lowland rainforests. (Note: lowlands were defined as areas below 1000 ft contour). The proposals were confined to the lowlands because of the extraordinary development pressures placed on the lowlands from about 1955 onwards.
1971	Establishment of CSIRO Tropical Forest Research Station in Atherton.
1973	Peter Stanton reviewed status of reserves in the lowlands and identified additional areas for reservation.
1974	Biosphere Reserve model proposed for the region by the Man and the Biosphere (MAB) section of UNESCO but State Government declined to proceed.
1974	Rainforest Conservation Society established.
1974	Australian Government inquiry into the National Estate and recognition of the urgent need to conserve rainforests.
1975	Creation of separate National Parks and Wildlife Service (previously a Department of Forestry function).
1975	Commonwealth establishes the Australian Heritage Commission and introduces National Estate legislation.
1975	Overall classification and mapping of Wet Tropics forests by Tracey and Webb.
1976	Focus on our Northern Heritage – workshop organised by WPS in Cairns.
1978	Conservation groups nominated several areas for listing on the National Heritage Register.
1980	Second World Wilderness Congress held in Cairns (June 1980).

1980	Australian Heritage Commission listed a number of rainforest areas (Greater Daintree region – 350,000 ha) on the Register of the National Estate (October 1980).
1980	State Parliament presented with a petition signed by 12,000 Queenslanders seeking protection of the Wet Tropics rainforests.
1981	Mt Windsor logging operations blockaded by conservationists (13 people arrested) in November 1981.
1981	Australian Conservation Foundation launched the Rescue the Rainforest campaign in Cairns and the Cairns and Far North Environment Centre was formed.
1981	The original proposals by the conservation movement was for a *"Greater Daintree National Park"* including only the Cape Tribulation NP, Roaring Meg/Alexandra Creek catchments, Daintree River catchment, Mt Windsor Tableland, Mt Spurgeon, Mossman Gorge, Mt Lewis, Cedar Bay area and Walker Bay area.
1982	Bernie Hyland's (taxonomist) card key for the identification of rainforest trees of north Queensland published.
1982	Descriptions of Wet Tropics vegetation types published by Geoff Tracey (rainforest ecologist): *The Vegetation of the Humid Tropical Region of North Queensland*.
1982	The impetus for World Heritage listing of the Wet Tropics came with the 1982 publication "The World's Great Natural Areas" and included on IUCN's 1982 list of places deserving World Heritage protection.
1983	Clearing commenced for a new Cape Tribulation-Bloomfield Road. Construction started December 1983 to be met by a blockade of protesters. Elevated the campaign to national and international levels and drew the Federal Government into the debate.
1983	Two significant events occurred at the national level in 1983. The first was the election of Bob Hawke on 5 March on the promise of saving Tasmania's Franklin, and secondly, the landmark High Court ruling in the Tasmanian Dams Case on 1 July which validated the new *World Heritage Properties Conservation Act* which became law on 22 May 1983. The Act was necessary to protect the Tasmanian Wilderness World Heritage Area which had been listed in 1982.
1984	Cape Tribulation-Bloomfield Road blockade continued.
1984	Australian Heritage Commission engaged the Rainforest Conservation Society of Queensland to evaluate and report on the international conservation significance of the Wet Tropics between Cooktown and Townsville (January 1984). The report (completed in June 1984) concluded that the area met all four natural heritage criteria and this finding was supported by several international referees.
1984	Conservationists from around Australia met in Brisbane to form a national coalition to seek listing of the Wet Tropics as a World Heritage site.
1984	Rainforest management conference held in Cairns. As a result of this workshop the Federal Government initiated a national rainforest conservation program.
1984	General Assembly for IUCN passed a resolution recognising the value of the Wet Tropics.
1985	Downey Creek logging blockade.
1986	Opinion poll found 61% of North Queenslanders supported cessation of logging in virgin rainforest.
1986	Commonwealth establishes a $22.5 million National Rainforest Conservation Program but Queensland Government refuses to participate.
1987	Norman Myers emphasises the importance of protecting Australia's wet tropical forests.
1987	Commonwealth announced (5 June 1987 just prior to the 1987 election) that they would proceed immediately and unilaterally towards nomination of the Wet Tropics to the World Heritage list.
1987	A Federal Rainforest Unit, with offices in Canberra and in Cairns, was established in July 1987 to co-ordinate Commonwealth action in relation to the protection of the proposed area.

1987	Queensland establishes the Northern Rainforest Management Agency (NORMA) to co-ordinate rainforest management planning of the Wet Tropics (August 1987).
1987	Senator Graham Richardson announced the indicative boundary for a World Heritage nomination and launches a public consultation process to obtain views and to help decide the final boundary and to assist in the development of socio-economic strategies to offset impacts. The public comment phase elicited 1,350 suggestions for changes to the indicative boundary. As a result of the reassessment almost 100 square kilometres of freehold land, recently cleared land, some eucalypt forests and areas with exotic plantations were excised from the nominated area.
1987	Commonwealth released final boundaries for the proposed nomination to the public (11 December 1987) and announced it was proceeding with the nomination.
1987	Social Impact Assessment commissioned by Commonwealth.
1987	Nomination presented to the Bureau of the World Heritage Committee on 23 December 1987 based on proposal prepared by the Rainforest Conservation Society.
1987	Through the act of nomination of the Wet Tropics, the Commonwealth assumed responsibility under the *World Heritage Convention* to protect the outstanding universal values of the region. Successive High Court decisions confirmed that the "external affairs power" in the Australian Constitution supports Federal laws that give effect to obligations contained in international treaties to which Australia is a party. To the extent that a law of an Australian State is inconsistent with such a Federal law, the State law would be invalid.
1988	In January 1988, Commonwealth Environment Minister Graham Richardson assures Rainforest Aboriginal people that activities such as hunting and gathering will not be stopped on DOGIT lands in the Wet Tropics as a result of World Heritage listing.
1988	Commonwealth decided that logging was incompatible with protection of these values and made a regulation under the *World Heritage Properties Conservation Act 1983* to prevent activities associated with commercial forestry operations in the area covered by the nomination.
1988	Commonwealth decided that Quaid's Road (Southedge Road) was incompatible with protection of these values and made a regulation under the *World Heritage Properties Conservation Act 1983* to prevent activities associated with opening the road in the Area covered by the nomination.
1988	Commonwealth released proposals for the management of the Area. This document established the context and objectives of management and suggested mechanisms by which management would be implemented. Central to the scheme was the establishment of a joint State-Commonwealth management authority.
1988	Submission against listing from shire councils.
1988	Commonwealth established the Wet Tropics of Queensland Structural Adjustment Package to offset the impacts of the cessation of logging ($75.3 million).
1988	Amendments to the Commonwealth's *World Heritage Properties Conservation Act* were enacted in March 1988 to more fully exercise the Federal Government's constitutional powers and to strengthen interim protection for potential World Heritage sites.
1988	The proposed World Heritage Area is listed on the Register of the National Estate on 26 April 1988 under the *Australian Heritage Commission Act 1975*.
1988	In June 1988 a Queensland anti-delegation team, consisting of the Queensland Environment Minister, two Traditional Owners, and 16 other delegates, was sent to Paris to rally against World Heritage listing.
1988	The Chairman of Yarrabah Council writes to the Commonwealth Environment Minister in June 1988 voicing an opposition to the inclusion of Aboriginal lands in the nominated area.
1988	At its meeting in Paris (June 1988) the Bureau recommended the Area (then called the "Wet Tropical Rainforests of North-east Australia") be inscribed as a World Heritage area but requested the Commonwealth to provide clarification and further information on several points, particularly in relation to future management arrangements involving the State and Federal governments, and a revision of the proposed boundaries to exclude areas which did not contribute significant natural values.

1988	Commonwealth boundary review team held discussions with representatives of local government bodies in the week commencing 22 August 1988.
1988	Commonwealth boundary review team examined in detail two large areas (approximately 30,000 ha – Mt Windsor Tableland and 60,000 ha – Paluma Range) and 67 small areas. The small areas considered for exclusion were the irregularly shaped boundaries, isolated blocks, fingers protruding from the main area, or areas where new information had become available. Consideration was also given to adding small areas that would lead to a more coherent nomination. A total of 31 areas were excised (totalling about 6,300 ha) and eight areas (totalling about 630 ha) were added. An additional area of land at Mt Leach was treated separately. The review team found no scientific justification for major changes to the boundary.
1988	DASETT prepared a report to the World Heritage Committee Secretariat (September 1988) addressing the recommendations of the Bureau, particularly information on future management, boundaries, land ownership and use of the area, including traditional non-commercial purposes by Aboriginal people. The report suggested a more appropriate name for the nominated area should be the "*Wet Tropics of Queensland*" previously the nominated area was referred to as the "Wet Tropical Rainforests of North-east Australia".
1988	State and Commonwealth could not reach agreement. Commonwealth ignored State protests and resubmitted its nomination report in October 1988 with a reduction of 1% of the area originally nominated.
1988	In November 1988 the Chairperson of Yarrabah Council again writes to the Commonwealth Environment Minister opposing the inclusion of Aboriginal lands in the nominated area.
1988	At meeting in Brasilia in December 1988, the World Heritage Committee formally accepted the Commonwealth nomination and the Area was officially inscribed on the World Heritage list (9 December 1988). 12th Session of the World Heritage Committee meeting in Brasilia, Brazil from 5-9 December 1988.
1989	State Government's legal challenge to the constitutional validity of the listing was rejected by the High Court (30 June 1989).
1989	Labor Government elected in Queensland (2 December 1989) which withdrew challenge in the Federal Court that selection logging did not detract from World Heritage values.
1990	Commonwealth and new Qlueensland Government sign the *Wet Tropics World Heritage Area Management Scheme* – an intergovernmental agreement. The agreement is scheduled to the Queensland Act and given effect by s.3 of the Commonwealth Act. This agreement comprised an exchange of correspondence agreeing to broad structural and funding arrangements for the management scheme (November 1990), including development of the Wet Tropics Management Authority and Wet Tropics Management Agency.
1990	A Ministerial Council is established comprising two Federal Ministers and two State Ministers.
1991	World Heritage Bureau (June 1991) expressed concern at delays in the management planning process, lack of funds for field management activities, the pace of tourism development and a proposed hydropower development (Tully-Millstream scheme).
1992	Establishment of the Wet Tropics Management Authority. Staff and executive director comprised the Wet Tropics Management Agency. The Wet Tropics Management Authority is what is now referred to as the Board. The current usage of Authority and Board occurred when we became a statutory authority following gazettal of the *Wet Tropics World Heritage Protection and Management Act 1993*.
1992	Wet Tropics Management Plan consultation started (March 1992) with a discussion paper and questionnaire called: "*Wet Tropics Plan: Your First Invitation to Comment*".
1992	*Wet Tropics Plan: Strategic Directions* published August 1992.
1992	World Heritage Committee (December 1992) noted with satisfaction the level of progress made in instituting management arrangements, drafting legislation, improving budgetary allocations, and rehabilitating degraded forest areas.
1992	Queensland's *Nature Conservation Act 1992* gazetted.
1992	Rainforest Aboriginal Network (RAN) established - as first Rainforest Aboriginal representative entity.

1993	Queensland legislation: *Wet Tropics World Heritage Protection and Management Act 1993* proclaimed on 1 November 1993 (apart from ss.56 and 57). The Act provides for the establishment, functions and powers of the Wet Tropics Management Authority and its Board. The functions of the Authority set out in the Act loosely amalgamate the functions of the former Authority and the Agency from the WTWHA Management Scheme.
1994	Commonwealth and State announce joint funding of $23 million over four years for the Daintree Rescue Program.
1994	Commonwealth legislation: *Wet Tropics of Queensland World Heritage Area Conservation Act 1994* proclaimed on 15 March 1994.
1994 /1995	Bama Wabu replaces the RAN as representative organisation for Rainforest Aboriginal interests.
1995	Bama Wabu begins a review into Aboriginal involvement in World Heritage management.
1995	Draft Wet Tropics Plan placed on public exhibition (October 1995). The draft remained on public exhibition for over six months.
1995	A revised version of the intergovernmental agreement signed (December 1995).
1997	Wet Tropics Plan gazetted on 7 August 1997 and its provisions were due to come into force on 1 November 1997 but subsequently repealed due to court challenge.
1997	*Protection Through Partnerships: Policies for implementation of the Wet Tropics Plan* published (August 1997).
1998	*Wet Tropics Management Plan* gazetted on 22 May 1998 and came into force on 1 September 1998.
1998	Proclamation of ss.56 and 57 of the Wet Tropics World Heritage Protection and *Management Act 1993* occurred on 1 September 1998.
1998	At the June 1998 World Heritage Bureau meeting the issue of possible land clearing within the World Heritage Area was raised by NGOs. This triggered the need to formally respond through the process of a World Heritage Reactive Report coordinated by ACIUCN to determine whether the Wet Tropics should be placed on the list of World Heritage in Danger.
1988	*Which Way Our Cultural Survival? The Review Of Aboriginal Involvement in the Management of the Wet Tropics World Heritage Area* prepared by the Review Steering Committee in 1998.
1999	Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) gazetted.
1999	*World Heritage Properties Conservation Act 1983* repealed by the *Environmental Reform (Consequential Provisions) Act 1999.*
1999	*Vegetation Management Act 1999* gazetted.
2000	State Party's Response Report to the World Heritage Reactive Report developed, establishing State Party's benchmark response to the ACIUCN focused recommendations.
2000	Wet Tropics Nature Based Tourism Strategy published August 2000.
2001	Wet Tropics Walking Strategy published October 2001.
2001	*The Interim Negotiating Forum (INF)* begins. The process is aimed at developing an agreement which would address the 163 recommendations put forward by the Review Steering Committee in *Which Way Our Cultural Survival* produced from the Wet Tropics Ministerial Council sponsored *Review of Aboriginal Involvement in the Management of the WTWHA*.
2001-2004	The INF conducted nine forums and several regional workshops (attended each time by up to 300 Aboriginal people) to develop the Wet Tropics Regional Agreement.
2002	Wet Tropics first Periodic Report prepares and submitted to Environment Australia as requested by UNESCO.

2002	Rainforest CRC preparation of draft Statement of *Aboriginal Cultural Heritage Significance for the Wet Tropics Region of North Queensland.*
2003	Name change from Lumholtz National Park to Girringun National Park.
2004	Wet Tropics Conservation Strategy published September 2004.
2005	The Authority establishes the Rainforest Aboriginal Advisory Committee (RAAC) under s.40 of the Wet Tropics Act as prefaced by the in-principle Wet Tropics Regional Agreement.
2005	The Wet Tropics Regional Agreement is signed by 18 Rainforest Aboriginal tribal groups, the Australian Government, the Queensland Government and the Authority.
2005	Rainforest Aboriginal Advisory Committee appointed under the Act as an advisory committee to the Board.
2005	The Wet Tropics Aboriginal Cultural and Natural Resource Management Plan (the Bama Plan) is launched by over 17 Wet Tropics Tribal Groups and Terrain NRM.
2005	The Aboriginal Rainforest Council (ARC) is established and has representation from all 18 tribal groups. The ARC is an outcome of the Interim Negotiating Forum (INF) and is recognised and supported in the Regional Agreement.
2005	Transfer of 39 forest reserves and three other land parcels in the Wet Tropics (totalling 380,000ha) to national park tenure (mostly within the Wet Tropics World Heritage Area).
September 2005	The Aboriginal Rainforest Council (ARC) is established and has representation from all 18 tribal groups. The ARC is an outcome of the INF and is recognised and supported in the Regional Agreement.
2005	Data capture and digitisation of the 1:50,000 vegetation mapping of the Wet Tropics completed in August.
2006	The *Wet Tropics World Heritage Protection and Management Act 1993* is amended to allow for a second Aboriginal board member.
2007	Kuku Yalanji Indigenous Land Use Agreement signed for much of the World Heritage Area from Mossman north to the Bloomfield area.
2007	Wet Tropics of Queensland World Heritage Area listed on the National Heritage List.
2008	The ARC ceases operation.
2008	Twentieth anniversary of World Heritage listing – recognised by publication of 'From the Heart'.
2009	COAG abolishes all Ministerial Councils. In the Wet Tropics this is replaced with an annual Ministerial Forum.
2009	Focus group becomes North Queensland Traditional Owner Land and Sea Management Alliance and has inter-regional interests including the Dry Tropics and Northern Gulf.
2011	Terrain NRM Traditional Owner Advisory Group advises Terrain Board that it would disband.
2012	Retrospective listing of the World Heritage Area as a serial nomination for 14 separate sections.
2012	Retrospective statement of Outstanding Universal Value for the Wet Tropics of Queensland adopted by the World Heritage Committee in St Petersburg.
2010 -2012	Rainforest Aboriginal Peoples Alliance (RAPA) established - a non-incorporated alliance between the Girringun Aboriginal Corporation, Jabalbina Yalanji Aboriginal Corporation and Central Wet Tropics Institute. This alliance has memberships of individuals and organisations covering the Wet Tropics.
2012	The Wet Tropics is listed as a National Landscape.
2012	National Heritage listing of the World Heritage Area for Indigenous heritage values.
2013	Twenty-fifth anniversary of World Heritage listing.
2018	Thirtieth anniversary of Wet Tropics World Heritage listing.

Appendix 2. *In their own words* contributors

Peter Hitchcock

Executive Director (1991-1997)

Peter was the inaugural executive director of the Wet Tropics Management Authority.

He has over 40 years of experience working internationally as an environment and heritage consultant, specialising in protected areas and World Heritage. He is also an advisor to the Papua New Guinea, South Asia, Guyana, Lebanon, Indonesia and Borneo governments on policy and field operations, as well as serving two terms on the Australian Heritage Commission.

Associate Professor Peter Valentine

Chair of the Wet Tropics Board (2010-2013); Chair of Community Consultative Committee (1995-2000); Wet Tropics Board Director 2000-2006; Chair Conservation sector Liaison Group (2000-2006) and Scientific Advisory Committee member (2007-2010)

Peter has served in a number of roles for the Authority since it was first established, leading to a distinguished term as chair of the Authority. Peter was a senior academic at James Cook University, and in 1988, was appointed as the special IUCN reviewer of Wet Tropics World Heritage nomination. Peter has a particular interest in management issues for protected areas and related nature conservation issues, particularly the use of ecotourism to support conservation and development, especially in poorer countries in the Asia-Pacific region.

Professor Stephen Williams

Chair Scientific Advisory Committee (2011-14) and Scientific Advisory Committee member (2007-2010)

Professor Steve Williams is based at the Centre for Tropical Biodiversity and Climate Change at James Cook University. Steve is chair of the IUCN Climate Change and Biodiversity Specialist Group. His research is focussed on understanding biodiversity, assessing the vulnerability of biodiversity to global climate change and using this knowledge to maximise the positive benefits of conservation management and adaptation. He was one of the first to identify global climate change as a severe threatening process in the tropics and that we are facing many species extinctions in mountain systems globally. This work resulted in the Australian Wet Tropics being internationally recognized by the IPCC as one of the world's most vulnerable ecosystems.

Dr Lea M. Scherl

Scientific Advisory Committee member (2010-2013 and 2016 to present)

Dr Lea M. Scherl is an environmental and social psychologist who has had a long association with the Wet Tropics of Queensland World Heritage Area, including: involvement in the advocacy for World Heritage listing; serving in the Authority's first Scientific Advisory Committee (SAC); and contributing to a range of planning processes and reports. As a long-term resident of North Queensland Dr Scherl has travelled extensively through the World Heritage Area, enjoying many of its attributes and environmental services. She is currently a member of the SAC, contributes to teaching and research at James Cook University and works for the United Nations Food and Agricultural Organization.

Dr Rosemary (Ro) Hill

Wet Tropics Board Director (2012-2015); Community Consultative Committee member (1995-1998) and Scientific Advisory Committee member (2000-2008)

Ro is a leader within the conservation movement and was first vice-president of the Cairns and Far North Environment Centre (CAFNEC). She was central to the environmental campaigns that led to the establishment of the Wet Tropics World Heritage Area. Ro has extensive experience in cross-cultural research with indigenous peoples and in collaborative knowledge platforms. She is a member of the IUCN Commission on Environment Economic and Social Policy, the World Commission on Protected Areas, and the expert taskforce for Indigenous and local knowledge of the intergovernmental platform on biodiversity and ecosystem services.

Ms Allison Halliday

Wet Tropics Board Director (2008-2012)

Allison Halliday identifies as a rainforest Bama of the Malanbarra Clan of the Yidinji Tribe. She is chair of the Dulabed Malanbarra and Yidinji Aboriginal Corporation RNTBC as well as a director on the Terrain NRM board. Allison has been actively involved in Aboriginal issues in the Wet Tropics since 1994. As co-chair of the Aboriginal Negotiating Team for the Rainforest Aboriginal People of the Wet Tropics World Heritage Area, she officially signed off on the Regional Agreement with both State and Commonwealth governments. Allison continues to play a leadership and advisory role as a key member of the Traditional Ownership Leadership Group. Whilst board director of the Authority, Allison was appointed to the Australian World Heritage Advisory Committee and the Australian Indigenous World Heritage Advisory Committee.

Bruce Jennison

Principal Conservation Officer (1994-present)

Bruce manages the environmental assessment and regulatory work for the Wet Tropics Management Authority. With over 30 years' experience in the management of the Wet Tropics World Heritage Area, Bruce has expertise in planning, conservation management and environmental impact assessment and has developed high level skills in consultation, policy development, legislation and project management. He is particularly interested in issues associated with managing urban planning and infrastructure development in a tropical environment and specialises in the rehabilitation of tropical vegetation systems.

Tim Nevard OAM

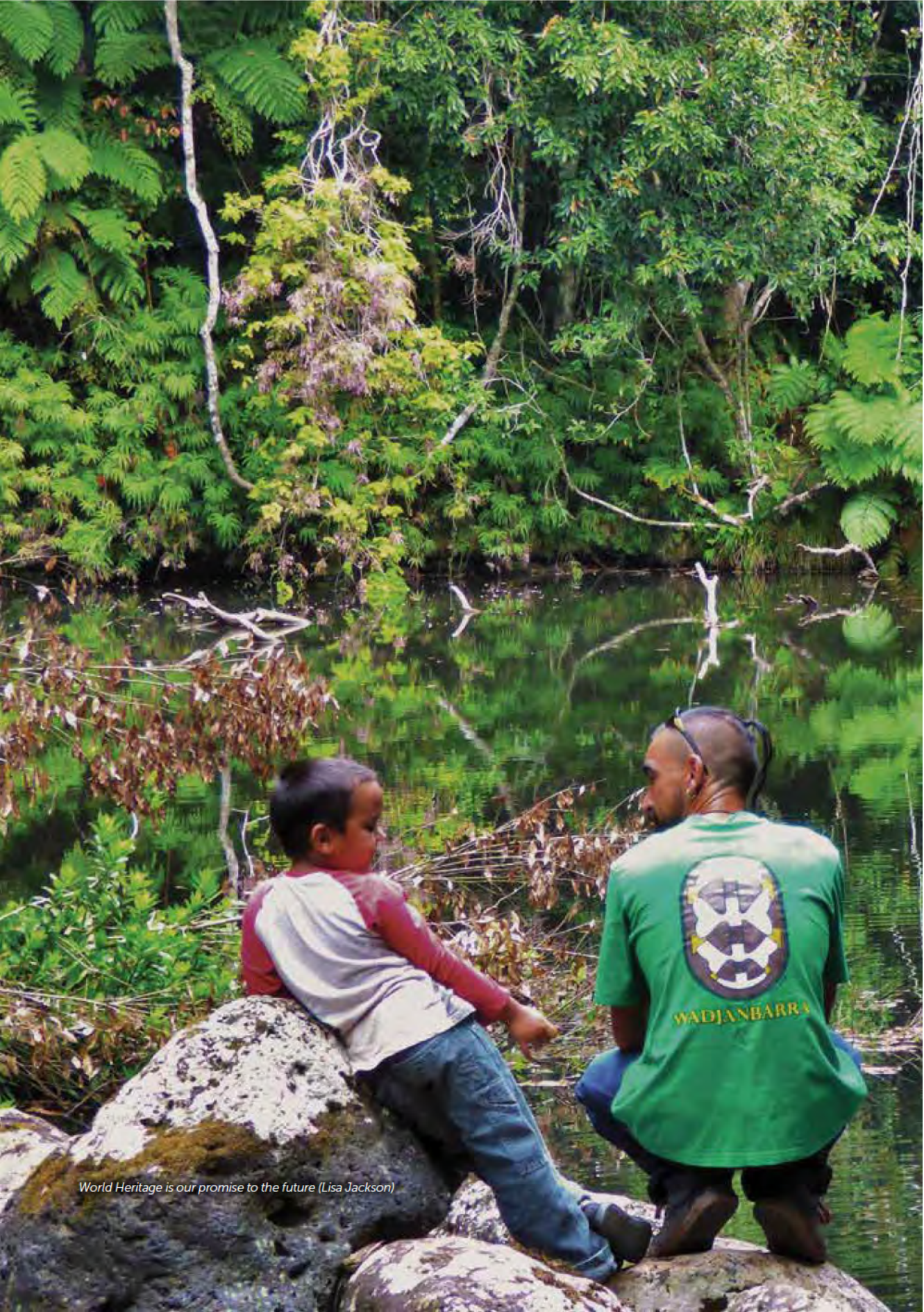
Tourism advocate

Tim has committed his working life to conservation, sustainable agriculture, design and development, and has successfully initiated and managed corporate branding and sustainability programmes in the development, fast-moving consumer goods and agricultural sectors.

