Nature and extent of likely impact

Address any impacts on the members of any listed migratory species, or their habitat.

Potential impacts to EPBC listed Migratory or Marine birds from the proposed LHI REP include:

- Primary poisoning from consumption of bait pellets
- Secondary poisoning from consumption of poisoned rodents or invertebrates
- Disturbance as a result of helicopter activities.

Any potential impacts are likely to be very localised and temporary in nature.

Risks to non-target bird species during an eradication program are a function of the species present on the island group and their behaviour, susceptibility of those species present to the poison, composition and delivery method of the bait and the probability of exposure to the poison either directly or indirectly.

Many of the records for EPBC listed Migratory or Marine bird species on the LHIG refer to species that rarely visit the island group and such visits typically involve only a small number of individuals. These are considered vagrants, rare or irregular visitors. Even if the proposed baiting constituted a real threat to these individuals, no viable local population of the species is likely to be placed at risk by the proposed action. In most cases the low overall number of individuals involved, their diet or the small possibility that they will be in the vicinity during the baiting operation means that while some individuals may be at risk it is not possible for there to be any impact at a population level from the eradication. Assessment of risk to these species is detailed in the table below.

During the trial conducted on LHI, some ants, slugs, cockroaches and snails (not Placostylus) were observed feeding on baits (LHIB, 2007). For each of these groups only a small proportion of individuals had consumed bait; consequently it is unlikely that any of the birds on LHI will consume contaminated invertebrates exclusively to the point where there is a risk of secondary poisoning from insects.

The risk of collision with helicopter to the several seabird species that will be present during the baiting will be reduced by taking advantage of the diurnal movements of seabirds. In this way sections of LHI will be baited when those birds are foraging at sea and away from their roosting grounds. To reduce disturbance to those species that are present throughout the day, baiting height for the helicopters will be set at an altitude that does not unduly disturb roosting or nesting birds.

Table 12: Significant Impacts to EPBC Listed Migratory Birds

Species	**EPBC Act Status**	**Significant Impact from the LHI REP**
Migratory Marine Birds and Migratory Wetland Birds		
Bar-tailed Godwit *Limosa lapponica*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait.
Black-browed Albatross *Diomedea melanophris*	V, Mi, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
Black-naped Tern	Mi, Ma	No. Species unlikely to be present

Sterna sumatrana		
Black-tailed Godwit *Limosa limosa*	Mi, Ma	No. Species unlikely to be present
Black-winged Petrel *Pterodroma nigripennis*	Ma	No. Species unlikely to be present
Brown Booby *Sula leucogaster*	Mi, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
Brown Noddy *Anous stolidus*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait. Helicopters flying baiting transects over noddy roosting-sites may cause birds to take to the wing, and so endanger themselves and the flight crews, however this can be avoided by flying transects when the birds are at sea foraging, avoiding early in the morning or late in the afternoon.
Buff-breasted Sandpiper *Tryngites subruficollis*	Mi, Ma	No. Species unlikely to be present
Bullers Albatross *Thalassarche bulleri*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.
Campbell Albatross *Thalassarche melanophris impavida*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.
Caspian Tern *Sterna caspia*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait.
Cattle Egret *Ardea ibis*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait.
Chatham Albatross *Thalassarche eremita*	E, Mi, Ma	No. Known to forage in the area but unlikely to have exposure to bait.
Common Greenshank *Tringa nebularia*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait.
Common Sandpiper *Tringa hypoleucos*	Mi, Ma	No. Species unlikely to be present.
Common Tern *Sterna hirundo*	Mi, Ma	No. Species unlikely to be present.