He has extensive hands-on experience of the financial aspects of nature conservation and land management, especially in relation to market mechanisms, and has a particular interest in sustainable development and agriculture, as well as habitat restoration, conservation breeding and recovery.

Tim was one of the founders and deputy MD of the RPS consulting group and in 1996 conceived and developed the Mareeba Tropical Savanna and Wetland Reserve; and co-founder of the Wildlife Conservancy of Tropical Queensland/Forever Wild. He was the founding director of the Centre of Tropical Urban and Regional Planning at James Cook University from 1994-99 and principal scientist at GHD from 2002-7. He has served as a ministerial appointee on a number of industry and academic bodies.

Late afternoon at Mossman Gorge (TTNQ Images)



World Heritage is our promise to the future (Lisa Jackson)

WET TROPICS
MANAGEMENT AUTHORITY

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FRONT COVER IMAGE: Stoney Creek (Wet Tropics Images / Charlotte Hellings)

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Document 18

Min No: MC
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RECEIVED 06 NOV 2018 Environment Minister

☐ Covering Brief ☐ Departmental Reply
☑ Minister Reply ☐ Appropriate Action
☐ CoS/Adviser Reply ☐ For Information
☐ Refer to:..... ☐ Campaign ☐ Advice/Min

Also sent to Diary Manager

Hon. Melissa Price, MP
Minister for Environment
House of Representatives
Parliament House
P O Box 6022
CANBERRA ACT 2601

SHARK BAY
world heritage

Dear Minister Price

Shark Bay World Heritage Advisory Committee meeting

A meeting of the Shark Bay World Heritage Advisory Committee (SBWHAC) is scheduled for 26/27 November in Denham/Monkey Mia.

As seven of the 11 committee members have been recently appointed, this will be their initial meeting and the agenda will include presentations from both State and Commonwealth officers providing a wealth of information relating to World Heritage, including;

- World Heritage (WH) Convention and obligations
- Understanding WH criteria and values
- Outstanding Universal Value (OUV)
- Environment Protection Biodiversity Conservation Act (EPBC)
- Matters of National Environmental Significance (NES)
- Bilateral Agreements – assessment and approvals process, and
- International Union for Conservation of Nature (IUCN) Charter.

In September, the SBWHAC convened a Climate Change workshop to lay the foundations for the development of a climate change adaptation strategy and action plan for the World Heritage Property with Shark Bay initiating the use of a rapid assessment tool – the Climate Change Vulnerability Index (CVI).

Over 20 participants from diverse groups across Australia attended the two day workshop with the National Environmental Science Program (NESP) Earth Systems and Climate Change (ESCC) Hub and CSIRO also involved. The workshop report will be presented and discussed at the forthcoming meeting.

State Environment Minister Dawson attended the previous committee meeting and in addition to addressing the group, held an open discussion forum with members. Topics reviewed included; dugong population and abundance monitoring, nature-based tourism opportunities, Dirk Hartog Island restoration project and WH funding issues.

Whilst your many commitments as the recently appointed Federal Minister for the Environment are acknowledged, it would be greatly appreciated if you could give consideration to attending the next SBWHAC meeting, and I therefore extend an invitation for you to address the committee.

RECEIVED 6 NOV 2018 Maps

RECEIVED 6 NOV 2018 Maps

Shark Bay World Heritage Advisory Committee

Please address all correspondence to:

The Chair
c/- Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
Denham WA 6537

s22

(Executive Officer)

www.sharkbay.org

PATRIMONIO MUNDIAL • WORLD HERITAGE • PATRIMOINE MONDIAL

Should you be available to attend the World Heritage meeting, please advise the Executive Officer, s47F either via email; s47F or by telephone on s47F so that the meeting agenda can be scheduled to accommodate your arrangements.

Yours sincerely

Thomas Day
Chair

25 October 2018

cc s47F Natural Heritage Branch, Department of Environment and Energy Canberra
DBCA - Parks and Wildlife Service, Midwest Region, Shark Bay District and s47F

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Document 19

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☐ Covering Brief ☐ Departmental Reply
☐ Minister Reply ☑ Appropriate Action
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☐ Refer to: ☐ Campaign ☐ Advice/Min

Hon Melissa Price, MP
Federal Minister for the Environment
Parliament House
P O Box 6022
CANBERRA ACT 2601

Dear Minister

Shark Bay World Heritage Climate Change Workshop

The role of the Shark Bay World Heritage Advisory Committee (SBWHAC) includes providing advice on threats and risks to the World Heritage property's (WHPs) Outstanding Universal Value (OUV) and integrity.

Strategies and actions to minimise the impacts of climate change on the World Heritage values are contained within the *Shark Bay World Heritage Property* (SBWHP) *Strategic Plan 2008-2020*, and for some time the Committee has been exploring options to conduct a workshop to progress these.

The significant negative impacts of the 2010/11 marine heatwave event have been a catalyst to commence planning for a climate change adaptation plan for the WHP to support the ongoing conservation of the Shark Bay WHPs OUV.

The SBWHAC engaged with representatives from the Earth Systems and Climate Change Hub (ESCC) of the National Environmental Science Program (NESP) within CSIRO in Canberra, to collaborate in a workshop which would lay the foundations for developing a climate change adaptation strategy and action plan for the SBWHP.

The overarching goal of the workshop was to develop a climate change strategy for the SBWHP by identifying areas of focus for an adaptation and action plan and to consider the potential for management interventions to control or prepare for change.

The workshop was conducted in mid-September and attended by more than 20 participants from agencies and organisations across Australia who considered how the values and attributes which comprise Shark Bay's OUV will be impacted by a changing climate in future.

A rapid assessment approach was utilised during the workshop, which has been prepared with a view to completing similar assessments in other WHPs. Shark Bay is the first WHP to 'road test' this assessment tool (Climate Change Vulnerability Index – CVI), which provides a method for systematically assessing the vulnerability of specific WH values to climate change impacts, focusing on OUV.

This methodology concentrates on identifying the three most significant climate change stressors to OUV and considers their implications and our ability to prepare and respond. The approach enabled input from a group of scientists and managers who have relevant experience and knowledge of the SBWHP.

Attendees drew on the impacts of the 2011 marine heatwave as an example of extreme climate events which are likely to become more frequent and have significant negative impacts on the local environment.

SHARK BAY
world heritage

Shark Bay World Heritage Advisory Committee

Please address all correspondence to:

The Chair
c/- Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
Denham WA 6537

s47F

(Executive Officer)

www.sharkbay.org

The assessment revealed that the acute stressors of marine heatwaves and intense storms, as well as the chronic rise in air temperature, presented the most immediate and significant threats to OUV. These stressors have the potential to tip the balance of biological and physical systems in this unique area.

We witnessed coincident events of marine heatwave and intensive storms in 2011, with the combination of prolonged, elevated temperatures, as well as significant run-off and sediment deposits from flooding due to heavy rainfall, resulting in a substantial dieback of the seagrass meadows, which are a significant contributor to OUV.

Given that the size and integrity of the seagrass banks are a vital component of the complex environment and marine ecosystem of Shark Bay – providing food and shelter to a myriad of organisms and animals - the ESCC is working with the SBWHAC using climate change projections to undertake a case study on the 'Impact of Climate Change on Seagrass in Shark Bay', which will be an important element in the climate change adaptation plans for Shark Bay.

The attached Workshop Summary and Report identifies the key climate change stressors and modifiers and also examines adaptive capacity, OUV vulnerability, knowledge gaps and future actions. The WA Marine Science Institution (WAMSI) will facilitate implementation of the future strategy and also the development of a science plan to support future management of Shark Bay through a changing climate.

Committee members encourage you to take note of the outcomes of the report and look forward to keeping you appraised of, and having your support for, activities that are required to develop and implement a climate change adaptation strategy and plan for the SBWHP.

We would appreciate the opportunity to brief you in person regarding the workshop, its outcomes and plans for future actions.

Yours sincerely

Tom Day
Chair

14 December 2018

cc s47F Natural Heritage Branch, Department of Environment and Energy
Director General, Peter Sharp, Director, Parks and Visitor Services, Midwest Regional Manager, Shark Bay District Manager, Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service
Sue Sargent, Chair, Australian World Heritage Advisory Committee
Simon Woodley, Chair, Ningaloo Coast World Heritage Advisory Committee
Gavin Robins, CEO, Gascoyne Development Commission

WORKSHOP SUMMARY

Earth Systems and Climate Change Hub

National Environmental Science Programme

Climate change and the Shark Bay World Heritage Area: Foundations for a climate change adaptation strategy and action plan

The Shark Bay World Heritage Area in Western Australia is one of 19 listed World Heritage properties in Australia.

Extending across 2.3 million hectares – 70% of which is marine – the site has 1500 km of coastline. Located at a transition between temperate, sub-tropical and temperate zones, and with unique biogeochemical features – including hypersaline pools and extensive seagrass beds – Shark Bay is home to assemblages of plants and animals, terrestrial and marine, that are not encountered anywhere else.

The Earth Systems and Climate Change Hub is working with the people responsible for managing Shark Bay to understand how climate change will impact the World Heritage Area.

The workshop

In September 2018, the Shark Bay World Heritage Advisory Committee convened a workshop to lay the foundations for the development of a climate change adaptation strategy and action plan for the Shark Bay World Heritage Property using a rapid assessment tool (Climate-change Vulnerability Index).

Shark Bay World Heritage Area

Shark Bay was listed as a World Heritage property in December 1991 on the basis of its outstanding universal value; that is, it has:

- outstanding examples representing the major stages of the Earth's evolutionary history (including the stromatolites and microbial mats of Hamelin Pool)
- outstanding examples representing significant ongoing geological process, biological evolution and man's interaction with his natural environment (including steep salinity gradients, three biotic zones, Wooramel seagrass bank, seagrass meadows, *Fragum erugatum* shell deposits)
- superlative natural phenomena, formations or features (including Faure Sill, Hamelin Pool, Zuytdorp Cliffs, Dirk Hartog Island, inundated birridas and lagoons)
- the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value still survive (including five endangered mammal species, 12 threatened reptile species, marine megafauna including dugongs)

Climate changes such as changes in air temperature and in the intensity and frequency of storms and extreme marine heat events are expected to threaten the resilience of areas in Shark Bay and the outstanding universal value of the area that led to its World Heritage listing.

The **Earth Systems and Climate Change Hub** is funded by the Australian Government's National Environmental Science Program

Climate change

Climate change refers to long-term changes in the average pattern of weather that occur over decades, centuries or longer. Climate variability, for example, due to the El Niño Southern Oscillation, occurs at shorter timescales of years to decades, while weather occurs on the timescale of hours to days.

Climate change projections are not predictions, but they tell us about the response of the climate system to possible future scenarios. Our confidence in projections is determined by considering climate model results along with our physical understanding of the climate system and past observations.

Climate projections for Shark Bay include:

- increased average temperatures in all seasons (very high confidence)
- More hot days and warm spells with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (very high confidence)
- decreasing winter and spring rainfall (high confidence); rainfall changes in summer and autumn are not as clear
- more intense extreme short-duration rainfall (high confidence) and the wettest day of the year will get wetter
- fewer but more intense tropical cyclones (medium confidence)
- a small winter decrease in wind later in the century; a small increase in spring wind speeds (low confidence).
- increased fire weather risk (low confidence)
- increased potential evapotranspiration in all seasons (high confidence)
- decreased humidity in winter and spring (high confidence) and in summer and autumn (medium confidence) later in the century
- increased winter radiation (medium confidence) later in the century
- rising mean sea level and increased height of extreme sea-level events (very high confidence).

Detailed climate change projections are available at climatechangeinaustralia.gov.au – Shark Bay is in the Rangelands (South) sub-cluster. Sea-level rise projections for coastal councils are also available at coastadapt.com.au.

Climate-change vulnerability index

The Climate-change Vulnerability Index (CVI) is being developed to provide method for systematically assessing climate change impact across all World Heritage properties.

In determining the CVI for the Shark Bay World Heritage Area, storm intensity and frequency, extreme marine heat events and air temperature change were identified as the climate stressors with the greatest potential impact on Shark Bay's outstanding universal value (OUV). The vulnerability of Shark Bay's OUV to each of these drivers was HIGH (on a three-point scale: low, moderate, high), resulting in an overall assessment of HIGH vulnerability to climate change.

Next steps

The Hub will work with the Shark Bay World Heritage Advisory Committee to conduct a case study using climate change science information to determine the impact of climate change on Shark Bay's seagrasses. We will also work closely with stakeholders to facilitate the use of climate change science to inform climate risk assessment and the development of the climate change adaptation strategy for Shark Bay.

The Shark Bay World Heritage Advisory Committee will develop a climate change adaptation strategy and action plan, identifying knowledge gaps along the way. The Western Australian Marine Science Institution will facilitate implementation of the plan and develop an appropriate science plan to support the ongoing management of Shark Bay in a changing climate.

The full report from this workshop is available on the Earth Systems and Climate Change Hub website at www.nespclimate.com.au.

For more information on the Hub's work in Shark Bay, please contact:

Mandy Hopkins
ESCC Hub Knowledge Broker
E: mandy.hopkins@csiro.au
T: 03 9239 4649

Earth Systems and Climate Change Hub

National Environmental Science Programme

SHARK BAY world heritage

WORKSHOP REPORT

Climate change and the Shark Bay World Heritage Area

Foundations for a climate change adaptation strategy and action plan

November 2018

Earth Systems and Climate Change Hub Report No. 7

Australian Government

National Environmental Science Programme

The Earth Systems and Climate Change Hub is supported by funding through the Australian Government's National Environmental Science Program. The Hub is hosted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and is a partnership between CSIRO, Bureau of Meteorology, Australian National University, Monash University, University of Melbourne, University of New South Wales and University of Tasmania. The role of the Hub is to ensure that Australia's policies and management decisions are effectively informed by Earth systems and climate change science, now and into the future. For more information visit

NESP Earth Systems and Climate Change Hub. 2018. *Climate change and the Shark Bay World Heritage Area: foundations for a climate change adaptation strategy and action plan*, Earth Systems and Climate Change Hub Report No. 7, NESP Earth Systems and Climate Change Hub, Australia.

Enquiries regarding this report should be addressed to:

Earth Systems and Climate Change Hub
PMB 1
Aspendale Vic 3195

Published: November 2018

This report is available for download from the Earth Systems and Climate Change Hub website at . The ESCC Hub is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document, please contact .

The workshop was convened by the Shark Bay World Heritage Advisory Committee and supported by the Australian Government Department of the Environment and Energy, Western Australian Department of Biodiversity, Conservation and Attractions, the NESP Earth Systems and Climate Change Hub, the Australian Marine Conservation Society, and the NASA ROSES Ecological Forecasting grant #16-eco4cast-0032 to the University of Hawaii.

This report was prepared by Karen Pearce, Phil Scott, Mandy Hopkins, Scott Heron, Vanessa Hernaman, Diana Walker and Cheryl Cowell.

Cover photo credit: Karen Pearce

Contents

Executive summary

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Workshop

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Climate change

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Climate-change Vulnerability Index

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Next steps

The Shark Bay World Heritage Advisory Committee will develop a climate change adaptation strategy and action plan, identifying knowledge gaps along the way. The Western Australian Marine Science Institution will facilitate implementation of the plan and develop an appropriate science plan to support the ongoing management of Shark Bay in a changing climate.

1. Introduction

1.1 Background

Shark Bay has a unique combination of a large, sheltered, shallow body of water that provides exceptional marine environments and a series of promontories and islands that provide isolated terrestrial habitat – set in an area that contains elements of both temperate and tropical climate. The biology of the bay reflects this unique setting, providing opportunities for stromatolites and marine and terrestrial flora to survive, as well as supporting a very productive biological environment that sustains significant fisheries; an extensive and spectacular landscape; local communities and tourism activities. These are the reasons that Shark Bay was listed as one of Australia's first World Heritage properties.

In a changing climate, changes in air temperature and in the intensity and frequency of storms and extreme marine heat events are expected to threaten the resilience of areas in Shark Bay and the outstanding universal value (OUV) of the area that led to its World Heritage listing.

In September 2018, the Shark Bay World Heritage Advisory Committee (SBWHAC) convened a workshop in Denham to identify possible impacts of climate change on Shark Bay in order to lay the foundations for the development of a climate change adaptation strategy and action plan. The workshop featured presentations from subject matter experts before working through a rapid risk assessment tool (Climate-change Vulnerability Index, CVI) that is being developed for World Heritage properties.

1.2 Workshop context

For decades, the succession of advisory committees with responsibility for the Shark Bay World Heritage Area have been advocating an assessment of climate change impacts on Shark Bay's OUV. However, it wasn't until 900 km^2 of large, temperate, meadow-forming seagrass species[1] was lost (and other OUV attributes impacted) in the 2010/11 marine heatwave that this became an area of focus.

In 2012, a workshop was convened to pull together historical and current data to start to understand climate impacts on Shark Bay. The findings of this workshop were in a special issue of *Marine and Freshwater Research*.[2]

Additional publications followed up on the effects of the heatwaves. These were synthesised in Fisheries WA workshop volumes.[3] In addition to the loss of seagrass habitat, other impacts included: a drop in birth rates in dolphins; negative effects on crab, oyster and other fisheries; and tourism visitation that fell well short of projections.

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[1] Arias-Ortiz et al. 2018. A marine heatwave drives massive losses from the world's largest seagrass carbon stocks. *Nature Climate Change*, 8, 338–344

[2] Kendrick et al. 2012. Science behind management of Shark Bay and Florida Bay, two P-limited subtropical systems with different climatology and human pressures. *Marine and Freshwater Research*, 63, 941–951

[3]

In 2012, the World Heritage Scientific Advisory Committee recommended a coordinated multi-institutional and multi-discipline approach to research. However, five years on there was little evidence of such a coordinated approach to research.

Recognising the impending risks to Shark Bay's OUV, the Western Australian Marine Sciences Institution (WAMSI) organised a workshop in June 2018[4] to identify priority knowledge gaps and whether something could be done to address them. The importance of each gap was evaluated by comparing the consequences of 'taking action' versus 'doing nothing'. Outcomes from the gap analysis included:

- a shared vision for a cross-sectoral focused program to address the integrated management of Shark Bay under climate change for the values as outlined in the World Heritage site documentation and for sustainable tourism, commercial and recreational fishing and industry
- the need for a policy response to maintain resilience in both natural environment and human activities that rely on Shark Bay. The policy response should incorporate adaptive responses in the local industries to predictions of the effect of climate change to the Shark Bay ecosystem. There is enough prior research to make reasonable assessments of risk but this research needs to be captured
- the importance of continued focused research that advances predicting climate change in Shark Bay and that supports management responses and interventions is also a priority. Waiting and monitoring and doing nothing is not an alternative.

The outputs from the workshop have subsequently been turned into summaries and will be presented as a white paper for government action. Subsequently the SBWHAC encouraged the National Environmental Science Program Earth Systems and Climate Change Hub to become involved with Shark Bay.

The SBWHAC provided the drive for the September workshop, recognising that there was a need to:

- develop the CVI rapid assessment tool as a consistent methodology for other World Heritage areas
- use the CVI methodology to determine the vulnerability of the World Heritage area OUV to climate change
- use the methodology to focus on the key climate change stressors likely to impact on key OUV attributes for Shark Bay
- progress toward a climate change adaptation strategy and adaptation plan for the Shark Bay World Heritage property.

1.3 Workshop aims

Overall aim: To lay the foundations for the development of a climate change adaptation strategy and action plan for the Shark Bay World Heritage Property using a rapid assessment tool (Climate-change Vulnerability Index, CVI).

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[4]

Series of steps/aims to achieve this:

1. Understand the significant values that comprise the outstanding universal value (OUV) plus the other significant (but non-OUV) values of Shark Bay.
2. Agree on consistent terms to describe climate change stressors. Discuss the list of climate change stressors and their potential to impact the values of Shark Bay.
3. Discuss possible future climate change scenarios facing Shark Bay and agree to consider two scenarios for the future of Shark Bay (e.g. 'Business as Usual' and 'Paris Agreement').
4. To provide focus, conduct a high-level risk assessment (likelihood and consequence) of all climate change stressors impacting the values (prioritising the OUV) of Shark Bay – identifying the stressors representing the highest risks to OUV and then prioritise those risks.
5. Develop diagrams of key climate change stressors impacting the highest risk values of Shark Bay and then determine the related physical, ecological, economic and social impacts.
6. Understand the proposal for CVI and test its applicability using Shark Bay as a case study.
7. Discuss and agree on possible adaptation strategies to address the priority impacts.

1.4 This report

This report provides a summary of the information presented at the workshop and a high-level overview of the CVI process as applied to Shark Bay and the outcomes of that process. It is intended to provide a reference that will inform ongoing management of the Shark Bay World Heritage Area in a changing climate.

The workshop program and participant list are included in the appendices of this report.

1.5 Acknowledgements

The SBWHAC would like to acknowledge the time, money and effort put into preparing for and running this workshop. Representative agencies, organisations and individuals have been generous with their precious time and knowledge and they are all gratefully received. The workshop was organised by Cheryl Cowell and Phil Scott, both representing the SBWHAC.

This report was prepared by the National Environmental Science Program Earth Systems and Climate Change Hub. Thanks to all participants and in particular to the following people who presented at the workshop and made their notes and presentations available to assist with the preparation of the report:

- Simon Allen (dolphins)
- Arani Chandrapavan (fisheries, sea surface temperature)
- Cheryl Cowell (Shark Bay World Heritage Area and OUV)
- Vanessa Hernaman (climate change)
- Scott Heron (coral, CVI)

- Phil Scott (next steps)
- Luke Twomey (WAMSI's role)
- Di Walker (seagrass)
- Therese Morris (microbial communities)

Erica Suosaari did not attend the workshop but provided useful advice on climate impacts on stromatolites and the carbonate dominated marine environment.

Scott Heron facilitated the workshop and provided the CVI framework and tool. Scott was fully supported, and this report was partially supported, by NOAA grant NA14NES4320003 (Cooperative Institute for Climate and Satellites – CICS) at the University of Maryland/ESSIC.

Letter from Hamelin Pool

Hey

I got here before you
And you would not be, without me
I've learnt a trick or two over 3.8 billion years
But I've got nothing up my sleeve to fix my latest fears.

But my ear is to the ground
I heard a group was in town
A group that might help to see me through
The next decade or two.

You see, I've got these good friends that live out in the Bay
And some of them, well, they're struggling day to day
And we all depend on them in the bay
And I don't know what I'll do if they don't stay.

Anyway, you lot seem to be smart enough
To find a way to fix this stuff
Or at least, put up a fight.
Thanks, your friendly stromatolite.

(Thanks to Phil Scott for conveying this message from the stromatolites to the workshop participants.)

2. The Shark Bay World Heritage Area

The Shark Bay World Heritage Area (WHA) is located at the most westerly point of the Australian continent (Figure 1). Covering 2.2 million hectares and with more than 1500 km of coastline, Shark Bay (which is, in fact, two bays) is a biodiverse region of ecological, geological and hydrological significance as well as a region of exceptional beauty. Most of the WHA (70%) is marine waters.

Shark Bay has a semi-arid to arid climate, with hot dry summers and mild winters. Evaporation exceeds rainfall by a factor of 10: mean annual precipitation ranges from 200 mm in the east to 400 mm in the far south-west, while mean annual evaporation ranges from 2000 mm in the west to 3000 mm in the east.[5]

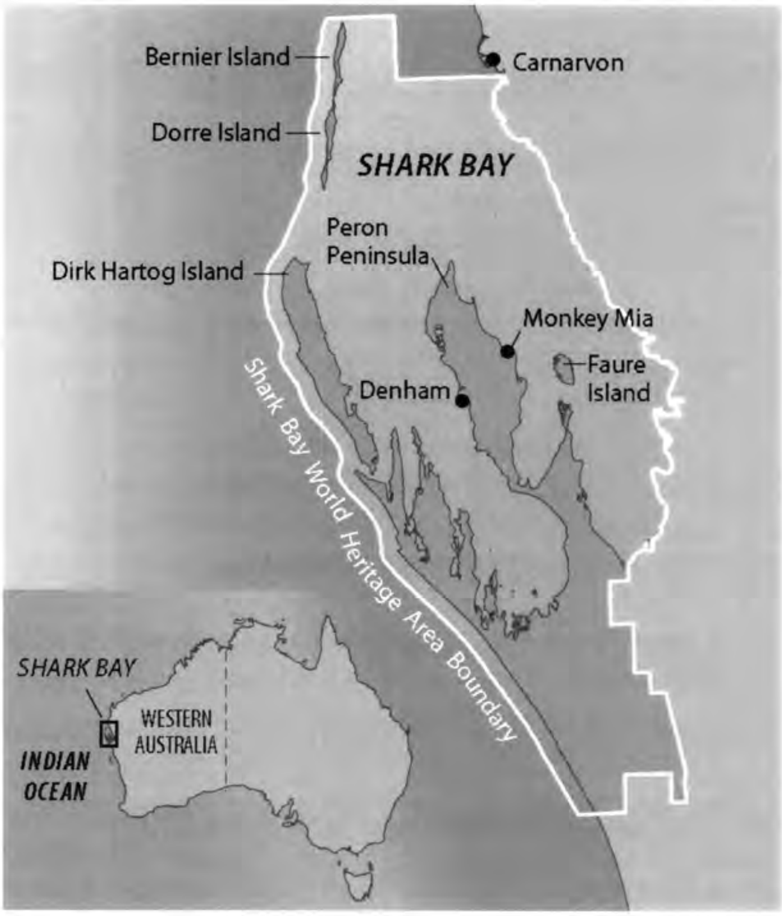

Figure 1. Shark Bay World Heritage Area (source: https://www.sharkbay.org/publications/brochures-maps/)

5 https://www.wamsi.org.au/sites/wamsi.org.au/files/[illegible]%20Shark%20Bay%20WHA[illegible]
Walker_SBWHA%20Values%20and%20risks.pdf

2.1 World Heritage listing – what this means

Shark Bay was listed as a World Heritage area in December 1991. It was the first World Heritage site in Western Australia.

World Heritage properties are sites of global natural or cultural significance that have been recognised through the World Heritage Convention. The Convention, adopted in 1972 through UNESCO, came into force in 1975. It recognises the need to preserve a balance between World Heritage values and how people interact with nature.

All States Parties signed up to the World Heritage Convention – currently 167 countries (including Australia) – agree to adhere to the Convention and to nominate properties for inclusion on the World Heritage List. They commit to protecting World Heritage values, which includes having management plans in place to protect these values and report on their condition.

There are currently 1092 properties on the World Heritage List – 845 recognised for their cultural value, 209 for their natural value and 38 for both cultural and natural value.

World Heritage properties are to be preserved for the future on the basis of their outstanding universal value (OUV). Each property has a statement of OUV which is:

- the principal reference for all plans and legislation relating to future protection and management of the property
- a point of reference for all monitoring, state conservation reporting and a mandate to maintain the values as per at Listing.

The fundamental concept is passing on the property to future generations with the values/attributes as they are recorded in the OUV.

There are 10 criteria for OUV – four natural and six cultural.[6] Shark Bay is one of only 21 sites (out of the 1092 listed worldwide) that meets all four natural criteria:

> vii. contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
>
> viii. be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.
>
> ix. be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.

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> x. contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

(Others meeting all four natural criteria include the Wet Tropics and Great Barrier Reef in Australia, Yellowstone National Park in the US, and the Galapagos Islands.)

World Heritage properties must also meet the conditions of integrity (natural sites) or authenticity (cultural sites) – that is, they must have sufficient protection/management in place to ensure the World Heritage values at Listing are maintained and safeguarded into the future. The IUCN defines the integrity of a World Heritage property as:

> "... a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes. Examining the conditions of integrity, therefore requires assessing the extent to which the property:
>
> a) includes all elements necessary to express its outstanding universal value;
> b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;
> c) suffers from adverse effects of development and/or neglect."[7]

Shark Bay's integrity as a World Heritage property is considered to be vulnerable to the impacts of climate change. This has been a significant motivation for commencing a systematic evaluation of future climate scenarios and planning for the future.

2.2 Management of Shark Bay World Heritage Area

The Australian Government has primary responsibility for the development and implementation of national policy on World Heritage matters.

Implementation of policy and day-to-day management is the responsibility of the Western Australian Government. Most of the on-ground responsibility is with the Parks and Wildlife Service within the Department of Biodiversity, Conservation and Attractions; however, other agencies (e.g. Department of Primary Industries and Regional Development) have significant responsibilities for managing fisheries and pastoral leases within the World Heritage area. Most of the World Heritage area is also state-listed marine and terrestrial conservation estate, which provides for conservation management separate to the World Heritage listing.

Local government also plays a role. 60% of the WHA is within the Shire of Shark Bay, 40% is in Carnarvon Shire. These shires work with state agencies to maintain the World Heritage values of the area.

The Shark Bay World Heritage Advisory Committee provides advice to State/Commonwealth Ministers, agencies, researchers, developers, etc. on:

7

- Protection, conservation, presentation and management of the WHA
- Threats and risks to the site's OUV and integrity
- Research and monitoring priorities
- Development proposals, EPBC Act referrals
- Dirk Hartog Island Ecological Restoration Project.

Shark Bay Statement of OUV[8]

Brief synthesis

On the Indian Ocean coast at the most westerly point of Australia, Shark Bay's waters, islands and peninsulas covering a large area of some 2.2 million hectares (of which about 70% are marine waters) have a number of exceptional natural features, including one of the largest and most diverse seagrass beds in the world. However it is for its stromatolites (colonies of microbial mats that form hard, dome-shaped deposits which are said to be the oldest life forms on earth), that the property is most renowned. The property is also famous for its rich marine life including a large population of dugongs, and provides a refuge for a number of other globally threatened species.

Criterion (vii): One of the superlative natural phenomena present in this property is its stromatolites, which represent the oldest form of life on Earth and are comparable to living fossils. Shark Bay is also one of the few marine areas in the world dominated by carbonates not associated with reef-building corals. This has led to the development of the Wooramel Seagrass Bank within Shark Bay, one of the largest seagrass meadows in the world with the most seagrass species recorded from one area. These values are supplemented by marine fauna such as dugong, dolphins, sharks, rays, turtles and fish, which occur in great numbers.

The hydrologic structure of Shark Bay, altered by the formation of the Faure Sill and a high evaporation, has produced a basin where marine waters are hypersaline (almost twice that of seawater) and contributed to extensive beaches consisting entirely of shells. The profusion of peninsulas, islands and bays create a diversity of landscapes and exceptional coastal scenery.

Criterion (viii): Shark Bay contains, in the hypersaline Hamelin Pool, the most diverse and abundant examples of stromatolites (hard, dome-shaped structures formed by microbial mats) in the world. Analogous structures dominated marine ecosystems on Earth for more than 3,000 million years.

The stromatolites of Hamelin Pool were the first modern, living examples to be recognised that have a morphological diversity and abundance comparable to those that inhabited Proterozoic seas. As such, they are one of the world's best examples of a living analogue for the study of the nature and evolution of the earth's biosphere up until the early Cambrian.

The Wooramel Seagrass Bank is also of great geological interest due to the extensive deposit of limestone sands associated with the bank, formed by the precipitation of calcium carbonate from hypersaline waters.

Criterion (ix): Shark Bay provides outstanding examples of processes of biological and geomorphic evolution taking place in a largely unmodified environment. These include the evolution of the Bay's hydrological system, the hypersaline environment of Hamelin Pool and the biological processes of ongoing speciation, succession and the creation of refugia.

One of the exceptional features of Shark Bay is the steep gradient in salinities, creating three biotic zones that have a marked effect on the distribution and abundance of marine organisms. Hypersaline conditions in Hamelin

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Pool have led to the development of a number of significant geological and biological features including the 'living fossil' stromatolites.

The unusual features of Shark Bay have also created the Wooramel Seagrass Bank. Covering 103,000 ha, it is the largest structure of its type in the world. Seagrasses are aquatic flowering plants that form meadows in near-shore brackish or marine waters in temperate and tropical regions, producing one of the world's most productive aquatic ecosystems. Australia has one of the highest diversity of seagrasses globally, with 12 species occurring in the Bay.

Criterion (x): Shark Bay is a refuge for many globally threatened species of plants and animals. The property is located at the transition zone between two of Western Australia's main botanical provinces, the arid Eremaean, dominated by *Acacia* species and the temperate South West, dominated by *Eucalyptus* species, and thus contains a mixture of two biotas, many at the limit of their southern or northern range. The property contains either the only or major populations of five globally threatened mammals, including the Burrowing Bettong (now classified as Near Threatened), Rufous Hare Wallaby, Banded Hare Wallaby, the Shark Bay Mouse and the Western Barred Bandicoot. A number of globally threatened plant and reptile species also occur in the terrestrial part of the property.

Shark Bay's sheltered coves and lush seagrass beds are a haven for marine species, including Green Turtle and Loggerhead Turtle (both Endangered, and the property provides one of Australia's most important nesting areas for this second species). Shark Bay is one of the world's most significant and secure strongholds for the protection of Dugong, with a population of around 11,000. Increasing numbers of Humpback Whales and Southern Right Whales use Shark Bay as a migratory staging post, and a famous population of Bottlenose Dolphin lives in the Bay. Large numbers of sharks and rays are readily observed, including the Manta Ray which is now considered globally threatened.

Integrity

At time of inscription in 1991 it was noted that human impacts, while not as pronounced as in other World Heritage properties due to the property's relative remoteness, have had some effects including impacts from pastoralism and feral animals. The small, local centre of Denham, along with industrial activities such as salt and gypsum mining in the region, could comprise threats if not properly managed. Tourism and recreational boating also needs to be carefully managed. The marine environment has undergone some modification through historically intensive pearl shell, fishing, trawling and whaling activities. However, the ecosystems in Shark Bay appear relatively unaltered by human impact, although this could change if terrestrial mining of mineral sands were to take place. Other potential threats could be from improved technology in producing drinking water which would lead to increased tourism and residential density, the upgrading of road access, agricultural developments to the east (dependent on water supply), expansion of gypsum mining, and the introduction of intensive aquacultural or fishing technologies. Climate change could also impact on the complex marine ecosystem. While the property meets the required conditions of integrity and contains the components required to demonstrate all aspects of the natural processes, it is important that the property's management arrangements provide the framework in which these integrity issues can be monitored and addressed.

Protection and management requirements

The Shark Bay World Heritage property encompasses a number of different land tenures and thus a variety of statutory and management arrangements protect its values. At the time of nomination of the property, existing conservation reserves totalled approximately 200,000 hectares and mainly consisted of small island nature reserves, Bernier and Dorre Islands and the Hamelin Pool Nature Reserve. Specific suggestions to increase the conservation tenure boundaries included expanding the northern boundary of the Hamelin Pool Class A Marine Nature Reserve; extending the southern boundary of the terrestrial park on the northern end of the Peron Peninsula; the inclusion of the Gladstone Embayment in the Hamelin Pool Marine Nature Reserve; the extension of the northern boundary line of the Marine Park in the Denham Sound area; securing reserve status for Dirk Hartog Island and the incorporation of the southern part of Nanga pastoral station into the reserve system.

Since inscription, Francois Peron National Park (52,586 hectares), Shell Beach Conservation Park (517 hectares), Monkey Mia Reserve (446 hectares), Monkey Mia Conservation Park (5 hectares), Zuytdorp

Nature Reserve (additional 58,850 hectares), Nanga pastoral lease (176,407 hectares), part Tamala pastoral lease (56,343 hectares), South Peron (53,408 hectares), part Carrarang pastoral lease (18,772 hectares), Bernier, Dorre and Koks Islands Nature Reserves (9,722 hectares) and Dirk Hartog Island National Park (61,243 hectares) have been added to the conservation estate. With the designation of the Shark Bay Marine Park (748,725 hectares) in 1990, incorporating the Hamelin Pool Marine Nature Reserve, the total formal conservation area of the World Heritage property is approximately 1.24 million hectares. In addition, the coastal portion of the Yaringa pastoral lease (19,396 hectares), part of Nerren Nerren pastoral lease (104,351 hectares) and part of Murchison House pastoral lease (37,578 hectares) have been added as a buffer. The Yaringa portion adjoins the Hamelin Pool Nature Reserve and in addition to having very high conservation value, is of strategic significance in bordering the World Heritage property.

A management agreement between the Australian Government and the State of Western Australia provides for management of the property to be carried out by the Western Australian Government in accordance with Australia's obligations under the World Heritage Convention. In addition, a comprehensive programme of management and administrative structures and planning processes has been implemented. Under the terms of the Agreement, a ministerial council and two advisory committees (scientific advisory and community consultative) were formed. The Shark Bay World Heritage Advisory Committee replaced the two previous Scientific Advisory and Community Consultative committees with a new committee consisting of community, scientific and Indigenous representatives. Owing to the diversity of land tenures and managing agencies and individual interests within the property, the *Shark Bay World Heritage Property Strategic Plan 2008-2020* was prepared to develop a partnership between governments and the community.

From July 2000, any proposed activity which may have a significant impact on the property became subject to the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*(EPBC Act), which regulates actions that will, or are likely to, have a significant impact on World Heritage values. In 2007, Shark Bay was added to the National Heritage List, in recognition of its national heritage significance under the Act.

Management issues raised at the time of inscription included the control of human use through both zoning and designation of conservation areas, restrictions on public access to certain areas, the management of the trawl fishery to protect values, the purchase of land for conservation use, and increased staffing. Since then, climate change has emerged as an additional potential threat to the World Heritage values. Fire also represents a threat to species that are highly restricted in their distribution, particularly populations which only survive on islands which could be severely affected by a single large fire. Australia has introduced a range of measures at both the national, and property-specific, level to address these potential threats.

2.3 Seagrasses, salinity, stromatolites and species

Shark Bay's four most significant attributes, recognised in the Statement of OUV, are its extensive seagrass beds, salinity gradient, stromatolites and species assemblages, including some species that are found nowhere else in the wild. More information about Shark Bay's significance is available at www.sharkbay.org.au. This workshop explored the exposure to climate change of these four key attributes.

2.3.1 Seagrasses

Shark Bay has extensive seagrass beds. They cover more than 4000 km^2 and produce 8 million tonnes of leaves annually. They are comprised of 12 species of seagrass, the most

seagrass diversity in any one place on the planet. The most abundant species is *Amphibolis antarctica* (southern wireweed), which covers approximately 3700 km^2 of the bay.[9]

The seagrass meadows are the foundation of the marine ecosystem in Shark Bay. They provide food, shelter and nursery areas for many marine animals, including dugongs.

The seagrass beds have also modified Shark Bay's geology and chemistry. Faure Sill is a massive seagrass bank that restricts tidal flow to Hamelin Pool, contributing to its hypersalinity.

Following the 2010/11 marine heatwave, around 36% of the bay's seagrass meadows died off. Two years after the event, leaf biomass showed some recovery, but below ground mass decreased. (Information presented by Diana Walker at the workshop.)

While the impacts do not appear to have affected dugong populations, the seagrass loss had an impact on the abundance and distribution of blue swimmer crabs and brown tiger prawns, with consequences for both fisheries.

2.3.2 Salinity

Shark Bay has a strong salinity gradient from marine to metahaline to hypersaline (Figure 2). This is caused by a combination of the seagrass banks, high evaporation rates, shallow water and climate. Water in L'haridon Bight and Hamelin Pool is almost twice as salty as the open ocean. The high salinity conditions mean that the waters are relatively free of predators and competitors. This allows salt-tolerant species, like the cockleshell *Fragum erugatum* to flourish, leading to unusual phenomena such as Shell Beach. The hypersaline Hamelin Pool Marine Nature Reserve is the only marine nature reserve in Western Australia.

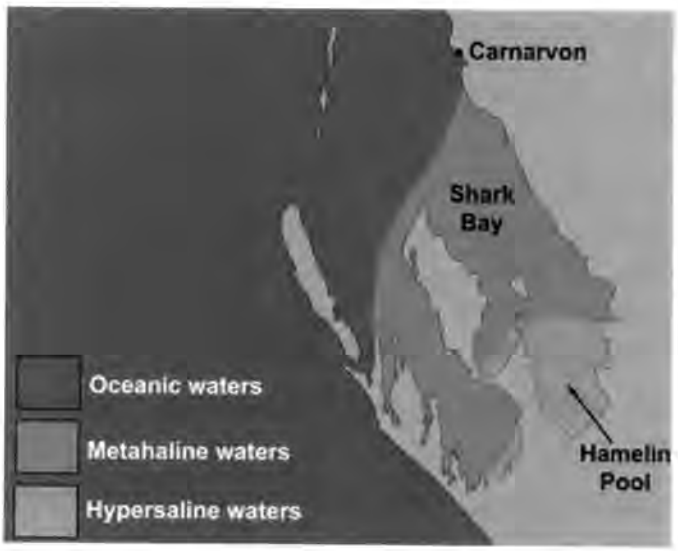

Figure 2 Shark Bay's salinity gradient (source [illegible])

[9] *Shark Bay: twin bays on the edge*, p 55

Flooding of Faure Sill due to sea-level rise would lead to a decrease in salinity which will impact *stromatolite value* (overgrowth of eukaryotes) and *hypersalinity value* (increased species diversity with increased grazing/scraping fish, gastropods, etc. and changes in biotic zonation). (Information provided by Erica Suosaari.)

2.3.3 Stromatolites

The hypersaline environment of Hamelin Pool (and consequent absence of predators) has allowed salt-tolerant micro-organisms to thrive and form microbial mats, which are diverse and complex ecosystems. When these mats trap particles and create stone they become microbialites. Tall, layered microbialites are called stromatolites. The micro-organisms that built the stromatolites are similar to those found in fossil evidence of the first life on earth, around 3.7 billion years ago. The Shark Bay stromatolites are the world's most extensive and diverse system of living stromatolites.

Climate impacts on stromatolites

- Suppression of groundwater. Evidence suggests that having a seasonal influx of fresh water is important for stromatolites. The water gets less saline with groundwater input during the time of the year that the sea level is lower, suggesting that sea-level rise will increase hydrostatic pressure, inhibiting groundwater infiltration.
- Increased storms/increased precipitation/storm surge would topple stromatolites and increase turbidity, impacting on the *stromatolite and seagrass value.* Erosion and runoff of fine terrigenous sediments could smother the stromatolite building microbial mats.
- Changing wind patterns could affect how the water piles up on different sides of the basin, impacting the seasonal function of water levels experienced by microbial surface communities, so impacting on *stromatolite value*. Changing winds may also lead to changing morphology of stromatolites, which reflects wind/current patterns for the last thousand+ years.
- Increased temperatures and extreme heat events will impact on *seagrass value, hypersaline value* and possibly *stromatolite value*. Increased temperature will have an unknown effect on stromatolites (Brendan Burns has shown that the microbes can experience stress under high temperatures). Stromatolites generally thrive in extreme environments, so the effect of increased heat events on them is unclear. Extreme heat events will likely result in a die-off of the seagrass, which could cause a destabilisation of the Faure Sill and associated flooding with open marine water (decreased salinity).
- Reduction in carbonate precipitation will impact on *stromatolite value* and *carbonate dominated marine environment value*. Cementation of stromatolites and precipitation of grains will be reduced with increased ocean acidification. Preservation potential will be reduced. Stromatolite community may cease to build structures.

(Information provided by Erica Suosaari.)

2.3.4 Species

Shark Bay is a transition zone between temperate, sub-tropical and desert zones, contributing to its significant biodiversity. The region has 145 known plant species at their northern limit and 39 known plant species at their southern limit, and 230 species of birds.

There are 98 species of reptiles and amphibians, a number of which are at the northern end of their range.

There is a rich and diverse range of marine megafauna and marine life, including around 10% of the world's dugong population as well as dolphins, sharks, rays, fish and turtles – including Australia's largest nesting colony of loggerhead turtles.

Shark Bay's bottlenose dolphins have been studied since 1982 at Monkey Mia (eastern Shark Bay) and since 2007 at Useless Loop (western Shark Bay). Shark Bay's dolphins have incredibly complex social behaviour, with multi-level alliance formation, tool use (sponges and shells) and cooperation.

Following the 2011 marine heatwave, researchers identified more 'shelling' activity (where the dolphins use large shells to catch fish then tip them into their mouths), fewer calves born and a decline in survival (less so for 'sponging' dolphins, that is, those that use sponges as beak guards while foraging for fish).

(This information was presented by Simon Allen at the workshop. More information about Shark Bay's dolphins is available at .)

The islands of Shark Bay also provide refuges for wild populations of endangered and threatened animals. There are over 120 isolated islands in Shark Bay. Bernier and Dorre Islands are nature reserves and are home to some species now found nowhere else in wild populations – banded hare wallaby, rufous hare wallaby (Mala), western barred bandicoot and Shark Bay mouse. The islands are relatively free of feral cats, foxes and rabbits. Dirk Hartog Island, a national park, was recently declared feral herbivore free and cat free in the southern section, allowing for the introduction of banded and rufous hare-wallabies. Salutation Island is home to a thriving population of re-introduced stick nest rats (which became extinct on the mainland in the 1930s, although they were once found throughout south and western arid Australia).[10]

The 2010/11 marine heatwave and above-average summer temperatures in the following two summers had a significant impact on key fisheries in Shark Bay.[11]

The 2011 commercial scallop catch in Shark Bay that started just after the heatwave event was well below the prediction based on a fishery-independent survey in November 2010. This was attributed at the time to poor growth and mortality of scallops with fishers also reporting poor meat quality. The October and November 2011 scallop survey in Shark Bay showed very low recruitment and poor survival of 1+ scallops that had been left behind after fishing ceased in the middle of that year. This low abundance resulted in closure of the fishery between 2012 and 2015. Recruitment in Denham Sound has since returned to historic levels but northern Shark Bay continues to fluctuate at relatively low abundance.

[10] Greater stick-nest rat fact sheet.

[11] Caputi et al. 2015 and Caputi et al. 2016.

The Shark Bay crab fishery produced reasonable catches immediately after the marine heatwave but the abundance dropped rapidly by the middle of the year with a very low recruitment to the fishery in 2011/12. While the warm temperatures during the juvenile phase in the summer showed a negative effect on recruitment, warm temperatures during the autumn/winter spawning appears to be beneficial to recruitment. The cause of the low recruitment to the fishery in 2011/12 was considered to be a combination of a very cool winter in 2010 followed by the 2011 heatwave event. The stock abundance has returned to historic levels.

There were above-average catches of brown tiger and western king prawns after the 2011 heatwave event; however, there was an apparent shift in the distribution of the brown tiger prawns in the eastern part of the bay (this is regarded as the key tiger prawn spawning area). A very low spawning stock abundance was recorded for 2012 in this area. The higher summer sea surface temperature in 2010/11 that affected the seagrass may have influenced recruitment and distribution in subsequent years.