Curlew Sandpiper *Calidris ferruginea*	CE, Ma, Mi	No. May be small number present but unlikely to have significant exposure to bait.
Double-banded Plover *Charadrius bicinctus*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Eastern Curlew *Numenius madagascariensis*	CE, Mi, Ma	No. Species unlikely to be present.
Eastern Great Egret *Ardea modesta*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Eastern Reef Egret *Egretta sacra*	Ma	No. Species unlikely to be present.
Flesh-footed Shearwater *Ardenna carneipes*	Mi, Ma	No. Unlikely to have significant exposure to bait.
Fork-tailed Swift *Apus pacificus*	Mi, Ma	No. Species unlikely to be present.
Glossy Ibis *Plegadis falcinellus*	Mi, Ma	No. Species unlikely to be present.
Gould's Petrel *Pterodroma leucoptera*	E, Ma	No. Species unlikely to be present.
Great Knot *Calidris tenuirostris*	Mi, Ma	No. Species unlikely to be present.
Greater Sand Plover *Charadrius leschenaultii*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Grey Plover *Pluvialis squatarola*	Mi, Ma	No. Species unlikely to be present.
Grey-tailed Tattler *Heteroscelus brevipes*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Grey Ternlet *Procelsterna cerulea*	Ma	No. Unlikely to have significant exposure to bait. Birds may be disturbed from the nest sites by over-flying helicopters but, unless baiting takes place in September (the month when egg laying starts), this limited disturbance is unlikely to significantly affect breeding. Impacted by rodents so

		eradication will benefit them and most likely lead to increased breeding success on main island.
Latham's Snipe *Gallinago hardwickii*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Least or Lesser Frigatebird *Fregata ariel*	Mi, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
Lesser Sand Plover *Charadrius mongolus*	Mi, Ma	No. Species unlikely to be present.
Little Curlew *Numenius minutus*	Mi, Ma	No. Species unlikely to be present.
Little Shearwater *Puffinus assimilis*	Ma	No. Unlikely to have exposure to bait. The birds feed at sea, departing before sunrise and returning after sunset to feed their young. As the adults are away from the island during daylight hours, it is very unlikely that any will be hit by the baiting helicopter. Collisions will be avoided by elevated helicopter heights and timing operations around masked booby areas for mid morning. Rodents are restricting the capacity of this species to recolonise the main island. The species is expected to benefit from the eradication.
Little Tern *Sternula albifrons*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Long-tailed Jaeger *Stercorarius pomarinus*	Mi, Ma	No. Species unlikely to be present.
Marsh Sandpiper *Tringa stagnatilis*	Mi, Ma	No. Species unlikely to be present.
Masked Booby *Sula dactylatra tasmani*	Mi, Ma	No. Unlikely to have exposure to bait. The birds feed at sea, departing before sunrise and returning up until dark to feed their young. As the adults are away from the island during daylight hours, it is very unlikely that any will be hit by the baiting helicopter. Any individuals sitting on eggs are unlikely to be disturbed by helicopter operations.
Northern Giant Petrel *Macronectes halli*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.
Northern Royal Albatross *Diomedea epomophora sanfordi*	E, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.

Oriental Cuckoo *Cuculus saturatus*	Mi, Ma	No. Species unlikely to be present.
Oriental Plover *Charadrius veredus*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Oriental Pratincole *Glareola maldivarum*	Mi, Ma	No. Species unlikely to be present.
Pacific Golden Plover *Pluvialis fulva*	Mi, Ma	No. May be small number present but unlikely to have significant exposure to bait.
Painted Snipe *Rostratula benghalensis*	E, Mi	No. Species unlikely to be present.
Pectoral Sandpiper *Calidris melanotos*	Mi, Ma	No. May be very small number present but unlikely to have significant exposure to bait.
Providence Petrel *Pterodroma solandri*	Mi, Ma	No. Helicopter operations around Providence Petrel areas will be timed to occur when the majority of birds are feeding at sea (mid morning). Some non breeding birds will be present during the day therefore there is the possibility of collision with low-flying helicopters dropping bait. This will be mitigated as much as possible through pilot education and vigilance. Unlikely that significant disruption to breeding cycle or population level impacts will occur.
Rainbow Bee-eater *Merops ornatus*	Mi, Ma	No. Species unlikely to be present.
Red Knot *Calidris canutus*	Mi, Ma	No. Species unlikely to be present in significant numbers
Red-footed Booby *Sula sula*	Mi, Ma	No. Species unlikely to be present.
Red-necked Stint *Calidris ruficollis*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Red-tailed Tropicbird *Phaethon rubricauda*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Ruddy Turnstone *Arenaria interpres*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait
Salvin's Albatross	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.

Thalassarche cauta salvini		
Sooty Tern *Onychoprion fuscata*	Ma	No. Unlikely to have exposure to bait. Small risk of collision with helicopter if baiting extends into late September, mitigated by appropriate altitude and vigilance.
Sharp-tailed Sandpiper *Calidris acuminata*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Short-tailed Shearwater *Puffinus tenuirostris*	Mi, Ma	No. Species unlikely to be present.
Shy Albatross *Thalassarche cauta cauta*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.
Sooty Shearwater *Puffinus griseus*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Southern Giant Petrel *Macronectes giganteus*	E, Mi, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
Southern Royal Albatross *Diomedea epomophora epomophora*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait.
Swift Parrot *Lathamus discolor*	E, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
Terek Sandpiper *Xenus cinereus*	Mi, Ma	No. Species unlikely to be present.
Wandering or Snowy Albatross *Diomedea exulans* (sensu lato) Amsterdam Albatross *Diomedea amsterdamensis* Antipodean Albatross *Diomedea antipodensis* Tristan Albatross *Diomedea dabbenena* Gibson's Albatross *Diomedea antipodensis gibsoni*	V, Mi, Ma	No. Species unlikely to be present and unlikely to have exposure to bait
Wandering Tattler *Tringa incana*	Mi, Ma	No. Species unlikely to be present.
Wedge-tailed Shearwater	Mi, Ma	No. Unlikely to be present in significant numbers and unlikely to have exposure to bait. Any birds in the area will be feeding at sea, departing

Puffinus pacificus		before sunrise and returning up until after dark sunset and it is very unlikely that any will be hit by the baiting helicopter. Rodent eradication will benefit breeding success.
Westland Petrel *Procellaria westlandica*	Mi, Ma	No. Species unlikely to be present.
Whimbrel *Numenius phaeopus*	Mi, Ma	No. Species unlikely to be present in significant numbers.
Whiskered Tern *Chlidonias leucoptera*	Mi, Ma	No. Species unlikely to be present.
White-bellied Storm-petrel *Fregetta grallaria*	V, Ma	No. Species unlikely to be present and unlikely to have exposure to bait.
White-capped Albatross *Thalassarche cauta steadi*	V, Mi	No. Species unlikely to be present and unlikely to have exposure to bait. Will benefit from rodent eradication as a result of the potential to recolonise main island for nesting.
White-tailed Tropicbird *Phaethon lepturus*	Mi, Ma	No. Species unlikely to be present.
White Tern *Gygis alba*	Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait
White-throated Needletail *Hirundapus caudacutus*	Mi, Ma	No. Species unlikely to be present in significant numbers and unlikely to have exposure to bait
White-winged Black Tern *Chlidonias leucopterus*	Mi, Ma	No. Species unlikely to be present.
Wilson's Storm- petrel *Oceanites oceanicus*	Mi, Ma	No. Species unlikely to be present.

Potential Impacts to Migratory Marine Species (Fish, Sharks, Whales and Turtles)

Potential impacts to Listed migratory marine species are limited to accidental bait entry into the water (either through aerial distribution or a spill) leading to pollution of water, primary or secondary poisoning. Any potential impacts are likely to be very localised and temporary in nature.

Pollution of marine water resulting in impacts to threatened marine species is considered extremely unlikely considering the minimal amount of bait likely to enter the water, the insolubility of Brodifacoum and the huge dilution factor.

Fish, rays and sharks are unlikely to have sufficient exposure to the bait to have a significant impact at an individual level and certainly not at a population level.

There is no realistic pathway by which marine mammals can be significantly exposed to rodenticide at the LHIG as a result of the proposed aerial baiting with Pestoff® 20R. The combination of Brodifacoum being practically insoluble in water, the infinitesimal amount of Brodifacoum that may land in the sea and the huge dilution factor preclude any significant effect upon marine mammals. Marine mammal species are also rare visitors to LHI waters, passing through on the annual migration and are therefore unlikely to encounter the bait.

It is very unlikely that Green Turtles *Chelonia mydas* could be exposed to rodenticides by consuming baits directly or prey items that have ingested rodenticides. Adult Green Turtles feed exclusively on various species of seagrass and seaweed. Plants have not been documented to take up and store anticoagulants, therefore no effect on adult Green Turtles is expected to occur from ingestion of rodenticide in their food.