While crabs, scallops and prawns have relatively short life cycles (two to three years), demersal scalefish such as pink snapper can live for 30 years, reaching maturity after four to six years. Very low numbers of three- to four-year-old fish were found in commercial catches in oceanic waters outside Shark Bay during 2015. This suggested poor recruitment in 2011, 2012 and possibly 2013 spawning seasons within Shark Bay, when the very high temperatures associated with the marine heatwave event and related environmental conditions may have negatively impacted spawning and subsequent recruitment.

3. Climate change

3.1 Weather, climate, climate variability and climate change

Weather is how we experience climate, but weather and climate are not the same thing. Weather refers to atmospheric conditions and events that occur over short periods of time, typically hours to days. Climate is the average pattern of weather over an extended period of time, typically around 30 years.

Climate is what you expect, weather is what you get.[12]

The climate is not uniform, but varies over months, years and decades (Figure 3). These variations are due to natural processes. On a timescale of months, climate varies due to seasonal cycles. On a timescale of years, the El Niño–Southern Oscillation[13] causes variations in climate, while climate variability at a decadal timescale is influenced by processes such as the Pacific Decadal Oscillation.[14]

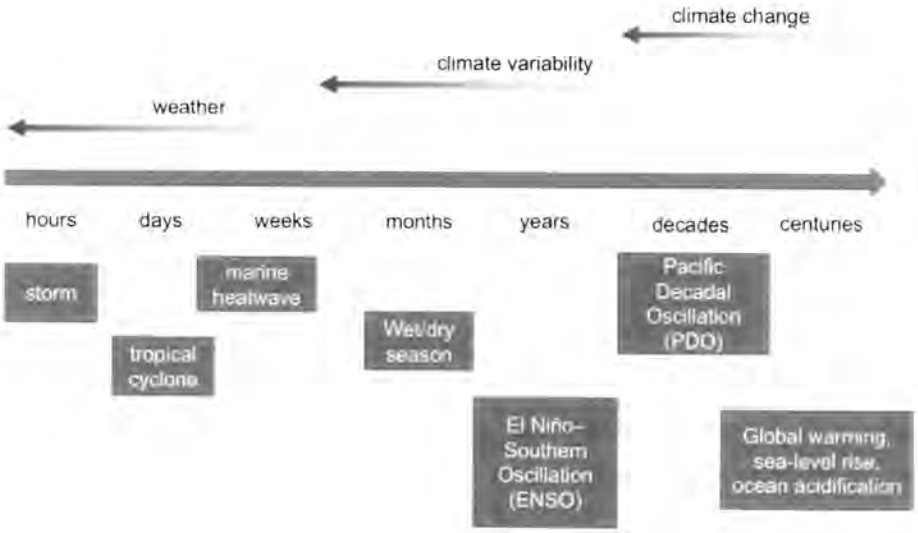

Figure 3 Climate and weather time scales

Climate change refers to long-term changes in the average pattern of weather that occur over decades, centuries or longer. It is the result of natural and man-made processes. Since industrialisation, rapidly increasing concentrations of greenhouse gases in the atmosphere have resulted in global warming. As the climate becomes warmer, other climate processes also change.

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[12] Often attributed to Mark Twain, this quote is from Robert A. Heinlein's 1973 science-fiction novel, *Time Enough for Love*.

[13]

[14]

3.2 What influences Western Australia's climate?

As global temperatures increase, the hydrological cycle intensifies and atmospheric circulation patterns change, the tropical belt widens and winter storm tracks and subtropical dry zones move towards the poles. In Western Australia, the subtropical ridge, Indian Ocean Dipole, El Niño–Southern Oscillation and Madden-Julian Oscillation help shape the climate (Figure 4).

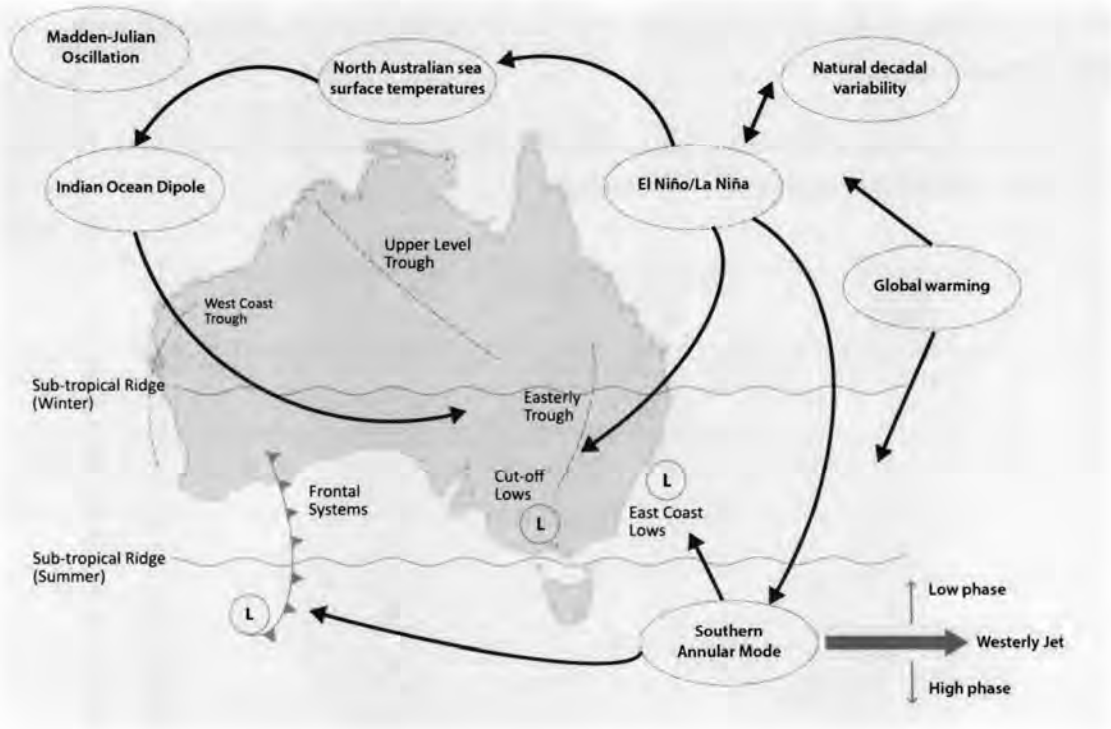

Figure 4. Climate influences on Western Australia (Source: ESCC Hub)

The **subtropical ridge** runs across a belt of high-pressure systems. In summer it sits to the south of the continent but moves northwards over central Australia in winter. The movement of the subtropical ridge is related to the monsoon trough that brings cloud and rain to northern Australia. As the subtropical ridge moves south, the monsoon moves over the northern part of Australia. As the subtropical ridge moves north, the monsoon moves northwards. The subtropical ridge can block rain-bearing fronts from the west.

The **Indian Ocean Dipole** (IOD) is the difference in sea surface temperature (SST) between the eastern and western tropical Indian Ocean. In its positive phase, when SST in the west is warmer than normal and SST in the east (near Australia) is cooler than normal, rainfall can be reduced. In its negative phase, when SST near Australia is higher than average, rainfall can be enhanced.

The **El Niño–Southern Oscillation** (ENSO) is a natural cycle driven by SST and winds in the central and eastern tropical Pacific. An El Niño develops when trade winds weaken and SST in this region is warmer than usual. A La Niña is when the opposite occurs: winds are stronger and SST is cooler than usual. In a La Niña, the Leeuwin Current is stronger than usual, carrying warmer water further south along the Western Australian coast. The 2010/11

marine heatwave off the Western Australian coast occurred during a La Niña event. In an El Niño, the current weakens and ocean temperatures cool.[15]

The **Madden-Julian Oscillation** (MJO) is a ~60-day pulse of cloudiness/rain that moves eastwards around the topics. It can have an effect on the timing and intensity of the monsoon, leading to enhanced rainfall.

3.3 Observed climate trends

3.3.1 Temperature

In the Shark Bay region, annual mean surface air temperature has increased by around 1.0°C (~0.1°C /decade) since 1910 (Figure 5).

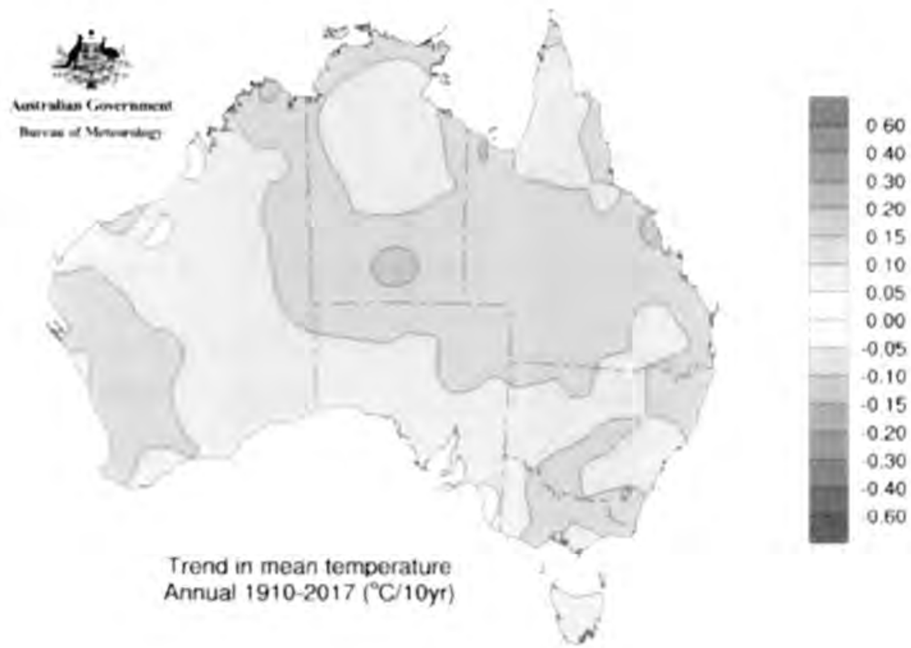

Figure 5. Trend in mean annual temperature for 1910–2017 in °C per decade. (source: Bureau of Meteorology)

3.3.2 Rainfall

Annual mean rainfall has decreased by 10 to 20 mm per decade since 1970 around Shark Bay (Figure 6).

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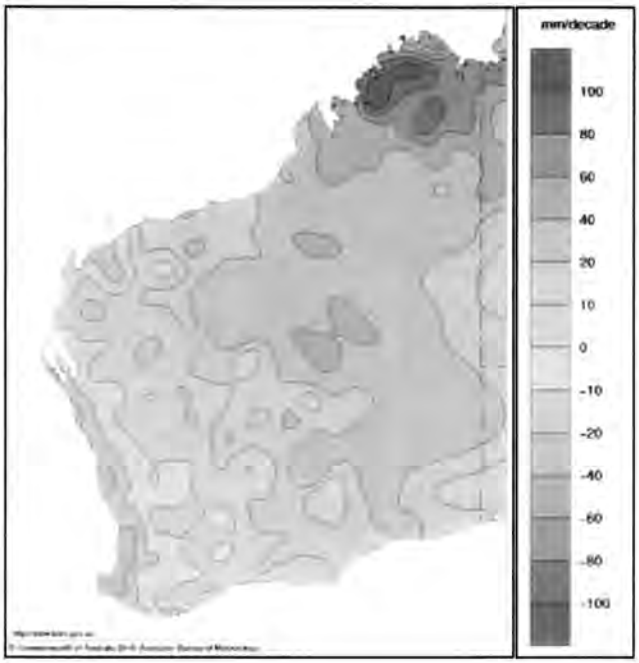

Figure 6. Mean annual trend in rainfall for 1970–2017 in mm per decade. (source: Bureau of Meteorology)

3.3.3 Sea surface temperature

Shark Bay sits adjacent to the south-west Australia marine 'hot spot' – a region warming faster than the global average. Sea surface temperature off the Western Australian coast has warmed around 1.2°C since 1960. The warming varies seasonally, with the maximum rate of increase occurring in summer (Figure 7). Local hydrodynamics within Shark Bay have a strong influence in modifying seawater coming into the bay from offshore. In summer, sea surface temperature within Shark Bay increases landward with intruding upwelled water cooling the bay. In winter, water from the Leeuwin Current warms the bay. This effect is greatest near the entrances.[16]

The Leeuwin Current is a warm, ocean boundary current that flows south from Indonesia along the west and south coasts of Australia. It is driven by the sea level in the Indonesian archipelago, which builds up in La Niña years (pushing more warm water south) and drops off in El Niño years. The Leeuwin Current is stronger in winter than in summer, and its year-to-year variability has profound impacts on marine ecosystems off the west and south coasts of Australia.

[16] www.[illegible]

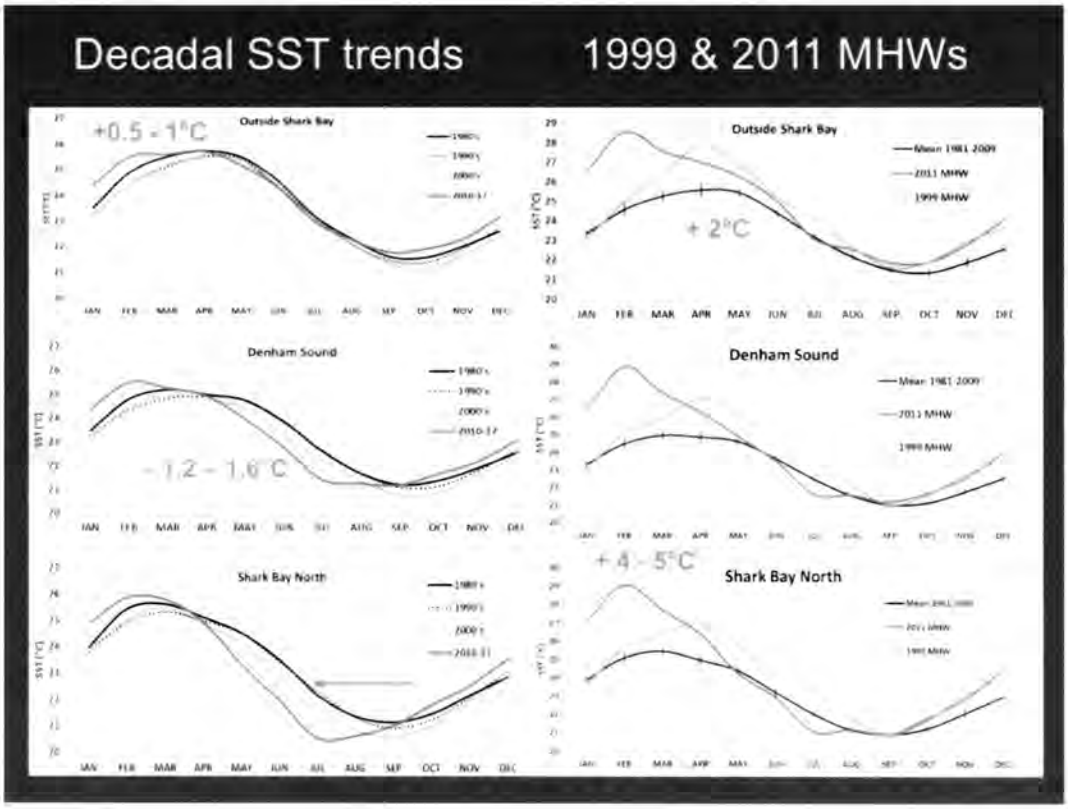

Figure 7. Decadal sea surface trends (left) and marine heatwave water temperature (right) presented by Arani Chandrapavan (Department of Primary Industries and Regional Development) at the workshop. Plots use satellite data from www.oisst.noaa.gov.

3.3.4 Marine heatwaves

Shark Bay has experienced two significant marine heatwaves, in 1999 and 2011 (Figure 7). In the summer of 2010/11, SST increased to up to 5°C above average along Western Australian coast due to the combined effects of long-term warming, a strong La Niña, and strengthening of Leeuwin Current.

3.3.5 Leeuwin Current

The Leeuwin Current is influenced by large-scale processes such as the Pacific Decadal Oscillation and ENSO. During La Niña, there is strengthening of the Leeuwin Current resulting in higher sea levels and warm waters are transported further south along the Western Australia coast. Conversely, during El Niño, there is lower sea levels and a weaker current.

3.4 Looking to the future

With the past climate no longer being a good indicator of what we can expect in the future, climate projections are useful tools for planning ahead. Climate projections are developed using global climate models, which simulate the future climate based on emissions scenarios (see *Representing emissions*, next page). They can be from an individual model, or the mean of many models (known as the multi-model mean). Projections are presented

as averages over 20-year periods. For convenience they are referred to by the central year in the period, so projections for 2070 actually cover 2060–2079. Projections are relative to a baseline time period (e.g. 1986–2005), so if a projection was for a 2°C increase in temperature, it is relative to the baseline period and can be presented as the change between the historic and the future (e.g. an increase of 2°C), or change applied to an observational dataset (e.g. mean annual temperature of 30°C).

Climate projections are not predictions. A prediction estimates a sequence of events in the future, including the effect of climate change and variability. Given the timescale and uncertainties (such as emissions concentrations) associated with climate change, predictions are not possible. Instead, we use projections, which tell us about the likely response of the climate system to a possible future scenario. Climate projections do not tell us the climate of a particular day or month or predict a specific series of events, but rather how the probabilities of climate conditions (including the changing odds of extremes) may change in our changing climate.

3.4.1 Global climate models

Global climate models (GCMs) are mathematical representations of the climate system based on the laws of physics. They take into account interacting processes that shape the global climate, including atmospheric dynamics and physics, oceans and sea ice, land surface processes, and aerosols, carbon and biogeochemical cycles. The models are very complex and run on powerful supercomputers.

GCMs have been developed in many centres around the world and are continually being improved. A global project – the Coupled Model Intercomparison Project (CMIP) – coordinates experiments and data archiving of climate model simulations. The most recent phase of this project, CMIP5, contains simulations from 60 models from 28 modelling centres (including ACCESS, Australia's national climate model).[17]

GCMs are tested for their ability to reproduce past climate, including mean values; seasonal cycle; major processes (e.g. monsoon). The better they are at reproducing the past, the more confidence we have in their simulations of the future.

3.4.2 Representing emissions

GCMs are comprised of various sub-models that interact to project rates of global warming for different concentrations of greenhouse gases and aerosols. While the laws of physics govern the climate system, they cannot tell us about social, political and economic aspects of the future, which will have a bearing on emissions. Instead, the science community defined a set of four future scenarios called representative concentration pathways (RCPs) that represent a range of economic, technological, demographic, policy and institutional futures (Table 1).

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[17]

Table 1. Summary of representative concentration pathways (RCPs)

	At the end of the century (2100)		
RCP	**CO_2 concentration***	**Radiative forcing****	**Warming*****
2.6 (low emissions)	420 ppm	2.6 W m^{-2}	0.3°C to 1.7°C
4.5	540 ppm	4.5 W m^{-2}	1.1°C to 2.6°C
6.0	660 ppm	6.0 W m^{-2}	1.4°C to 3.1°C
8.5 (high emissions)	940 ppm	8.5 W m^{-2}	2.6°C to 4.8°C

* 2018 CO_2 concentration is 407 ppm
** Radiative forcing is a measure of the energy absorbed and retained in the lower atmosphere; more forcing = more warming.
*** Global mean surface warming for 2081–2100 relative to 1986–2005.

Because of natural variability in the climate, results from the different emissions scenarios are quite similar to 2030 – after this time, the higher the emissions, the more climate change signal is evident by 2100.

It is worth noting that these RCPs were developed prior to the Paris Agreement, so they do not align directly with the Paris targets of 1.5°C and 2.0°C (relative to pre-industrial) by 2100. However, RCP2.6 *could* be regarded as a trajectory that would arrive at around 1.5°C warming by 2100 – but this change is relative to 1986–2005, not pre-industrial (mid 1800s).

3.4.3 Confidence in projections

Our confidence in climate change projections is determined by considering climate model results along with our physical understanding of the climate system and past observations. Confidence is higher for some projections (e.g. temperature) than others (e.g. rainfall).

Confidence is based on the direction and size of the long-term trend, not the ups and downs each year (Figure 8). This is why projections are delivered as 20- or 30-year averages – to account for the year-to-year variability and so capture the overall trend.

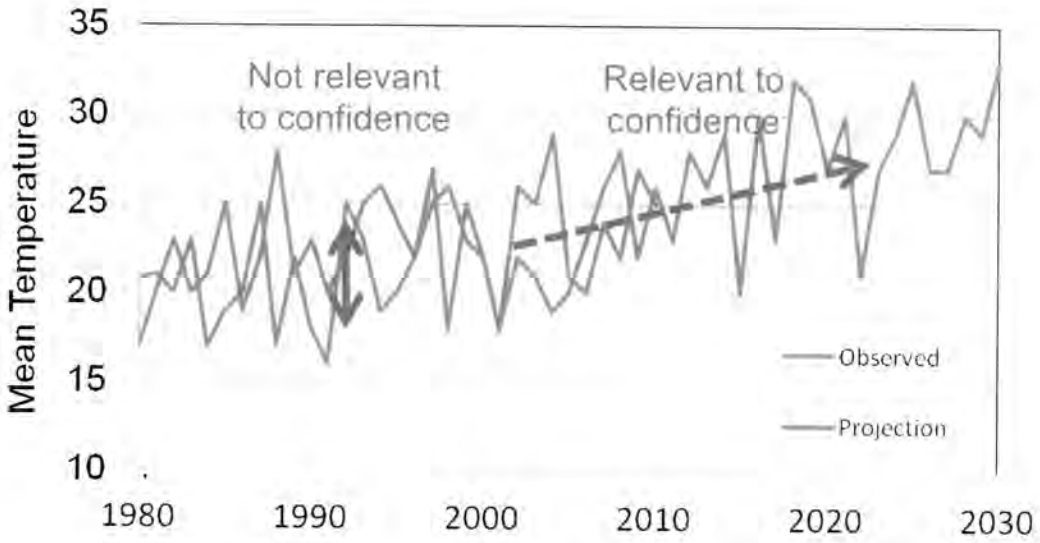

Figure 8. Confidence in climate change projections is based on the direction and size of the long-term trend, not the year-to-year variability. (source: workshop presentation by Vanessa Hernaman)

3.5 Shark Bay's future climate

While we do not know exactly how the future will unfold in the decades out to 2100, we can draw on climate change science to tell us what the future climate might be like.

We can use science-based climate change information to provide the evidence for understanding risk and developing 'climate smart' policies and plans for sectoral adaptation and disaster risk management.

Using the latest climate science and modelling, climate projections can help us plan for a smaller range of options by narrowing down the range of possible future climates.

3.5.1 Australia's national climate change projections

Australia's national climate change projections[18] were developed by CSIRO and the Bureau of Meteorology in 2015 for the Commonwealth Natural Resource Management funded projections project. They are reported on the basis of clusters, which correspond to the broadscale climate and biophysical regions of Australia (Figure 9). Shark Bay is in the Rangelands (South) sub-cluster.