Juvenile Green Turtles and the other four species of turtle (Flatback Turtle *Natator depressus*, Hawksbill Turtle *Eretmochelys imbricata*, Leatherback Turtle *Dermochelys coriacea* and Loggerhead Turtle *Caretta caretta*) that may be encountered in the marine park are carnivorous, and will eat soft corals, shellfish, crabs, sea urchins and jellyfish. However, it is unlikely that these turtles will encounter marine invertebrates that may have been contaminated with Brodifacoum as a result of aerial baiting the LHIG with Pestoff® 20R. The mitigation techniques that will be used to minimise bait going into the lagoon i.e. hand baiting of the foreshore and use of a deflector on the bucket will minimise access to bait in that area. Evidence against the existence of a significant dietary exposure pathway for invertebrates is outlined in section 3.1 f).

No turtle nesting occurs on the LHIG.

In summary, the proposed baiting of LHI does not pose a threat to listed marine life (Cetaceans, turtles, fish or sharks) because:

- The use of specialised equipment on the bait hopper will ensure minimal bait entry to the water. The amount of bait that may bounce off the cliffs to fall into the sea will be minimal (Howald *et al.* 2005; Samaniego-Herrera *et al.* 2009);
- The breakdown of baits that do land in the sea will be rapid (Empson and Miskelly 1999), therefore the opportunity for fish to take baits will be limited;
- Fish have shown a lack of interest in baits (Samaniego-Herrera *et al.* 2009, U.S. Fish and Wildlife Service and Hawai'i Department of Land and Natural Resources 2008), so it is unlikely that many fish will take baits;
- The possible death of those few fish that find and eat enough baits to prove fatal does not pose a threat at the population level;
- Baiting other islands using similar methods, although sometimes using significantly more bait, has not resulted in adverse effects on the marine environment
- Any potential impacts are likely to be very localised and temporary in nature.

Further details regarding potential impacts to the marine environment are provided in Section 3.1 f).

Table 13: Significant Impacts to EPBC Listed Migratory Marine Animals

Species	**EPBC Act Status**	**Significant Impact from the LHI REP**
Antarctic Minke Whale *Balaenoptera bonaerensis*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Brysdes Whale *Balaenoptera edeni*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Blue Whale *Balaenoptera musculus*	E, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Pygmy right whale *Caperea margniata*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait
Great White Shark *Carcharodon carcharias*	V, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Loggerhead Turtle *Caretta caretta*	E, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Green Turtle *Chelonia mydas*	V, Mi	No. Unlikely to have sufficient exposure to bait.

Leatherback Turtle *Dermochelys coriacea*	E, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Hawksbill Turtle *Eretmochelys imbricata*	V, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Southern Right Whale *Eubalaena australis*	E, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Dusky Dolphin *Lagenorhynchus obscurus*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait
Mackeral Shark *Lamna Nasus*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait
Reef Manta Ray *Manta alfredi*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Giant Manta ray *Manta birostris*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Humpback Whale *Megaptera novaeangliae*	V, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Flatback Turtle *Natator depressus*	V, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Killer Whale *Orcinus Orca*	Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.
Sperm Whale Physeter macrocephalus	V, Mi	No. Species unlikely to be present or present in small numbers. Unlikely to have sufficient exposure to bait.

3.1 (f) Commonwealth marine area

(If the action is <u>in</u> the Commonwealth marine area, complete 3.2(c) instead. This section is for actions taken outside the Commonwealth marine area that may have impacts on that area.)

Description

Ocean waters from the high water mark to three nautical miles offshore from Lord Howe Island (including the Admiralty Islands and Balls Pyramid) form part of the state of NSW and are protected under the approximately 47,000 hectare NSW Lord Howe Island Marine Park, declared in 1999 (see attachment 1.3).

The Australian Economic Exclusion Zone and Territorial Sea commence three nautical miles from shore of the LHIG, extending 200 nautical miles. The recently declared 110,000km^2 Lord Howe Commonwealth Marine Reserve (replacing the former 3,000km^2 Lord Howe Island Marine Park (Commonwealth Waters)) also commences three nautical miles from the high water mark of the LHIG (see Attachment 1.4). Transitional management arrangements were in place however no operational changes were yet in effect.

It is difficult to distinguish the values of the NSW Lord Howe Island Marine Park from the Lord Howe Commonwealth Marine Reserve so a summary of value is presented below.

The waters of Lord Howe Island are renowned for their clarity, relatively high coral and algae cover. The island supports the southernmost barrier coral reef and associated lagoon in the world, differing considerably from more northerly warm water reefs. It also provides a rare example of the transition between coral and algal reefs due to movement of tropical and temperate water around the Island (known as the Tasman Front). This front forms where the eastward flow of the warm East Australian Current meets the waters of the southern temperate Tasman Current (Environment Australia, 2002).

The fringing coral reef and associated sheltered lagoon, open coast, near shore rocky reefs, sandy beaches, mid-shelf reefs, intertidal reefs, seagrass beds, mangroves, unconsolidated shelf habitats, rugged seamount shelves and slopes, pelagic waters shallow inshore lagoons, and the steep drop offs to deep ocean create a diverse topography that maximises exposure to ocean currents from all directions and thus the potential for high biodiversity (Environment Australia, 2002). Tropical species tend to dominate in terms of total species counts, although temperate animals and plants dominate in terms of abundance and biomass (Marine Parks Authority 2010b). A number of EPBC listed species are recorded within Lord Howe Island waters. These are discussed in previous sections of this referral.

Examples of World Heritage values of the Lord Howe Island Group specific to the marine environment (Environment Australia, 2002) include:

- the unusual combination of tropical and temperate taxa of marine flora and fauna, including many species at their distributional limits, reflecting the extreme latitude of the coral reef ecosystems which comprise the southernmost true coral reef in the world;
- the diversity of marine benthic algae species, including at over 300 species of which 12 per cent are endemic
- the diversity of marine fish species, including 447 species of which 400 are inshore species and 15 are endemic; and
- the diversity of marine invertebrate species, including more than 83 species of corals and 65 species of echinoderms of which 70 per cent are tropical, 24 per cent are temperate and 6 per cent are endemic (Environment Australia, 2002)

Limited information is available on the productivity and ecological importance of the flora, fauna or communities of the deeper shelf waters other than to note that they are clearly unique (Environment Australia, 2002).

The seamount areas appear to be isolated marine systems and that low species overlap between different seamounts in the region leads to highly localised species distributions that are exceptional for the deep sea. (Environment Australia, 2002)

Fish

Lord Howe Island supports a diverse fish fauna, with 447 species and 107 families recorded the Island. There are 47 species of wrasse, 25 of damselfish, 23 gobies and 22 coralfish. Butterfly cod, parrot fish, painted morwong and the doubleheader are commonly found in the lagoon (Environment Australia, 2002). The deep-water pelagics known through fishing activities include marlin (blue and striped), sharks (Galapagos, whalers, some tigers, whites and makos), sailfish, dolphin fish, yellowfin tuna, wahoo, trevally, bonito, yellow-tail kingfish and spangled emperor.

Corals, Invertebrates and Echinoderms

Coral and echinoderm species found at Lord Howe Island include common and widespread tropical forms which also occur on the Great Barrier Reef, as well as tropical species at their southern limits of distribution and subtropical species which are rare or absent from the Great Barrier Reef.

There are at least 83 species from 33 genera in 11 families; this represents relatively high diversity considering the Islands' latitude and isolation from other major coral communities. More than 65 species of echinoderms, made up of 70 per cent

tropical species, 24 per cent temperate species and 6 per cent endemic species, have also been recorded (Environment Australia, 2002).
Mobile invertebrates are highly diverse, with more than 1,500 species of molluscs (snails and shellfish) likely to occur in the park, in addition to at least 110 species of echinoderms (Hoggett and Rowe 1988), and 70 species of crustaceans (Marine Parks Authority 2010b).

Whilst there is limited information available on deep-water invertebrates offshore from the Lord Howe Island group, it is believed that the shelves had a high conservation value due to their relatively pristine state compared to other Australian shelves and the high endemicity of the Island's fauna (Environment Australia, 2002).