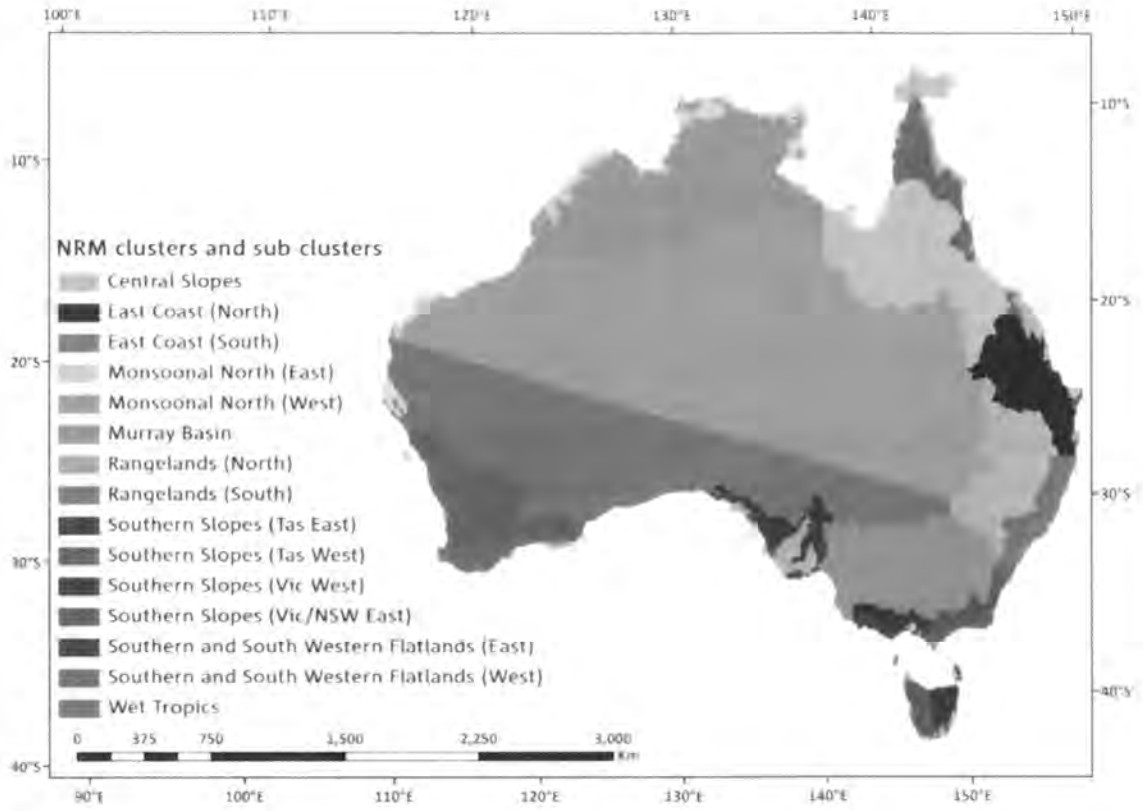

Figure 9: Clusters and sub-clusters used in Climate Change in Australia

[18] Climate Change in Australia,

The following projections are for the Rangelands (South) sub-cluster taken from the Rangelands cluster report[19] unless noted otherwise. The appendix of the Rangelands report contains a table of annual and seasonal projections for nine climate variables (temperature, daily maximum temperature, daily minimum temperature, rainfall, wind speed, solar radiation, relative humidity, evapotranspiration, soil moisture) for three emission scenarios (RCP2.6, RCP4.5 and RCP8.5) and two time periods (2030 and 2090). Projections for five marine variables (sea-level rise, sea surface temperature, sea surface salinity, pH and aragonite saturation) are also included. Where available, this workshop report also provides some projections for 2050.

3.5.2 Temperature

Average temperatures are projected to continue to increase in all seasons (*very high confidence*).

Table 2. Projected annual average warming (°C) relative to 1986–2005

	RCP 2.6	RCP 4.5	RCP 8.5
2030	0.6–1.2	0.6–1.2	0.7–1.3
2050	0.7–1.5	1.0–1.8	1.4–2.4
2090	0.6–1.7	1.3–2.6	2.8–5.1

3.5.3 Extreme temperature

More hot days and warm spells are projected with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (*very high confidence*). What we currently consider an extreme will become the new norm as we move through the century. For example, in 2030, an average year is slightly warmer than the 2013 record (Figure 10).

Table 3. Projected number of extreme heat days (>35°C and >40°C) for Denham and Carnarvon in 2030 and 2090[20]

	Historic (1981–2010)	2030 (RCP4.5)	2090 (RCP4.5)	2090 (RCP8.5)
Annual average no. days max temp >35°C				
Denham	27	34 (32–35)	42 (38–47)	65 (52–77)
Carnarvon	26	34 (31–36)	43 (37–48)	69 (53–84)
Annual average no. days max temp >40°C				
Denham	6	9 (8–10)	12 (10–13)	19 (15–23)
Carnarvon	5	7 (6–8)	10 (8–12)	19 (13–24)

19

20 Extracted from

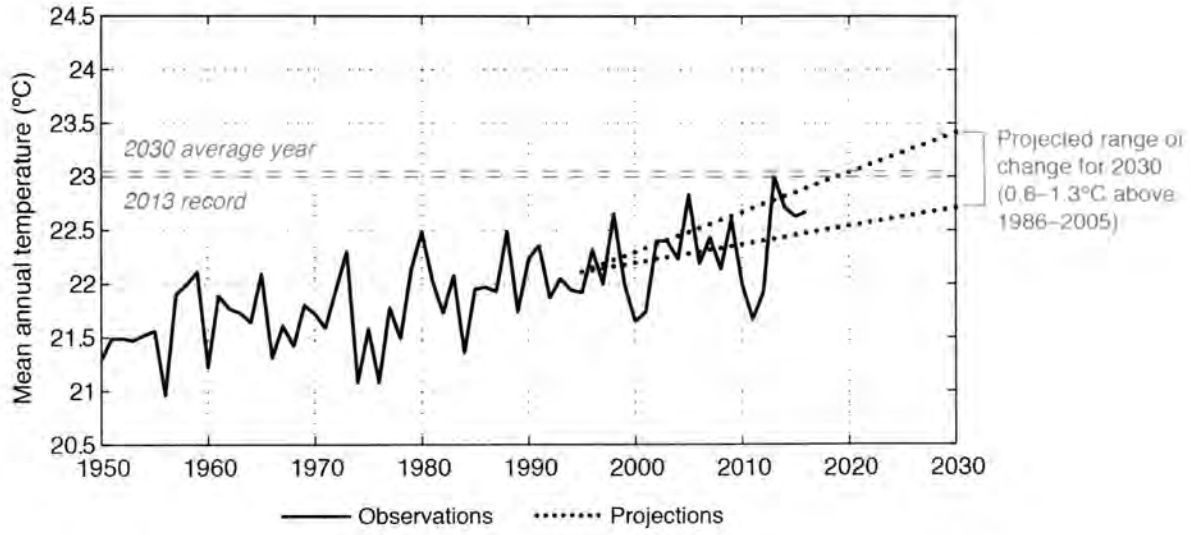

Figure 10. Temperatures that we currently consider extreme will become the norm in the future (source: Using climate change information to 2030[21])

Projections for additional temperature extremes for the Shark Bay council area are available on the CoastAdapt website (coastadapt.com.au). These projections are the multi-model means from eight climate models, averaged over 30-year periods (so 2030 is 2016–2045). Only the mean is provided in the table below. See the website for information about the range.

Table 4. Projected number of extreme hot days, warm nights and heatwaves for Shark Bay shire in 2030 and 2090[22]

	Historic (1981–2010)	2030 (RCP4.5)	2090 (RCP4.5)	2090 (RCP8.5)
Hot days Mean annual no. days max temp >30°C	89	110	131	183
Warm nights Mean annual no. days max temp >30°C	7	14	24	58
Heatwaves Average of longest run of days in each year with max temp >30°C	14	20	26	56

3.5.4 Rainfall

In the near future (2030) natural variability is projected to dominate over trends from greenhouse gas emissions. Winter rainfall is projected to decrease (*high confidence*), due to the southward shift of winter storm systems together with rising mean atmospheric pressure. Changes to summer and autumn rainfall are possible but are less clear because changes in these seasons are more strongly linked to the large-scale pattern of tropical sea surface temperature which varies considerably among models.

21

22

Table 5. Projected average change in rainfall (%) for 2030 and 2090 relative to 1986–2005

	2030 (RCP4.5)	2090 (RCP4.5)	2090 (RCP8.5)
Annual	–14 to 7	–19 to 7	–29 to 13
Summer	–22 to 10	–24 to 12	–24 to 21
Autumn	–23 to 18	–25 to 22	–42 to 29
Winter	–25 to 18	–36 to 6	–46 to 1
Spring	–18 to 17	–26 to 15	–53 to 22

3.5.5 Extreme rainfall

Extreme short-duration rainfall (e.g. hourly, daily) is projected to intensify with *high confidence*, even in regions where mean rainfall decreases. This is because a warming atmosphere can hold more moisture. Increases in rainfall extremes have already been observed for short duration (3-hour or less) rainfall.

The increase in intense rainfall can be even greater when the increased moisture in the air provides more energy for storms. This is already evident in the most extreme hourly rainfall, particularly in summer storms. Almost all models agree that the wettest day of the year will get wetter, regardless of the scenario.

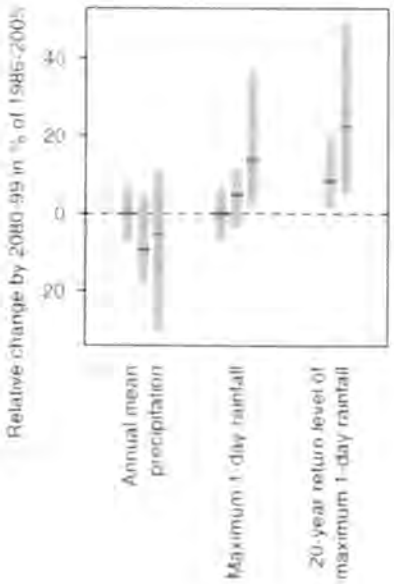

Figure 4.1: Projected change in rainfall extremes (%) for 2090 relative to 1986–2005. RCP4.5 (lower emissions scenario) in blue and RCP8.5 (high emissions scenario) in pink. The grey bars represent natural climate variability.

Changes in the frequency of short-duration rainfall events are more difficult to project, because global climate models run at too coarse a resolution to simulate the small-scale systems that lead to these events, and because frequency is also influenced by future circulation changes that will affect changes in storms and weather systems. This is an active area of climate research.

3.5.6 Tropical cyclones

Fewer but more intense tropical cyclones are projected (*medium confidence*).

3.5.7 Wind

Average surface winds over the Rangelands are mostly south-easterly in summer and westerlies in winter. A small winter decrease in wind associated with the southward shift of westerlies in winter is projected. Due to limited understanding of physical mechanisms, there is only *low confidence* in the projections for an increase in wind speeds in spring despite strong model agreement.

3.5.8 Fire weather

Bushfire in the Rangelands depends highly on fuel availability, which mainly depends on rainfall. Given sufficient fuel availability, ignition, fuel dryness, and suitable weather conditions for fire spread (i.e. hot, dry, and/or windy) are also factors. Future fire weather risk can be projected using the Forest Fire Danger Index (FFDI), which captures two of the factors (fuel dryness and conditions for spread) and is calculated using daily maximum temperature, relative humidity, wind speed, rainfall, and an estimate of fuel state provided by the drought factor, which is estimated from 1- and 5-day rainfall plus a soil moisture index. A tendency toward increased fire weather risk is expected in future, due to higher temperature and lower rainfall, but there is *low confidence* in the magnitude of fire weather projections.

3.5.9 Evaporation

Potential evapotranspiration is projected to increase in all seasons as warming progresses (*high confidence*).

3.5.10 Humidity

Little change in relative humidity is projected for the near future (2030) while later in the century a decrease is projected in winter and spring (*high confidence*) and in summer and autumn (*medium confidence*). The decreasing trend in winter and spring is due to the increased moisture holding capacity of warming atmosphere, and greater warming of land compared to sea. This leads to increases in relative humidity over the ocean and decreases over continents.

3.5.11 Solar radiation

There is little change projected for solar radiation in the near future (2030), and for later in the century, increased radiation is projected in the south in winter (*medium confidence*). Increased winter radiation is related to decreases in cloudiness associated with reduced rainfall. Changes to radiation can be caused by changes to cloud cover or to the presence of aerosols in the atmosphere, or can decrease due to thermally driven increases of water vapour in the atmosphere.

3.5.12 Sea level

Mean sea level will continue to rise and height of extreme sea-level events will also increase (*very high confidence*).

The following projections (Table 6 and Figure 12) are for open coast. They account for thermal and dynamic influences on sea level, including changes in ocean currents (but not wave height), but not for local land movements. Additional changes are possible for closed bays or estuaries.[23]

Table 6. Sea-level rise for Shark Bay shire area relative to 1986–2005 (source: Coast Adapt)

	2030	2050	2070	2090
RCP2.6	0.11 (0.07–0.16)	0.20 (0.13–0.28)	0.30 (0.18–0.42)	0.38 (0.22–0.56)
RCP8.5	0.12 (0.08–0.17)	0.24 (0.16–0.33)	0.41 (0.26–0.55)	0.61 (0.39–0.84)

The rate of change at 2100 under RCP2.6 is 4.1 mm/year, or 11.0 mm/year under RCP8.5.

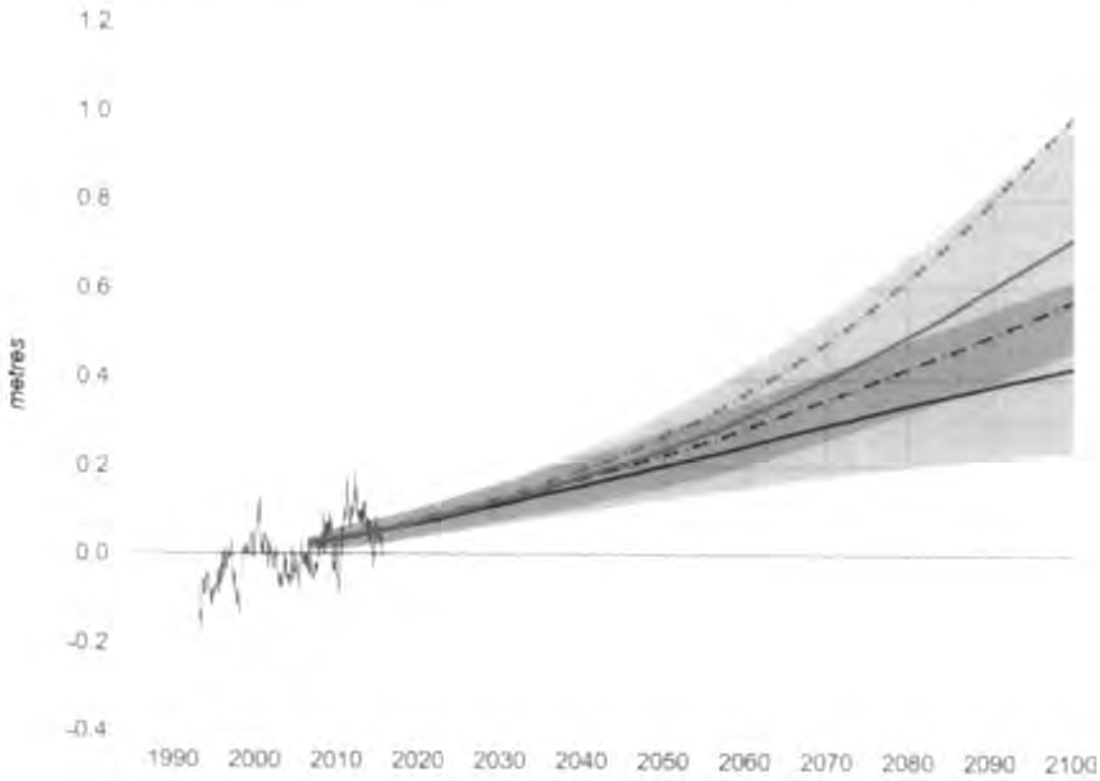

Figure 12. Sea-level rise (solid lines) and allowances (dashed lines) for Shark Bay shire area (RCP2.6 purple, RCP8.5 red). An allowance is the height that coastal defences would need to be raised in order to provide the same level of protection as they do today. Green line is observed data (satellite) sea-level rise is relative to 1986–2005 average, shaded area is likely range for each scenario. (source: CoastAdapt)

23

3.5.13 Coastal extremes

Long-term sea-level rise can exacerbate event-based extreme sea levels caused by combination of factors including astronomical tides, storm surge and wind-waves.

3.5.14 Sea surface temperature

Table 7. Median sea surface temperature projections (°C) for Carnarvon relative to 1986–2005

Time	RCP	SST (°C)
2030	RCP4.5	0.7 (0.4 to 0.9)
2090	RCP4.5	1.3 (1.1 to 1.7)
2090	RCP8.5	2.6 (2.4 to 3.5)

3.5.15 Ocean chemistry

Projections are available for a number of ocean chemistry variables, including salinity, pH and aragonite saturation (aragonite is the form of calcium carbonate used by corals, clams, oysters and foraminifera to build shells and skeletons).

Time	RCP	Sea surface salinity (g/kg)	Ocean pH	Aragonite saturation
2030	RCP4.5	-0.08 (-0.23 to 0.18)	-0.07 (-0.07 to -0.06)	-0.34 (-0.37 to -0.29)
2090	RCP4.5	-0.15 (-0.43 to -0.04)	-0.14 (-0.15 to -0.14)	-0.73 (-0.77 to -0.68)
2090	RCP8.5	-0.14 (-0.63 to 0.30)	-0.31 (-0.32 to -0.30)	-1.45 (-1.53 to -1.33)

Salinity projections span a wide range that includes increases and decreases. Salinity will also be affected locally by increased fresh water from river discharges.

Around 30% of all anthropogenic carbon dioxide emitted over the past 200 years has been absorbed by oceans, which has led to 0.1 unit decrease in global surface ocean pH.

The projections provided above are for the open ocean, but for estuaries and bays, such as Shark Bay, local hydrodynamics are also important as they can modify the seawater characteristics such that the salinity and temperature within the bay can be very different to that outside it (Figure 13).

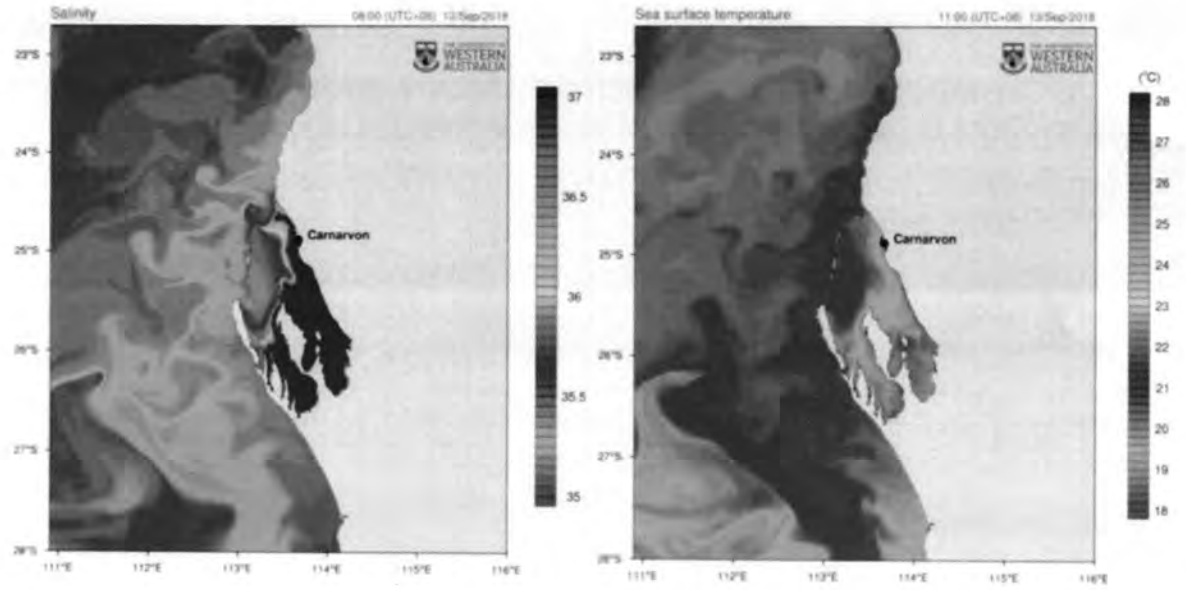

Figure 13. Salinity (left) and sea surface temperature (right) within Shark Bay can be very different to that outside it due to local hydrodynamics.[24]

3.5.16 Leeuwin Current

While most climate models project a decrease of the strength of the easterly trade winds along the equatorial Pacific, there are uncertainties about the magnitude of the changes. A decrease in the easterly winds corresponds to a weakening trend of the Leeuwin Current.

[24] www.wamsi.org.au/sites/wamsi.org.au/files/files/2_Workshop_Pattaratchi_oceanography_s.pdf

4. How will climate change affect the values of the Shark Bay World Heritage Area?

This section outlines the process and results of a rapid risk assessment tool used in the workshop to lay the foundations for the development of a Climate Change Adaptation Strategy and Action Plan for the Shark Bay World Heritage Property.

The Climate-change Vulnerability Index (CVI) is being developed by Jon Day, Scott Heron and Imogen Zethoven to provide a method for systematically assessing climate change impact across all World Heritage properties. Its use at this workshop served to:

- Road test the methodology
- Identify possible areas of focus for the development of a climate change adaption strategy and action plan.

4.1 Developing the CVI

Workshop participants worked through the following steps to develop the CVI for the Shark Bay WHA:

1. Reviewing the significant values for Shark Bay – including attributes of OUV and other values.
2. Identifying relevant climate drivers[25] (potential climate stressors).
3. Identifying the potential impacts of climate change on these values.
4. Conducting a high-level risk assessment (likelihood and consequence) of these impacts to identify the three key potential climate stressors likely to impact on the Shark Bay values within a specified time frame.
5. Considering related physical, ecological, economic and social impacts.
6. Considering the likely adaptive capacity in relation to the three key potential climate stressors.
7. Using a spreadsheet-based model to consider the vulnerability of Shark Bay's OUV to the three key potential climate stressors.

The CVI framework followed that of the *North American MPA Rapid Vulnerability Assessment Tool*[26], which was modified from the IPCC Vulnerability Framework[27]. As noted

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[25] The CVI process uses the term 'climate drivers' to refer to aspects of the climate system that will be affected by climate change and impact on Shark Bay. However, in climate change science, a 'climate driver' is understood to be something that alters the energy balance of the climate system (e.g. aerosols, greenhouse gases, solar radiation, land surface properties). This report uses the term 'potential climate stressors' to avoid confusion with reports and data in wider climate change literature.

[26]

[27]

in the latter, assessment of vulnerability involves scientific uncertainty and value judgements.

For the rapid assessment of the CVI, framework components (Figure 14) were evaluated using a categorical system, with category thresholds drawn from various existing resources. Since the Shark Bay workshop, and with further consultation with vulnerability experts and practitioners, the CVI framework has adopted the (unmodified) IPCC Vulnerability Framework (as applied in the Third and Fourth Assessment Reports). In this the elements Likelihood, Consequence and Risk are substituted by Exposure, Sensitivity and Potential Impact, respectively. However, the process of the rapid assessment of the CVI is such that the outcomes identified for Shark Bay will remain valid under both versions of the framework.

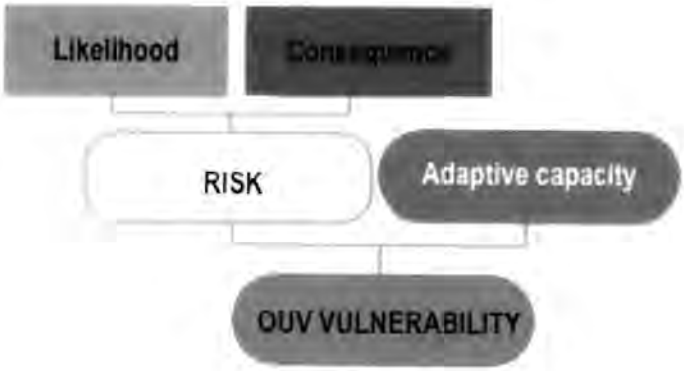


Figure 14 The Climate-change Vulnerability Index framework

4.1.1 Significant values and relevant potential climate stressors

The values considered in this rapid risk assessment were the attributes of Shark Bay's OUV at the time of listing. These values are fixed. There may be global (e.g. Ramsar, CITES) and local values that will need to be identified and considered in addition to OUV in the development of a climate change adaptation strategy and action plan.

A list of 15 potential climate stressors (seven atmospheric, eight marine; Table 8) was provided to streamline and standardise the rapid risk assessment process. The list is for application across all World Heritage sites, with relevant stressors for each site identified during the CVI process. Stressors were identified as either chronic (persistent over long periods) or acute (high intensity, short period). The CVI uses the synonyms in Table 8 to facilitate understanding of these stressors.

Table 8. Potential climate stressor used to develop the Climate-change Vulnerability Index

Potential climate stressor	Synonyms	Time frame
Atmospheric		
Air temperature change	*Warming; seasonal shift; hotter average weather; increase evaporation; desiccation; fire frequency and intensity*	Chronic
Change in wind	*Gale; gusts; storms ... also changes in wind direction?*	Chronic
Drought frequency and severity	*Aridity; dehydration; below average rainfall; prolonged water shortage*	Chronic
Extreme temperature events	*Heatwaves, bleaching; hot spell; desiccation*	Acute
Humidity change	*Evaporation; moisture content; oppressiveness; condensation; clamminess; sweatiness*	Chronic
Precipitation change	*Rainfall; rainstorms; showers; drizzle; heavy dew; hailstorms; sleet; snow*	Chronic
Storm intensity and frequency	*Cyclone; hurricane; typhoon; blizzard; tornado; storminess*	Acute
Marine		
Water temperature change	*SST; warming; seasonal shift*	Chronic
Storm surge	*Storm floods; storm tides; coastal flooding; cyclones; hurricanes*	Acute
Storm intensity and frequency	*Cyclone; hurricanes; typhoon; waterspout; blizzard; storminess*	Acute
Extreme marine heat events	*Heatwaves; bleaching; hot spell; desiccation*	Acute
Sea level change	*Sea level rise; flooding; subsidence; post-glacial rebound; coastal vulnerability; coastal inundation*	Chronic
Precipitation change	*Rainfall; rainstorms; showers; drizzle; heavy dew; hailstorms; sleet; snow*	Chronic
Ocean acidification	*OA; pH change; acidity; calcification rate; chemical reaction; chemical change; CO_2/O_2 concentration*	Chronic
Changing ocean currents	*Ocean circulation; ocean dynamics; ocean 'conveyor belt'*	Chronic

Potential climate stressors likely to impact on each key value (i.e. attribute of OUV) were determined by workshop participants. The outcomes are recorded in Table 9.

Table 9. Potential climate stressors impacting on Shark Bay's OUV

Key values	Excerpts taken from Statement of OUV	Potential climate stressors impacting on key values
Seagrass	the Wooramel Seagrass Bank. Covering 103,000 ha, it is the largest structure of its type in the world one of the largest seagrass meadows in the world with the most seagrass species recorded from one area	air temperature change, change in wind, extreme marine heat events, extreme temperature events, precipitation change; ocean acidification; other water quality changes (salinity, dissolved oxygen, primary production)
Stromatolites	the most diverse and abundant examples of stromatolites (hard, dome-shaped structures formed by microbial mats) in the world	storm intensity and frequency, air temperature change, change in wind, extreme marine heat events, storm surge, precipitation change, sea level change, ocean acidification, salinity change
Geological significance	great geological interest due to the extensive deposit of limestone sands associated with the bank, formed by the precipitation of calcium carbonate from hypersaline waters	sea level rise, storm surge, storm intensity and frequency, change in wind, flooding events
Carbonate dominated marine environment	one of the few marine areas in the world dominated by carbonates not associated with reef-building corals	water temperature change, precipitation change, storm intensity and frequency, storm surge, extreme marine heat events, sea level change, ocean acidification

Key values	Excerpts taken from Statement of OUV	Potential climate stressors impacting on key values
Hypersaline waters	hydrologic structure of Shark Bay, altered by the formation of the Faure Sill and a high evaporation, has produced a basin where marine waters are hypersaline (almost twice that of seawater) the steep gradient in salinities, creating three biotic zones that have a marked effect on the distribution and abundance of marine organisms hypersaline conditions in Hamelin Pool have led to the development of a number of significant geological and biological features including the 'living fossil' stromatolites	water temperature change, storm surge, storm intensity and frequency, precipitation change, air temperature change, change in wind, extreme marine heat events, sea level change, ocean acidification, changing ocean currents, salinity change
Aesthetics	extensive beaches consisting entirely of shells profusion of peninsulas, islands and bays create a diversity of landscapes and exceptional coastal scenery	sea level change, precipitation change, storm surge, storm intensity and frequency (leading to increased water turbidity)
Evolutionary processes	one of the world's best examples of a living analogue for the study of the nature and evolution of the earth's biosphere up until the early Cambrian outstanding examples of processes of biological and geomorphic evolution taking place in a largely unmodified environment... including: evolution of the Bay's hydrological system the hypersaline environment of Hamelin Pool the biological processes of ongoing speciation, succession and the creation of refugia	storm intensity and frequency, air temperature change, change in wind, extreme temperature events, storm surge, precipitation change, sea level change, ocean acidification, drought frequency and severity, salinity change
Botanical significance	located at the transition zone between two of Western Australia's main botanical provinces a refuge for many globally threatened species of plants	precipitation change, extreme temperature events, drought frequency and severity, air temperature change, storm intensity and frequency, extreme marine heat events; sea level change
Threatened species	the only or major populations of five globally threatened mammals: • the burrowing bettong (now classified as Near Threatened) • rufous hare wallaby • banded hare wallaby • Shark Bay mouse • western barred bandicoot	air temperature change, change in wind, drought frequency and severity, extreme temperature events, humidity change, precipitation change, sea level change, storm surge
Marine turtles	sheltered coves and lush seagrass beds are a haven for marine species, including green turtle and loggerhead turtle (both Endangered), and the property provides one of Australia's most important nesting areas for this second species	marine heatwaves (affecting seagrass), air temperature change (at nesting beaches), storm intensity and frequency, change in wind (affecting water circulation), flooding (run-off and sediment into the bay) [timescale: short term]
Sharks and rays	large numbers of sharks and rays are readily observed, including the manta ray which is now considered globally threatened	water temperature change; other water quality changes

Key values	Excerpts taken from Statement of OUV	Potential climate stressors impacting on key values
Dugongs	one of the world's most significant and secure strongholds for the protection of dugong, with a population of around 11,000	marine heatwaves (affecting seagrass and habitat), flooding (mobile if they need to look for food in an event), water temperature change (changes in the distribution), storm intensity, sea level change [timescale: short term]
Whales and dolphins	increasing numbers of humpback and southern right whales use Shark Bay as a migratory staging post a famous population of bottlenose dolphin lives in the bay	water temperature change (chronic; the dolphin community in the east more affected than the west in the heat events?), storm intensity and frequency, more intense rainfall change, air temperature change [timescale: short term], whale foraging may be impacted
Integrity	impacts from pastoralism (grazing leases) and feral animals ecosystems in Shark Bay appear relatively unaltered by human impact, although this could change if terrestrial mining of mineral sands were to take place industrial activities such as salt and gypsum mining in the region, could comprise threats marine environment has undergone some modification through historically intensive pearl shell, fishing, trawling and whaling activities potential threats from: • improved technology in producing drinking water which would lead to increased tourism and residential density • upgrading of road access • agricultural developments to the east (dependent on water supply) • expansion of gypsum mining • introduction of intensive aquaculture or fishing technologies • petroleum exploration and extraction • unsustainable visitor use	storm intensity and frequency, precipitation change, extreme temperature events, air temperature change, extreme marine heat events, sea level change, water temperature change, drought frequency and severity (catchment flooding), ocean acidification, change in ocean currents, change in wind

Vulnerability to OUV was assessed for a 'business-as-usual' scenario (RCP8.5). When evaluating the likely impacts of the identified potential climate stressors, participants considered climate changes out to 2030 and 2050, having determined that impacts in the coming decades should take higher priority than those in the latter half of the century. With this time frame in mind, further discussion identified the most important potential stressors (up to three) for each key value (Table 10). The occurrence of each stressor was counted, allowing identification of the three most important stressors overall: **storm intensity and frequency** (eight occurrences), **extreme marine heat events** (five occurrences) and **air temperature change** (four occurrences). No other stressor was recorded more than three times. The methodology of counting the occurrence of each stressor implies equal weighting to all identified key values. Workshop attendees reflected on the priority of each key value

and confirmed that the three potential climate stressors identified were the three most important.

Table 10. Most important potential climate stressors impacting on Shark Bay's key values (that contribute to OUV)

Key value	Most important potential climate stressors		
Seagrass	**extreme marine heat event**	**storm intensity and frequency**	
Stromatolites	**storm intensity and frequency**	change in wind	
Carbonate dominated marine environment	**extreme marine heat event**	**storm intensity and frequency**	
Hypersaline waters	water temperature change	**air temperature change**	
Aesthetics	**storm intensity and frequency**	storm surge	sea level change
Evolutionary processes	precipitation change	drought frequency	extreme temperature events
Geological significance	sea level change	change in wind	**storm intensity and frequency**
Botanical significance	drought frequency	precipitation change	**air temperature change**
Threatened species	drought frequency	precipitation change	**air temperature change**
Marine turtles	storm surge	**storm intensity and frequency**	**air temperature change**
Dugongs	**extreme marine heat event**	**storm intensity and frequency**	
Whales and dolphins	**extreme marine heat event**	**storm intensity and frequency**	water temperature change
Sharks and rays	water temperature change	**extreme marine heat event**	
Integrity			

4.1.2 Likelihood, consequence and risk

The likelihood of each of the three key potential climate stressors impacting OUV out to 2030 was assessed using the following scale:

Likelihood based on IPCC	**Very likely** >90%	**Likely** 67–90%	**Possible** 34–66%	**Unlikely** 10–33%	**Very unlikely** <10%

Similarly, the measure of consequence on OUV from each of the three key potential climate stressors was assessed using the following scale:

Consequence based on IUCN	**Catastrophic** Loss or substantial alteration of majority of values (esp. the key values comprising OUV) will occur	**Major** Loss or alteration of many values comprising OUV will occur, leading to a significant reduction of OUV	**Moderate** Some loss or alteration of some values comprising OUV will occur; but not causing a significant reduction of OUV	**Minor** Some loss or alteration of a few values comprising OUV will occur; but not causing persistent or lasting effects on OUV	**Negligible** All elements of OUV will remain essentially intact; overall condition of property is stable or improving

For each of the three key potential climate stressors, risk was determined using the following matrix:

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Catastrophic
Very unlikely	low	low	low	low	low
Unlikely	low	low	moderate	moderate	moderate
Possible	low	moderate	moderate	high	high
Likely	low	moderate	high	high	extreme
Very likely	low	moderate	high	extreme	extreme

The likelihood, consequence and initial risk assessment are summarised in Table 11.

Table 11: Assessments of likelihood and consequence, and the initial risk assessment for the three most important potential climate stressors

	Air temperature change	Storm intensity and frequency	Extreme marine heat events
Time frame	Chronic	Acute	Acute
Likelihood	Very likely	Likely	Very likely
Consequence	Moderate	Major	Catastrophic
Initial risk	HIGH	HIGH	EXTREME

4.1.3 Applying modifiers

The CVI applies modifiers to both likelihood and consequence to account for temporal scale and trend (likelihood) and spatial scale and compounding factors (consequence). The effect of the modifiers above Level 1 is to amplify the likelihood and/or consequence (scaling by 1.0–1.3 in increments of 0.1 for each level), and thus increase the assessed risk. Modifiers were applied using the following scale:

Modifier	Level 1	Level 2	Level 3	Level 4
Likelihood				
Temporal scale The occurrence of each stressor and whether they are…	<1 event/ decade	1–5 events/ decade	5–10 events/ decade	on-going
Trend How the recent trend of the stressor has developed	declining/static	increasing slowly	increasing moderately	increasing rapidly
Consequence				
Spatial scale Extent (%) of WH property affected by climate change stressors at any one time	restricted <10%	localised 11–50%	extensive 51–90%	very widespread 91–100%
Compounding factors Is climate change likely to influence or interact with other non-climate stressors (e.g. invasive species) in the near future?	very unlikely/ unknown	low probability	medium probability	high probability

Table 12. Modified likelihood and consequence, and the final risk assessment for the three most important potential climate stressors in Shark Bay

	Air temperature change	Storm intensity and frequency	Extreme marine heat events
Time frame	Chronic	Acute	Acute
Modified likelihood	Very likely	Likely	Very likely
Modified consequence	Moderate–Major	Major–Catastrophic	Catastrophic
Modified risk	EXTREME	EXTREME	EXTREME
Value/s	Turtles – nest temperature, greater risk; Vegetation – lesser risk. Individual values can be affected differently.	Seagrass, habitat	Seagrass, marine fauna, coral
Notes	Don't know the ripple effect of one component being impacted interacting with another (unknown interactions/ unknowns)	Noted to have occurred and interacted with marine heatwave in 2011. Extreme rainfall (intense downpour) can occur in either winter or summer rains, not just cyclone-related rain.	A marine heatwave is an extreme event, driven by climate processes (ENSO, IOD)

The risk ratings for each of the three key potential climate stressors are **EXTREME**. It is notable that the consequence of extreme marine heat events is rated as catastrophic.

4.1.4 Adaptive capacity

Adaptive capacity describes the potential, capability or ability of a World Heritage property to adjust to climate change, to moderate potential damage, to take advantage of opportunities, or respond to the consequences.[28] In the CVI framework, adaptive capacity is considered in terms of the local management response, the level of scientific and/or technical support, and the effectiveness of these to address the climate stressor being considered (see the following matrix for scoring and In a situation where the resources available provide no effect to address the climate stressor, any identified adaptive capacity is nullified; where there is an effect, the adaptive capacity mitigates the risk of potential impact.

Table 13 for Shark Bay result).

Score	4	3	2	1
Local management response Capacity (i.e. resources, budget, knowledge) for management to respond at local level	high capacity	medium capacity	low capacity	no capacity and/or resources
Scientific/technical support Level of technical support for management at the local level	high level of support	medium level of support	low level of support	no support and/or scientific understanding

[28] After Foden et al. 2018. Climate change vulnerability assessment of species. *WIREs Climate Change*, doi: 10.1002/wcc.551

Effectiveness to address the climate stressor Extent to which local management will effectively address the climate stressor	high level of effectiveness	medium level of effectiveness	minimal/low level of effectiveness	very low/ negligible level of effectiveness

In a situation where the resources available provide no effect to address the climate stressor, any identified adaptive capacity is nullified; where there is an effect, the adaptive capacity mitigates the risk of potential impact.

Table 13. Adaptive capacity component scores and assessed level of adaptive capacity for the three key potential climate stressors in Shark Bay. Note that the order of colours is reversed from other usage to reflect that very low adaptive capacity is the least preferred category.

	Air temperature change	**Storm intensity and frequency**	**Extreme marine heat events**
Time frame	Chronic	Acute	Acute
Local management response	2	3	2
Scientific/ technical support	3	3	3
Effectiveness to address the climate stressor	1	2	1
Adaptive capacity	VERY LOW	LOW	VERY LOW

Where the adaptive capacity has an effect, it serves to mitigate the vulnerability of OUV, according to the vulnerability matrix below. This provides the OUV vulnerability for the property from the CVI framework, which for Shark Bay is the highest category – **HIGH**.

Risk	**Adaptive capacity**			
	Very low	Low	Moderate	High
Low	low	low	low	low
Moderate	moderate	moderate	low	low
High	high	moderate	moderate	low
Extreme	high	high	moderate	low

Table 14. Assessed risk and adaptive capacity combine to indicate the OUV vulnerability to the three key potential climate stressors and the overall OUV vulnerability for Shark Bay. Note that the order of colours is reversed from other usage to reflect that very low adaptive capacity is the least preferred category.

	Air temperature change	**Storm intensity and frequency**	**Extreme marine heat events**
Time frame	Chronic	Acute	Acute
Modified risk	EXTREME	EXTREME	EXTREME
Adaptive capacity	VERY LOW	LOW	VERY LOW
Vulnerability (climate stressor)	HIGH	HIGH	HIGH
Vulnerability (OUV)	HIGH		

Beyond assessment of OUV vulnerability, the CVI framework considers socio-economic sensitivity and capacity to determine vulnerability of the broader community (e.g. residents, industries). While these aspects were introduced during the Shark Bay workshop, the time available was not sufficient to pursue further consideration. Additionally, the participants self-assessed that they had insufficient expertise to address these components.

4.2 Implications for climate change adaptation planning

The CVI methodology provided a useful framework to assess the vulnerability of the OUV of Shark Bay to the key potential climate stressors in a changing climate and identified focal points for more detailed climate change impact assessment in Shark Bay.

The outcome confirmed that the vulnerability of OUV of the Shark Bay WHA to climate change is considered to be high. This rating provides reason and momentum to proceed further with climate change adaptation planning to better protect the WHA OUV of Shark Bay for future generations. The marine heatwave event of 2010/11 reinforces the immediate need for management plans for and monitoring of impacts of climate change, and also reinforced the potential for climate stressors to interact with each other to exacerbate impacts.

The workshop did not examine social and economic consequences, other than an initial discussion of effects and to note that they represent a further critical consideration. The workshop also did not consider in any detail the strategy or range of management actions to facilitate climate change adaptation for the Shark Bay area. These activities were noted to be critical to the development of a climate change adaptation strategy and plan, and hence remain as part of a number of next steps in facilitating climate change adaptation.

A further implication considered in the final session of the workshop was the identification of the significant planning and coordination required to implement climate change adaptation actions. The ownership of strategy and plan, and the individual actions will require not only identification of actions (with owners), but incorporation into the planning cycles (including budgeting), responsibilities and activities of a range of organisations relevant to Shark Bay, including DBCA, DPIRD, FESA, Shires of Shark Bay and Carnarvon, landowners (including pastoralists and conservation NGOs (Bush Heritage, Australian Wildlife Conservancy), as well as local industries and communities. The list above is not based on any substantive assessment and serves only to point out the significant challenge ahead and the need to inform, involve and facilitate broadly to maximise the ability to plan for climate change within the Shark Bay WHA.

5. Next steps

The way forward was briefly considered at the workshop and is summarised in Figure 15.

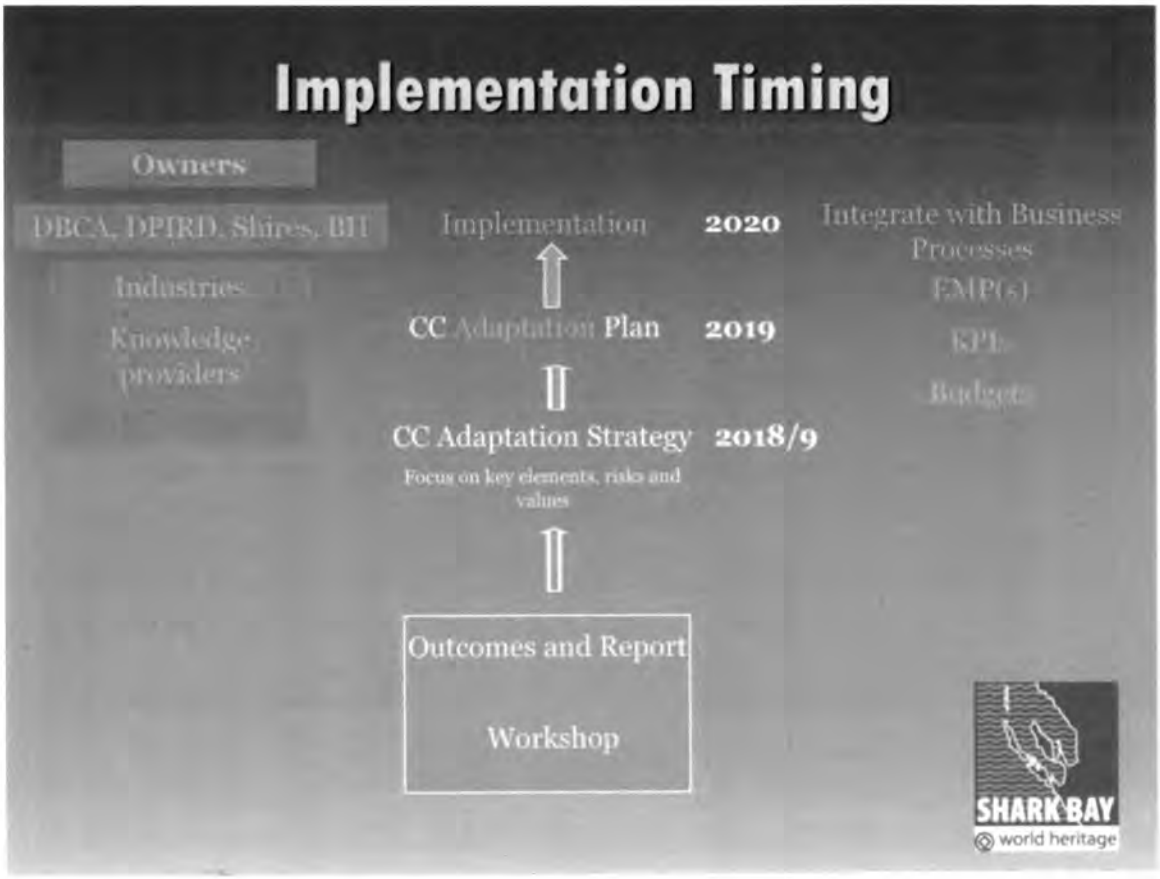


Figure 15. Summary of the path to a climate change adaptation plan for the Shark Bay World Heritage Area

There are several action pathways starting from this workshop (see Figure 16):

- Further discussion on the role of climate change science to inform climate risk assessment and the development of the climate change adaptation strategy for Shark Bay
- ESCC Hub and SBWHAC to conduct a case study using climate change science information to determine the impact of climate change on Shark Bay's seagrasses.
- Identification of the specific pathway and funding to develop the climate change adaptation strategy and plan for Shark Bay
- Identification of economic and social consequences of climate change on Shark Bay
- Acceptance and alignment across relevant organisations of a mandate to proceed and a vision for what can be achieved
- Development and implementation of a climate change adaptation strategy and plan for the Shark Bay WHA
- Identification of the specific knowledge gaps needed to inform the plan
- Development of the CVI methodology and its application to other WHA sites.

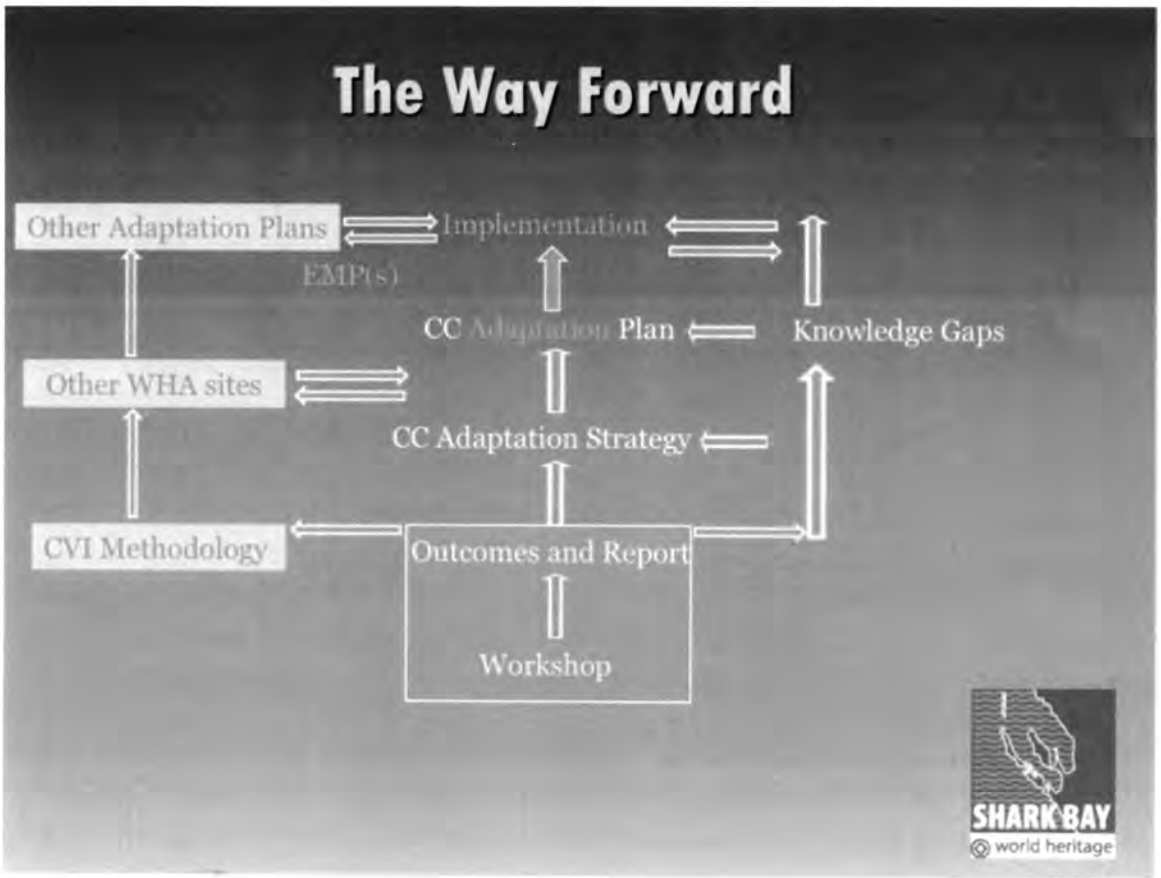


Figure 16. Action pathways starting from this workshop

5.1 Climate change adaptation strategy

The workshop commences a process that is identified as action section 4.3.15 of the Shark Bay World Heritage Property Strategic Plan:[29]

> Investigate the potential vulnerability of WHP species and communities to climate change (in particular species and communities of special conservation significance or likely to be highly vulnerable to climate change) and facilitate and complement delivery of broader climate-biodiversity research priorities.

The rapid assessment using the CVI framework has identified some of the key climate change risks to the OUV of Shark Bay and provided a focus for future management planning. It has highlighted the complexity of responsibility for actions, and the need for input to develop ownership for specific adaptation actions. Coordination between agencies with responsibilities for different areas, activities and information will be an essential component of success in developing adaptation strategy.

[29] Shark Bay World Heritage Property Strategic Plan 2008–2020. 2008 Department of Environment and Conservation. Perth, Western Australia.

5.2 Climate change adaptation action plan

The workshop focused on identifying key climate change stressors, rating the risk they represent to OUV and the potential for effective response to determine vulnerability. It did not attempt to speculate on specific climate change adaptation actions, to convey any input with respect to economic, social and other factors that will have a significant bearing on the development of meaningful and effective climate change adaptation actions. That input will need to be developed via other processes and will necessarily involve a broader range of people – many without a science background.

The complexity of ownership of actions, coordination of action and the identification and assessment of adaptation actions means that an effective action plan is expected to take considerable time (years), effort (by many good people, organisations), to require a mandate (from government), to require significant tools (understanding of thresholds, data, monitoring, investment decision making) and to have a shared vision of what we can achieve.

What the workshop did highlight was the significance of potential impact that key climate stressors are likely to have on OUV, and that the processes that operate on an acute basis provide urgency in planning for climate change, as they are noted to be already having an influence on the biology of the bay.

5.3 Knowledge gaps

While a considerable amount of research has been conducted in Shark Bay, leading to considerable advancements in knowledge, there were some key knowledge gaps highlighted by the workshop:

- Specific requirements of stromatolites to continue to survive and grow in Hamelin Pool (additional condition data on stromatolites is needed)
- Linkages between marine water conditions, chemical processes, seagrass, and organomineralisation processes in carbonate dominated marine environment, and thresholds for impacts on key attributes of OUV
- Thresholds for the protection of key elements of OUV
- The effect of compounding and interacting factors
- Consistent monitoring data relevant to OUV of Shark Bay
- Key strategy decisions – do the things we are capable of, or develop capability for dealing with the most significant impacts, or develop capability for the impacts we are likely to be able to influence. Assessment tools to help make these investment decisions.

Whilst there are some clear lines of responsibility for adaptation planning and actions, the protection of the OUV of Shark Bay potentially falls to many agencies and organisations. It is also clear that for actions to be owned and implemented, they need to be included in organisations individual planning, budgeting and performance management processes, and this needs to be coordinated. There is a gap in knowledge of how best to achieve this.

5.4 Implementation

The Western Australian Marine Science Institution (WAMSI) will facilitate the preparation and implementation of the climate change adaptation plan.

WAMSI has a shared vision for a cross sectoral focussed program to address the integrated management of Shark Bay under global climate change for the values as outlined in the World Heritage Site documentation and for sustainable tourism, commercial and recreational fishing and industry.

An appropriate science plan to support the management of Shark Bay in a changing climate will be collaborative, and research will be undertaken from gap analysis of the existing data and in areas where we think climate change is most likely to have significant impact (e.g. synergistic impacts of extreme marine heat events and turbidity on key species). There is already good existing information, but it's scattered, this needs to be collated and made available to all.

Appendix 1: Workshop program

Pre-workshop: Sunday 16 September
Venue: Denham Recreation Centre, Francis Street

Welcome dinner 6.00 pm. Background presentations to cover community and economic, marine heatwave event of 2010-11 (L Twomey, C Cowell, D Walker, T Morris, S Allen, S Heron)

Day 1: Monday 17 September
DBCA Offices. 61 Knight Terrace Denham

Introduction.

0830 In plenary (Scott and Phil to facilitate)

1. Overview of aims and introduction to key concepts of the workshop, use of plenary and small-group sessions, logistics (toilets, lunch, etc.).

Day 1 am. AIM 1: Understand the significant values that comprise the Outstanding Universal Value (OUV) plus the other significant (but non-OUV) values for Shark Bay

In plenary (Phil to facilitate)

2. Present OUV and Values tables
3. Ensure all participants are aware of the Statement of OUV for Shark Bay (Attachment 1) and how Table 1 was derived from the SoOUV
4. Ask participants to check/confirm that Table 2 comprises other key values of significance to Shark Bay (Attachment 2), and ensure they understand the distinction between Tables 1 and 2.

Day 1 am. AIM 2: Agree on consistent terms to describe CC drivers. Discuss the list of CC drivers and their potential to impact the values of Shark Bay.

In plenary (Scott to facilitate)

5. Show list of CC drivers – check for (i) missing? (ii) understanding? (iii) timescales? Briefly introduce IPCC scenarios. Do example together of brainstorming key CC drivers impacting ONE value from Table 1. Discuss driver linkages, cascading impacts.

In small groups

6. Using the list of CC drivers as agree above, ask participants in small groups to brainstorm what are the key CC drivers likely to impact the values in Tables 1 and 2. Split OUV and non-OUV lists of values between groups.

In plenary

7. Bring outputs from #6 back to plenary and ensure all participants agree on which CC drivers have the greatest potential to impact the values in Tables 1 and 2.

Day 1 pm. AIM 3: Discuss possible future CC scenarios facing Shark Bay.... and agree to consider two scenarios for future of Shark Bay *('Business as Usual'* and *'Paris Agreement')*

In plenary

Presentation: Vanessa Hernaman CSIRO. Understanding climate variability, extremes and change. Current, changing and future climate of the Shark Bay World Heritage Area. Projections for BAU and Paris

8. Provide overview of CC scenarios and what they might mean for Shark Bay – stromatolites for example. Ensure all participants understand the two scenarios being proposed for further consideration in the workshop.

Day 1 pm. AIM 4: To provide focus, conduct a high-level risk assessment (likelihood and consequence) of all CC drivers impacting the values (prioritising the OUV) of Shark Bay – identifying the drivers representing the highest risks to OUV.... and then prioritise those risks

In plenary (Scott to facilitate)

9. Introduce likelihood and consequence categories, as well as the risk matrix that combines these. Do example together for ONE OUV value from Tables 1 and 2.

In small groups

10. Participants in groups to assess the risk (ie. the likelihood and consequence) of the key CC drivers which will impact the values in Tables 1 and 2 using a risk assessment matrix - do this for both scenarios (as agreed in 7) with the objective to determine which are High or Extreme risks under both scenarios.

In plenary

11. Bring outputs from #9 back to plenary and ensure all participants agree on the risk levels caused by CC drivers impacting upon the values in Shark Bay (i.e., in both Tables 1 and 2). After consideration of both scenarios, then prioritise all the risks.

Day 2: Tuesday 18 September

Day 2 am. AIM 5: Commence development of diagrams of key CC drivers impacting the highest risk values of Shark Bay.... and then determine what are the related physical, ecological, economic and social impacts

In plenary (Scott to facilitate)

12. Show blank worksheet that links CC drivers to physical, ecological, economic and social impacts. Do example for ONE identified key CC driver (High or Extreme risk).

In small groups

13. Participants in groups develop diagrams of the values assessed as High or Extreme risk, for only the values that comprise OUV. Plot the key CC drivers and determine the related physical, ecological, economic and social impacts (using Worksheet at Attachment 3).
14. Repeat #12 (in small groups), for the High or Extreme risk non-OUV values

In plenary

15. Bring outputs from #12 and #13 back to plenary and get consensus from all participants on the physical, ecological, economic and social impacts on values of Shark Bay (i.e., endorse final versions of Worksheet at Attachment 3).

Day 2 pm. AIM 6: Discuss proposal for Climate Vulnerability Index (CVI) and test its applicability using Shark Bay as a case study

In plenary (Scott to facilitate)

16. Provide full overview of CVI concept, followed by questions.
17. Participants in plenary work through CVI worksheet under a '*Business as Usual*' scenario, getting consensus on relative scores.

In small groups

18. Participants in small groups work through CVI worksheet under a '*Paris Agreement*' scenario.

In plenary

19. Bring outputs from #17 to plenary, raising any issues about the worksheet/process.

AIM 7: Discuss possible adaptation strategies to address the priority impacts.

In plenary – Discussion on adaptation – what it is, how to plan for it.

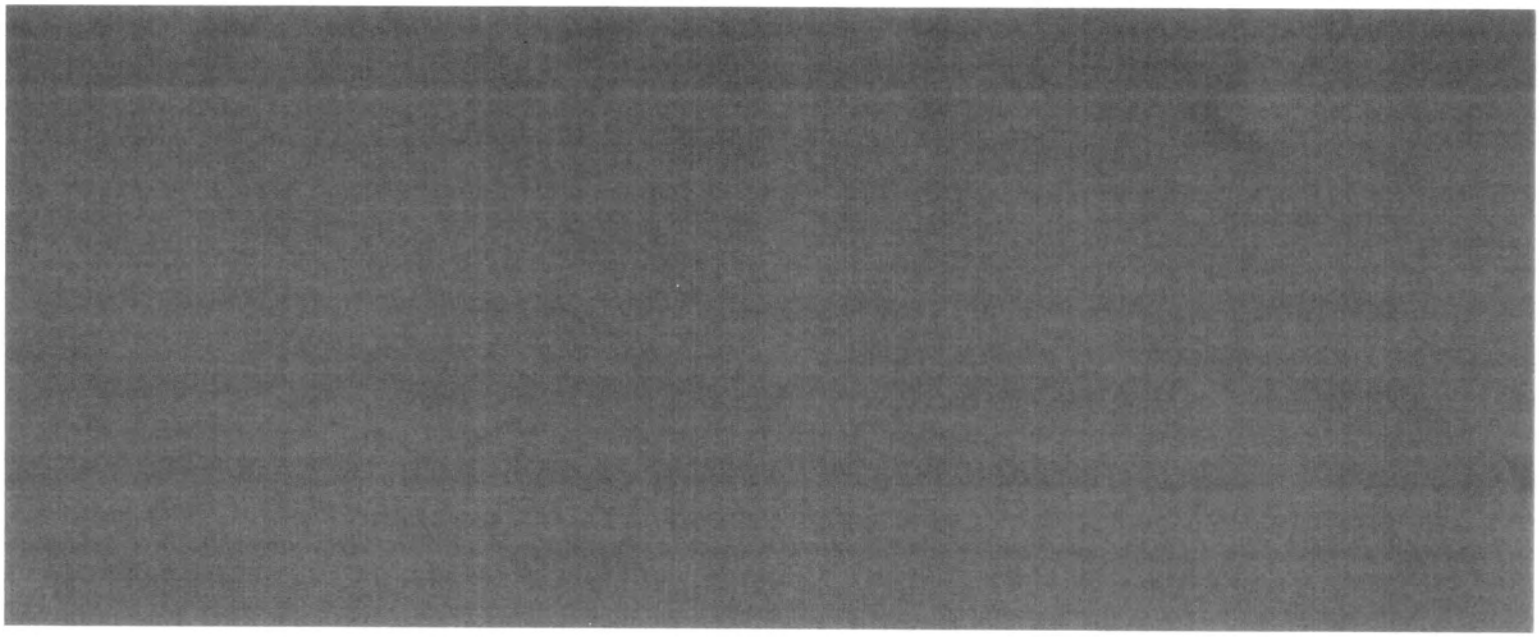
20. Participants (in plenary) get consensus on the priority impacts and discuss possible adaptation strategies for those that are agreed as High or Extreme vulnerability.
21. What climate change science information is needed for risk assessment?

Day 3: Wednesday 19 September – 8.30 am – 12.30 pm

Review of Workshop Outcomes

Appendix 2: Workshop participants

NAME	ORGANISATION	EXPERTISE
Simon Allen	UWA	Dolphins
Peter Barnes	DBCA Marine	Ningaloo Marine Park
Kim Branch	DBCA	Conservation
Patrick Cavalli	DPIRD - FISHERIES	Fisheries
Arani Chandrapavan	DPIRD - FISHERIES	Fisheries
Cheryl Cowell	SBWHAC	WHA OUV/Shark Bay
Vanessa Hernaman	NESP ESCC Hub	Climate change
Scott Heron	National Oceanic and Atmospheric Administration	CVI – **co-facilitator**
Mandy Hopkins	NESP ESCC Hub	Climate change
Alan Kendrick	DBCA Marine Science Program	Marine science
Elisabeth McLellan	Bush Heritage, SBWHAC	Ex-pastoral lease management
Therese Morris	Ex-SBWHAC member	Sedimentology
Steve Nicholson	DBCA	Shark Bay
Karen Pearce	NESP ESCC Hub	Science communication
Phil Scott	SBWHAC	WHA OUV – **co-facilitator**
Luke Twomey	WAMSI	Marine science
Ricky Van Dongen	DBCA	Remote sensing
Diana Walker	SBWHAC	Seagrass
Shaun Wilson	DBCA Marine Science Program	Marine science
Simon Woodley	NCWHAC	Ningaloo Coast WHAC Chair



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Mr Peter Millington
Chair, WA Marine Science Institution
University of WA
35 Stirling Highway
CRAWLEY WA 6009

Dear Mr Millington

Shark Bay Research Node

Thank you for your letter of 3 December providing further details in regard to the Western Australian Marine Science Institution (WAMSI) Board of Governors' endorsement for a Shark Bay Research Plan which will provide an increased capacity to respond to future environmental impacts.

Following s47F presentation to the Shark Bay World Heritage Advisory Committee (SBWHAC) at their recent meeting, I advise that the Committee resolved to endorse the formation of a Shark Bay Research Node and to develop a science plan collaboratively with WAMSI.

The three SBWHAC members who have expressed interest in nominating for the steering committee are s47F and s47F with s47F as a proxy. s47F

s22

I note that, in consultation with the SBWHAC, WAMSI will produce a business plan to support funding submissions for development of the science plan proposal.

The SBWHAC is eager to form a strong collaborative partnership with WAMSI in order to address marine management issues associated with climate change and other impacts and to build resilient ecosystems in order to preserve Shark Bay's World Heritage values.

Yours sincerely

s47F

Tom Day
Chair

14 December 2018

cc s47F Natural Heritage Branch, Department of Environment and Energy Canberra
Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service, Midwest Region and Shark Bay District

SHARK BAY
world heritage

Shark Bay World Heritage Advisory Committee

Please address all correspondence to:

The Chair
c/- Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
Denham WA 6537

s47F
(Executive Officer)
www.sharkbay.org

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MC19-000139

FOI 190505
Document 21

Hon Melissa Price, MP
Federal Minister for the Environment
Parliament House
P O Box 6022
CANBERRA ACT 2601

Min No: MC +1 RMD.
Division: Link:
DLO: KEA Date: 2/1/19
RECEIVED 2 JAN 2019 Environment Minister

☐ Covering Brief ☐ Departmental Reply
☐ Minister Reply ☑ Appropriate Action
☐ CoS/Adviser Reply ☐ For Information
☐ Refer to: ☐ Campaign ☐ Advice/Min

Dear Minister

Australian World Heritage Climate Change Response

Climate change is affecting natural systems and protected areas globally and planned and coordinated action is therefore essential for both understanding and responding to impacts to the Outstanding Universal Value (OUV) for which World Heritage properties have been listed.

Action to improve the resilience of OUV is imperative to ensure obligations to protect and conserve Australia's World Heritage properties (WHPs) are met. Already WHPs are recording negative climate change impacts to their values and attributes.

Irreversible damage to geological and geomorphologic heritage values (as expressed in UNESCO's World Heritage criteria) is predicted, with the implementation of comprehensive vulnerability assessments recommended for each WHP to reduce stress factors, increase resilience and conserve the integrity of our protected natural areas.

WHPs make a significant contribution to environmental, recreational and economic benefits in Australia and to date there is no coordination across properties to share solutions, achieve economies of scale and promote a holistic response.

A Climate Change Vulnerability Index (CVI) has been developed and was recently trialled by the Shark Bay World Heritage Advisory Committee (SBWHAC) during a Climate Change Adaptation Strategy and Action Plan workshop. This is a rapid assessment tool, able to be consistently applied to all WH properties (natural, cultural and mixed) in a systematic and comprehensive manner which is not overly complex.

The Australian World Heritage Advisory Committee (AWHAC) recently agreed on the need for a national World Heritage Climate Change response, including vulnerability assessments and adaptation plans which; identify specific likely impacts to OUV, provide actions to address those impacts, advance research, monitoring and reporting to inform collaborative action and enable funding opportunities to advance on-ground actions.

SBWHAC members have agreed to support AWHACs initiative to develop an Australian World Heritage Climate Change Response and to promote the CVI methodology as a template for application across WHPs to determine key climate stressors with the greatest potential impact on OUV.

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Shark Bay World Heritage Advisory Committee

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The Chair
c/- Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
Denham WA 6537

s22

(Executive Officer)

www.sharkbay.org

This Committee would therefore appreciate your active support for the development of a national World Heritage Climate Change Strategy and your advocacy for the CVI rapid assessment methodology.

Yours sincerely

s47F

Tom Day
Chair

14 December 2018

cc Hon Stephen Dawson, WA Minister for Environment
s47F Natural Heritage Branch, Department of Environment and Energy
Peter Sharp, Director – Parks and Visitor Services, Midwest Regional Manager, Shark Bay District Manager, Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service
Sue Sargent, Chair, Australian World Heritage Advisory Committee
Simon Woodley, Chair, Ningaloo Coast World Heritage Advisory Committee

s22

From: s47F
Sent: Thursday, 31 January 2019 3:05 PM
To: s22
Subject: RE: Shark Bay Climate Change letters [SEC=UNCLASSIFIED]

Hi s22

s22

I think the Index has highlighted some of the most vulnerable values to focus on, which has provided a starting point for considering adaptation/mitigation responses.
When you look at the big picture, it is so overwhelming that its hard to agree on what to concentrate on initially, so I believe the Index has been a positive step to commence with.
The case study on seagrass being conducted via CSIRO (to be finalised in May hopefully) is a spin off from the CC workshop which should also provide some future direction.

Cheers
s47F

-----Original Message-----
s22
Sent: Tuesday, 29 January 2019 9:54 AM
s22
Subject: Shark Bay Climate Change letters [SEC=UNCLASSIFIED]

Hey s22

s22

I've attached a reply to the SBWHAC on the two climate change letters - also included in the doc. I'll also put the letter in the post today.

What are your thoughts on the Vulnerability Index?

Regards

s22

-----Original Message-----
s22
Sent: Tuesday, 29 January 2019 12:36 PM
s22
Subject: Shark Bay SEC=Unclassified

Please find your scan attached to this Email.
_____

Australian Government
Department of the Environment and Energy

FOI 190505
Document 22a

PDR: MC19-000139

Mr Tom Day
Chair, Shark Bay World Heritage Advisory Committee
C/o Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
DENHAM WA 6537

Dear Mr Day

Thank you for your letters to the Minister for the Environment, the Hon Melissa Price MP, concerning the Shark Bay World Heritage Climate Change Workshop and proposing an Australian World Heritage Climate Change Response. Your letters have been passed on to the Department of the Environment and Energy to reply.

I would also like to thank you for sending a copy of the report of the climate change workshop held at Shark Bay in September 2018. It is particularly pleasing to note the cooperation between the Shark Bay World Heritage Advisory Committee and the Australian Government's National Environmental Science Program's (NESP) Earth Systems and Climate Change Hub, to better understand the potential impacts of climate change and prepare for these changes at Shark Bay.

Later this year the Department of the Environment and Energy plans to hold a meeting of World Heritage Executive Officers and officials, as was held in Canberra in October 2018. I anticipate that the meeting will be an opportunity to share experiences from Australia's World Heritage properties on the impacts of climate change, recent research, monitoring and preparation of adaptation strategies. We will keep you informed as plans develop for this meeting as it would be valuable for the work being done at Shark Bay to respond to climate change to be shared with the meeting participants.

Thank you again for bringing your concerns to the Government's attention.

Yours sincerely

David Williams
Assistant Secretary
Heritage Branch

24 January 2019

MC18-028581

Min No: MC
Division: HRMD Link:
DLO: AR Date: 20/12/18
RECEIVED 20 DEC 2018 Environment Minister

☐ Covering Brief ☐ Departmental Reply
☐ Minister Reply ☑ Appropriate Action
☐ CoS/Adviser Reply ☐ For Information
☐ Refer to ☐ Campaign ☐ Advice/Min

Hon Melissa Price, MP
Federal Minister for the Environment
Parliament House
P O Box 6022
CANBERRA ACT 2601

Dear Minister

Shark Bay World Heritage Climate Change Workshop

The role of the Shark Bay World Heritage Advisory Committee (SBWHAC) includes providing advice on threats and risks to the World Heritage property's (WHPs) Outstanding Universal Value (OUV) and integrity.

Strategies and actions to minimise the impacts of climate change on the World Heritage values are contained within the *Shark Bay World Heritage Property* (SBWHP) *Strategic Plan 2008-2020*, and for some time the Committee has been exploring options to conduct a workshop to progress these.

The significant negative impacts of the 2010/11 marine heatwave event have been a catalyst to commence planning for a climate change adaptation plan for the WHP to support the ongoing conservation of the Shark Bay WHPs OUV.

The SBWHAC engaged with representatives from the Earth Systems and Climate Change Hub (ESCC) of the National Environmental Science Program (NESP) within CSIRO in Canberra, to collaborate in a workshop which would lay the foundations for developing a climate change adaptation strategy and action plan for the SBWHP.

The overarching goal of the workshop was to develop a climate change strategy for the SBWHP by identifying areas of focus for an adaptation and action plan and to consider the potential for management interventions to control or prepare for change.

The workshop was conducted in mid-September and attended by more than 20 participants from agencies and organisations across Australia who considered how the values and attributes which comprise Shark Bay's OUV will be impacted by a changing climate in future.

A rapid assessment approach was utilised during the workshop, which has been prepared with a view to completing similar assessments in other WHPs. Shark Bay is the first WHP to 'road test' this assessment tool (Climate Change Vulnerability Index – CVI), which provides a method for systematically assessing the vulnerability of specific WH values to climate change impacts, focusing on OUV.

This methodology concentrates on identifying the three most significant climate change stressors to OUV and considers their implications and our ability to prepare and respond. The approach enabled input from a group of scientists and managers who have relevant experience and knowledge of the SBWHP.

Attendees drew on the impacts of the 2011 marine heatwave as an example of extreme climate events which are likely to become more frequent and have significant negative impacts on the local environment.

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Shark Bay World Heritage Advisory Committee

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(Executive Officer)

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The assessment revealed that the acute stressors of marine heatwaves and intense storms, as well as the chronic rise in air temperature, presented the most immediate and significant threats to OUV. These stressors have the potential to tip the balance of biological and physical systems in this unique area.

We witnessed coincident events of marine heatwave and intensive storms in 2011, with the combination of prolonged, elevated temperatures, as well as significant run-off and sediment deposits from flooding due to heavy rainfall, resulting in a substantial dieback of the seagrass meadows, which are a significant contributor to OUV.

Given that the size and integrity of the seagrass banks are a vital component of the complex environment and marine ecosystem of Shark Bay – providing food and shelter to a myriad of organisms and animals - the ESCC is working with the SBWHAC using climate change projections to undertake a case study on the 'Impact of Climate Change on Seagrass in Shark Bay', which will be an important element in the climate change adaptation plans for Shark Bay.

The attached Workshop Summary and Report identifies the key climate change stressors and modifiers and also examines adaptive capacity, OUV vulnerability, knowledge gaps and future actions. The WA Marine Science Institution (WAMSI) will facilitate implementation of the future strategy and also the development of a science plan to support future management of Shark Bay through a changing climate.

Committee members encourage you to take note of the outcomes of the report and look forward to keeping you appraised of, and having your support for, activities that are required to develop and implement a climate change adaptation strategy and plan for the SBWHP.

We would appreciate the opportunity to brief you in person regarding the workshop, its outcomes and plans for future actions.

Yours sincerely

Tom Day
Chair

14 December 2018

cc s47F Natural Heritage Branch, Department of Environment and Energy
Director General, Peter Sharp, Director, Parks and Visitor Services, Midwest Regional Manager, Shark Bay District Manager, Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service
Sue Sargent, Chair, Australian World Heritage Advisory Committee
Simon Woodley, Chair, Ningaloo Coast World Heritage Advisory Committee
Gavin Robins, CEO, Gascoyne Development Commission

MC19-000139

Hon Melissa Price, MP
Federal Minister for the Environment
Parliament House
P O Box 6022
CANBERRA ACT 2601

Min No: MC +1KRD
Division: Link:
DLO: KEA Date: 2/1/19
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Shark Bay World Heritage Advisory Committee

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Yours sincerely

Tom Day
Chair

14 December 2018

cc Hon Stephen Dawson, WA Minister for Environment
s47F Natural Heritage Branch, Department of Environment and Energy
Peter Sharp, Director – Parks and Visitor Services, Midwest Regional Manager, Shark Bay
District Manager, Department of Biodiversity, Conservation and Attractions - Parks and Wildlife Service
Sue Sargent, Chair, Australian World Heritage Advisory Committee
Simon Woodley, Chair, Ningaloo Coast World Heritage Advisory Committee

MC19-002367

Hon Melissa Price, MP
Minister for Environment
House of Representatives
Parliament House
P O Box 6022
CANBERRA ACT 2601

Dear Minister Price

Shark Bay World Heritage Advisory Committee

I am writing to inform you of the activities undertaken and meetings held during 2018 by the Shark Bay World Heritage Advisory Committee (SBWHAC). I also intend writing to the State Minister for the Environment in similar terms.

s22

SHARK BAY
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Shark Bay World Heritage Advisory Committee

Please address all correspondence to:

The Chair
c/- Department of Parks and Wildlife
Shark Bay District Office
Knight Terrace
Denham WA 6537

s47F

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s22

s22

Climate Change Workshop

Resolutions to pursue options and funding avenues for conducting a climate change workshop (to formulate mitigation and adaptation strategies for the preservation of the World Heritage values) were made at Meetings 11 and 12.

In collaboration with the Commonwealth Department of Environment and Energy (DEE), the National Environmental Science Program (NESP) Earth Systems and Climate Change hub (ESCC), CSIRO and s47F from the National Oceanic and Atmospheric Administration (NOAA), a workshop was held in mid-September 2018 with over 20 participants from a broad cross-section of Australian agencies.

Shark Bay was the first World Heritage property to 'road test' the Climate Change Vulnerability Index – CVI, a rapid risk assessment tool which provides a method for systematically assessing the vulnerability of values to climate change.

Focusing on the potential impacts to OUV, the CVI has identified areas for the development of a climate change adaptation and action plan for the Shark Bay World Heritage Property. A Workshop Report and Summary document have been produced by CSIRO.

The ESCC Hub is also working with the SBWHAC to conduct a case study using CSIRO climate change science information to determine and assess the impacts to Shark Bay's seagrass meadows of marine heatwaves and other climate change outcomes. The final draft of this impact assessment should be available in May 2019.

Shark Bay Research Node

In June 2018, The WA Marine Science Institution (WAMSI) coordinated a collaborative workshop to develop a series of actions to address issues associated with ecosystem change in Shark Bay.

The outcome of this, and the recent Climate Change workshop, highlighted a critical need for increased focus on knowledge-based adaptive management to provide greater capacity to adapt and respond to increasing and more frequent environmental changes.

The WAMSI Chief Executive Officer advised there was strong support from scientists and the State Government to establish a Shark Bay research node. In conjunction with the recently endorsed science plan, the WAMSI Board is eager to form a strong collaborative partnership with the SBWHAC which has supported the formation of a research node and nominated members as representatives on the Shark Bay Research Node Steering Committee.

s22

Australian World Heritage Advisory Committee (AWHAC)

The Committee was provided with an update on AWHAC's activities and outcomes from a recent Canberra meeting which included:

- s22
- Adapting to a Climate Change future.

Members discussed these key issues and agreed to support the need for a national World Heritage Climate Change response s22

s22

s22

s22

Should you require any additional information regarding the Committee, its activities or any of the matters raised above, please contact me or the executive officer.

Yours sincerely,

s47F

Tom Day
Chair

22 February 2019

Cc s47F Natural Heritage Branch, Department of Environment and Energy Canberra
Chair, Ningaloo Coast World Heritage Advisory Committee
Chair, Purnululu National Park World Heritage Advisory Committee
DBCA, Parks and Wildlife Service - Director General, Director Parks and Visitor Services, Managers - Midwest Region and Shark Bay District

Attachment 1

Shark Bay World Heritage Advisory Committee Membership

Members	***Member Category***
Tom Day	Chair
Prof Diana Walker	Science/Technical
s47F	Local Community
	Broader Community
	Science/Technical
	Indigenous
	Local Community
Geoffrey Wardle	Local Community
Phillip Scott	Science/Technical
s47F	Broader Community
	Indigenous

Membership as at November 2018

FOI 190505
Document 24

From: s47F
To: s22
Subject: FW: Future directions for the Shark Bay and Ningaloo Coast regional strategies
Date: Monday, 1 April 2019 7:34:50 PM
Attachments: image001.jpg
image002.png
NCWHAC_Submission Future Directions NCRS March 2019.pdf

Hi s22

Please see the attached committee submission in relation to Future Directions for the Ningaloo Coast Regional Strategy Carnarvon the Exmouth, for your reference.

Many thanks

s47F
World Heritage Program Manager
Ningaloo Coast
Department of Biodiversity, Conservation and Attractions
Parks and Wildlife Service | Exmouth District
s47F
wh

DBCA_Signatureblock

United Nations Educational, Scientific and Cultural Organization · Ningaloo Coast inscribed on the World Heritage List in 2011

NINGALOO COAST
WORLD HERITAGE ADVISORY COMMITTEE

Future Directions for the Ningaloo Coast Regional Strategy Carnarvon to Exmouth

Submission by the Ningaloo Coast World Heritage Advisory Committee

This submission addresses the Western Australian Planning Commission's (WAPC) "Future Directions for the Ningaloo Coast Regional Strategy Carnarvon to Exmouth", January 2019.

The Ningaloo Coast World Heritage Advisory Committee was established in 2013 by agreement between the Commonwealth and Western Australia governments. The role of the Committee is to provide advice to managing agencies, State and Federal Ministers on the protection, conservation, presentation and management of the Outstanding Universal Value (OUV) of the Ningaloo Coast World Heritage Area (NCWHA), (as at attachment 1). The Committee addresses activities within and adjacent to the World Heritage area that have the potential to affect the OUV for which the property was listed.

The Ningaloo Coast was inscribed on the World Heritage list in 2011 under the following criteria:

- (vii) superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;

- (x) the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

World Heritage listing creates obligations on the Commonwealth and State governments to ensure that the OUV of the World Heritage property is conserved for existing and future generations. On inscription of a World Heritage property, the World Heritage Committee adopts a "Statement of Outstanding Universal Value (SoOUV), a key reference point for the ongoing protection and management of the property. The NCWHA's SoOUV is at attachment 2.

s22

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201, Exmouth, Western Australia 6707
s47F

s22

s22

s22

Climate change

The forecasts for climate change effects for the NCWHA are for increased extreme events that will have profound implications for planning, human use and natural environments along the coast. The Committee has been commissioned by the State Minister for Environment to provide him with advice on climate change vulnerabilities; and adaptation and communication strategies for the NCWHA. Part of this assessment will include the adequacy of relevant planning regimes in addressing climate change scenarios and strategies for the NCWHA and Ningaloo Coast overall.

The Committee **recommends** that all agencies responsible for land use planning within and adjacent to the NCWHA be required to develop contingency plans and possible scenarios for climate change within local planning and development planning documents. Risks and vulnerabilities should be assessed, and adaptation strategies developed for the communities and areas under planning regimes.

s22

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201 Exmouth Western Australia 6707
s47F

s22

s22

United Nations Educational, Scientific and Cultural Organization

Ningaloo Coast inscribed on the World Heritage List in 2011

NINGALOO COAST
WORLD HERITAGE ADVISORY COMMITTEE

s22

If you would like further information on the Committee's above-mentioned recommendations please contact myself or s47F World Heritage Program Manager, Ningaloo Coast, details below.

Yours sincerely,

s47F

Simon Woodley
Chairperson, Ningaloo Coast World Heritage Advisory Committee
s47F

01 April 2019

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
s47F

References

s22

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201, Exmouth, Western Australia 6707
s47F

Attachment 1

Ningaloo Coast World Heritage Advisory Committee

The Ningaloo Coast World Heritage Advisory Committee was established as a representative stakeholder group in 2013 by agreement between the Commonwealth and Western Australia governments. Membership covers a wide range of expertise and community interest including indigenous heritage, pastoral interests, local government, planning, science, tourism, conservation and industry.

The role of the Ningaloo Coast World Heritage Advisory Committee is to:

- provide advice to the Commonwealth and State Environment Ministers and management agencies on the protection, conservation, presentation and management of the Outstanding Universal Value of the World Heritage area;
- represent the view point of the local and broader community and circulate information on key matters relevant the World Heritage area;
- contribute to enhancing the stewardship and community connection to the World Heritage area;
- develop and provide input into initiatives and opportunities for the promotion and presentation of the Outstanding Universal Value to local, national and international communities; and
- nominate members from the Ningaloo Coast World Heritage Advisory Committee to represent the Committee on the Australian World Heritage Advisory Committee and the Australian World Heritage Indigenous Network.

Ningaloo Coast World Heritage Advisory Committee Membership

Members	Stakeholder Affiliation
Mr Simon Woodley	Chair Scientific research/interests (marine)
s47F	Local community interests
	Broader community interests
	Tourism interests
	Conservation interests
	Scientific/research interests (terrestrial)
	Indigenous interests
	Indigenous interests
	Commerce/industry interests

*As at October 2018

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201, Exmouth, Western Australia 6707
s47F

Attachment 2

On inscription of a property, the WH Committee adopts a "Statement of Outstanding Universal Value which is the key reference point for ongoing protection and management of the property.

Ningaloo Coast World Heritage area 'Statement of Outstanding Universal Value'

Brief synthesis

The Ningaloo Coast is located on Western Australia's remote coast along the East Indian Ocean. The interconnected ocean and arid coast form aesthetically striking landscapes and seascapes. The coastal waters host a major near shore reef system and a directly adjacent limestone karst system and associated habitats and species along an arid coastline. The property holds a high level of terrestrial species endemism and high marine species diversity and abundance. An estimated 300 to 500 whale sharks aggregate annually coinciding with mass coral spawning events and seasonal localized increases in productivity. The marine portion of the nomination contains a high diversity of habitats that includes lagoon, reef, open ocean, the continental slope and the continental shelf. Intertidal systems such as rocky shores, sandy beaches, estuaries, and mangroves are also found within the property. The most dominant marine habitat is the Ningaloo reef, which sustains both tropical and temperate marine fauna and flora, including marine reptiles and mammals.

The main terrestrial feature of the Ningaloo Coast is the extensive karst system and network of underground caves and water courses of the Cape Range. The karst system includes hundreds of separate features such as caves, dolines and subterranean water bodies and supports a rich diversity of highly specialized subterranean species. Above ground, the Cape Range Peninsula belongs to an arid ecoregion recognized for its high levels of species richness and endemism, particularly for birds and reptiles.

Criterion (vii): The landscapes and seascapes of the property are comprised of mostly intact and large-scale marine, coastal and terrestrial environments. The lush and colourful underwater scenery provides a stark and spectacular contrast with the arid and rugged land. The property supports rare and large aggregations of whale sharks (Rhincodon typus) along with important aggregations of other fish species and marine mammals. The aggregations in Ningaloo following the mass coral spawning and seasonal nutrient upwelling cause a peak in productivity that leads approximately 300-500 whale sharks to gather, making this the largest documented aggregation in the world.

Criterion (x): In addition to the remarkable aggregations of whale sharks the Ningaloo Reef harbours a high marine diversity of more than 300 documented coral species, over 700 reef fish species, roughly 650 mollusc species, as well as around 600 crustacean species and more than 1,000 species of marine algae. The high numbers of 155 sponge species and 25 new species of echinoderms add to the significance of the area. On the ecotone, between tropical and temperate waters, the Ningaloo Coast hosts an unusual

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
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s47F

diversity of marine turtle species with an estimated 10,000 nests deposited along the coast annually.

The majority of subterranean species on land, including aquatic species in the flooded caves are rare, taxonomically diverse and not found elsewhere in the southern hemisphere. The combination of relict rainforest fauna and small fully aquatic invertebrates within the same cave system is exceptional. The subterranean fauna of the peninsula is highly diverse and has the highest cave fauna (troglomorphic) diversity in Australia and one of the highest in the world. Above ground, the diversity of reptiles and vascular plants in the drylands is likewise noteworthy.

Integrity

The property is embedded into a comprehensive legal framework for the various protected areas and all other land. As a National Heritage area, it is subject to the federal *Environment Protection and Biodiversity Conservation Act of 1999* (EPBC) according to which all proposed activities with possible significant impacts on the values of the site require assessments. The EPBC is applicable to activities located outside of the boundaries of the property. While no formal buffer zones have been established for the property, the Act therefore serves as a legal buffer zone. The boundaries encompass the key marine and terrestrial values with the exclusions being small in size and not conflicting with the maintenance of the values if managed adequately.

Both the marine and the terrestrial areas may face a number of threats to the property's integrity. Learmonth Air Weapons Range Facility, located within the property, includes an ancient reef-complex and cave fauna of exceptional importance. It was one of Australia's most active bombing ranges until around 1990 and future bombing activities may pose a threat, in particular for the Bundera sinkhole which is located on Defence Land. Tourism is on the increase leading to associated threats such as damage to vegetation, illegal fishing, sewage and waste disposal and disturbance to wildlife. Comprehensive management programs and an overall tourism development strategy are functioning as well as appropriate responses which require consolidation in anticipation of further increasing visitation. Future concerns include increased water demand leading to water abstraction with potential effects on the groundwater systems as well documented in arid areas with abruptly increasing numbers of visitors.

Fire, historically part of local indigenous management, is a potential threat to the terrestrial vegetation and requires monitoring and control. Livestock raising on pastoral leases continues to be an important land use which is compatible with nature conservation when managed appropriately.

Potential off-shore hydrocarbon extraction in the region surrounding the property requires careful consideration in order to prevent potential pollution and disturbance. The coastline's significant length and remoteness poses major challenges to responses to pollution incidents suggesting a need for further investments in emergency response.

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201, Exmouth, Western Australia 6707

Sea level rise and increases in seawater temperatures associated with climate change have had comparatively little effect on the property. The good overall integrity suggests a higher resilience that in disturbed systems under additional stress. Still, careful monitoring is highly recommended.

A concern affecting both marine and terrestrial parts of the property and requiring permanent monitoring and management are invasive alien species, most importantly foxes, cats, goats and weeds on land and some marine species.

Protection and management requirements

The Ningaloo Coast benefits from its remoteness and low population density affording it a high degree of natural protection. The entire, mostly state-owned property is comprehensively protected and managed, including by an overarching strategic management framework. Given the various governmental levels and agencies involved and the differentiation between terrestrial and marine parts of the property, effective coordination of the multiple plans in an overall management framework is critical. Full cooperation between agencies, including fisheries, are necessary to ensure management and law enforcement in the vast and remote marine and terrestrial areas. Funding from federal and state levels and staffing as of the time of inscription would benefit from increases.

There is a need for ongoing management of fisheries and careful planning of resource extraction and corresponding monitoring and disaster preparedness to protect the values of the property.

Communication, consultation and joint efforts with local and indigenous stakeholders, including negotiation of native title claims and pastoral leases, are indispensable elements of effective management and local acceptance of conservation efforts. Given the vastness of the area and the limited human and financial resources, co-management approaches with local stakeholders are a promising option. The establishment of a "Ningaloo Coast World Heritage Advisory Committee" or a similar body bringing together representatives from the traditional owners, local government, scientific experts and members of the community, has an important role to play in this regard.

Tourist numbers are expected to rise which will require additional management efforts. Increased water abstraction, including from demand from increased tourism, may affect fragile subterranean aquatic habitats and species communities will require constant monitoring and management.

Ningaloo Coast World Heritage Advisory Committee
The Chair
c/- Parks and Wildlife Service - Exmouth Office
Department of Biodiversity, Conservation and Attractions
PO Box 201, Exmouth, Western Australia 6707
s47F

s22

From: Leslie Shirreffs s47F
Sent: Tuesday, 16 April 2019 7:11 AM
To: Stephen Oxley s22
Cc: David Williams s22 ; 'BUCHANAN Scott'
s22

Subject: RE: URGENT & EMERGENT ISSUE: Climate change impacts on Wet Tropics World Heritage values

Sorry to hear that Stephen. I'll talk to the team this afternoon at 4pm (if you manage to get your IT sorted). Otherwise happy to discuss with you whenever you can/when you're back.
Best regards
Leslie

From: Stephen Oxley s22
Sent: Tuesday, 16 April 2019 2:03 AM
To: Leslie Shirreffs
Cc: David Williams; BUCHANAN Scott; s22
Subject: Re: URGENT & EMERGENT ISSUE: Climate change impacts on Wet Tropics World Heritage values

Hi Leslie

I have some serious IT problems, so you will be best to stick with the already arranged briefing with the team. Sorry.

Stephen

Sent from my iPad

On 15 Apr 2019, at 9:13 AM, Leslie Shirreffs s47F wrote:

> Hi Stephen,
> We had scheduled 2:30pm with David and s22 , but 4pm would suit if all others can shift too.
> Regards
> Leslie
>
> Sent from my iPad
>
> On 15 Apr 2019, at 4:15 pm, Stephen Oxley s22 wrote:

Hi Leslie

I am in Paris for a World Heritage Committee working group meeting this week. I would be able to talk by phone at around 4pm your time tomorrow (8am here). I would want relevant Canberra staff hooked in.

Cheers

Stephen

Sent from my iPhone

On 15 Apr 2019, at 4:22 am, Leslie Shirreffs s47F wrote:

> Dear Stephen
> As you know, we held a WTMA Board out of session teleconference late on Friday afternoon to discuss a response to the most recent, concerning evidence of climate impacts on the Wet Tropics World Heritage Area.
> Over the weekend we developed a response plan, and before we get that underway, I appreciate the opportunity to brief you (and your team if you wish) about our proposed way forward.
>
> Would you be available sometime tomorrow morning (or afternoon if needed) for a telephone discussion. I'm happy for early or late – recognizing you probably have a full calendar – should only take 15-20 minutes.
> Best regards
> Leslie
>
> Leslie Shirreffs PSM
> Chair, Wet Tropics Management Authority
> s47F

From: Stephen Oxley
s22
Sent: Wednesday, 10 April 2019 9:10 AM
To: 'BUCHANAN Scott'; s22
Cc: Leslie Shirreffs s47F ; David Williams
Subject: RE: URGENT & EMERGENT ISSUE: Climate change impacts on Wet Tropics World Heritage values [SEC=OFFICIAL]

Gidday Scott

Thanks for the heads-up about how the WETMA Board will be addressing this perplexing issue.

The Department would be very pleased to receive a briefing following the Board's meeting.

Cheers

Stephen

From: BUCHANAN Scott
s22
Sent: Tuesday, 9 April 2019 1:30 PM
To: s22
Stephen Oxley s22
Cc: Leslie Shirreffs s47F
s47F
Subject: URGENT & EMERGENT ISSUE: Climate change impacts on Wet Tropics World Heritage values

Dear Stephen, s22
I would like to alert you to an emerging issue that could have significant ramifications for the Wet Tropics World Heritage Area. The Board of the Wet Tropics Management Authority have consistently raised concerns about the impacts of climate change on the Wet Tropics World Heritage Area, and recent information indicates that the trends are worsening and that we are likely to see localised extinctions from some habitats in the very near future. At one particular site (previously a stronghold habitat within National Park estate), there are predictions of localised extinction of Lemuroid Possums by 2022. There are comparable results for Herbert River and Green ringtail possums as well.

Though we are currently developing a Climate Adaptation Plan for the area, the types of actions required to manage this issue are approaching the drastic stage.

The Board of the Wet Tropics Management Authority will see it as their role to bring the plight of the property to a broader audience. The Board will argue that the Government will need to make investments to deliver on

key actions such as:

- Land restoration;
- Re-initiate monitoring to increase understanding of potential refugia;
- In depth assessment of possible measures, examples could include genetic analyses or potential for ex-situ measures;
- A call for action on reducing global emissions.

The Board will be meeting this Friday to discuss strategies on how to progress this. The Chair Leslie Shirreffs will be seeking to brief the Minister's office after this extraordinary meeting.

It should be noted that the information I provide below has been shared with other groups (by the Scientist carrying out the research) so is likely to become public knowledge at some point.

Background:

- The 2015-16 State of the Wet Tropics Report focused on assessing the state of the ancient, endemic, rare and threatened vertebrates of the Wet Tropics.
- The Report identified that the most significant threat to the region was climate change.
- Based on long term monitoring, the Report indicated that the biodiversity of the World Heritage Area is declining with many vertebrate species already reduced in both distribution and population size. This decline was largely based on climate change impacts.
- This long term monitoring was used to inform a predictive model to ascertain species viability to climate change.
- Individual species modelling can correlate decreases in population based on temperature change.

Issues:

- Professor Steven Williams, one of the key contributors to the Report, has recently carried out limited ring tail possum monitoring to ascertain trends since the long term monitoring ceased in 2016.
- Prof Williams gave a briefing to some WTMA and QPWS staff on his monitoring results that gave

some alarming indications about massive species declines in upland endemics in the face of a changing climate.

- Essentially, 15 years of data has confirmed the consistent decline of endemic possum (and bird) species - a 10 year model using some 400,000 data points predicted a 60% loss of species, and, as Steve said, this is exactly what we've got.
- Following the hottest summer ever by a substantial amount, he is predicting localised extinction of Lemuroids at their most abundant site by 2022. This species is currently not even listed as endangered. He is finding comparable results for Herbert River and Green ringtails, and with bird species, like the Tooth-billed Bowerbird.
- He says it is now happening faster than earlier models, and this has significant challenges for the very things for which the Area is World Heritage listed, and, consequently, for our obligation to uphold the Convention.
- The Board of the Wet Tropics Management Authority has raised this emerging issue to current and previous relevant Ministers on a number of occasions.
- The implications of allowing this situation to worsen risks the Wet Tropics World Heritage Area drawing the interest of the World Heritage Committee as a potential in danger listing.
- The areas in question are protected areas, so the management regime is currently high.

As I said above, the Board will be meeting to discuss this on Friday afternoon and the Chair will be looking to brief the Minister's office quite soon after this. Please advise if you would like more information from me on this issue.

Regards

Scott

Scott Buchanan | Executive Director
Wet Tropics Management Authority

s22

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