Algae
Algae form one of the most striking features of the marine habitat within the Lord Howe Island area. For its size, the Island is one of the richest localities for green macroalgae. Lord Howe Island is also particularly important because it sits at the extreme latitudinal limit of many green algal species and genera. It holds the world's highest latitude populations of many species. There are 174 species of red algae, 68 species of brown algae and 76 species of green algae, which include at least 47 (15%) endemic species. The close proximity of temperate macroalgal and tropical coral community species is considered to be unique globally (Marine Parks Authority 2010b).

Marine Mammals
The bottlenose dolphin *Tursiops truncates* is common in Lord Howe Island waters. Migratory dolphins, such as the spinner dolphin, the dusky dolphin and pan tropical spotted dolphin, may pass through. The marine park is in the migratory pathways of species such as the humpback whale *Megaptera novaeangliae*. Other whale species recorded around Lord Howe Island include the sperm whale *Physeter macrocephalus*, pilot whales *Globicephala* sp. and the dense-beaked whale *Mesoplodon densirostris* (Marine Parks Authority 2010b).

Reptiles
Marine reptiles in the park consist of turtles and sea snakes. At least four species of turtle (green, hawksbill, leatherback and logger head have been recorded (Marine Parks Authority 2010). There are no recent records of turtles nesting on the islands of the park. 11 species of sea snake including the yellow-bellied sea snake have been recorded (Marine Parks Authority 2010b).

Birds
Sea birds are described above in sections 3.1 d) and e).

Cultural Heritage
The marine environment has contributed significantly to the cultural heritage value of the LHIG through the first reported sighting European sighting and subsequent claiming as a British possession in 1788, to visiting ships of the First, Second and Third Fleets to whaling, early settlement, trading and provisioning, scientific expedition, and the kentia palm and tourism industries. In addition it is believed that several ships have been lost in the Lord Howe area, including six believed to have been lost in the vicinity of Lord Howe Island however no shipwrecks have been located. Lost ships include the Wolf, wrecked in 1837, the Zeno, wrecked in 1895, Maelgyn, lost in 1907, and the Laura, wrecked in 1913. Another important part of the island's history is the era of the flying boat service, planes that were used for transport to the island from Sydney. Aircraft wreckage of some of these planes is known to be submerged in the deeper waters of the island.

The marine environment continues to be of primary importance to LHI residents and the local economy through recreation, food security and tourism and trade. The local fishing charter operators sell their catch to restaurants and visitors on the island.

Key tourism activities in the NSW and Commonwealth Marine Parks include beach and reef walking, swimming, snorkelling, scuba diving, fish feeding, surfing, underwater photography, windsurfing, sea-kayaking, fishing, sightseeing cruises and eco tours, and other water sports and beach activities

Nature and extent of likely impact

Address any impacts on any part of the environment in the Commonwealth marine area.

Potential impacts to the Commonwealth marine environment and the Lord Howe Commonwealth Marine Reserve from the proposed LHI REP are limited to:

- accidental bait entry into the water (either through aerial distribution or a spill) leading to:
    - pollution of water
    - primary or secondary poisoning of fish, marine mammals, marine reptiles, marine invertebrates or sea birds that inhabit or transit through the Lord Howe Commonwealth Marine Reserve.

Any potential impacts are likely to be very localised and temporary in nature.

As no underwater operations will occur, no impacts are expected to marine cultural heritage values.

Pollution of water

The fate of the Pestoff bait pellet and the toxin Brodifacoum in the marine environment is described in Section 2.1 above.

As mentioned previously, the application rate of Pestoff 20R over the LHIG group will be two applications (14- 21 days apart); 12/kg/ha and 8kg/ha giving a total application rate of 20kg/ha of Pestoff 20R pellets. For simplicity this can be considered a single application. At 20mg/kg Brodifacoum concentration this will result in application of 0.4g/ha of Brodifacoum. In the marine and aquatic environment, the dosage rate of 0.4 g/ha Brodifacoum equates to 0.4 g /1.5ML (1 ha of water 15cm deep) or 0.2ug/L in the worst case scenario. This worst case scenario assumes that the entire 20kg/ha (i.e. all of the bait from coastal swaths in both bait drops) ends up in the water. This is considered highly unlikely considering Howald *et al*. (2005) showed that when baits were applied aerially to steep cliffs, (application rate of 15kg/ha) a mean of only 72 baits over 500 m stretch of coast (~2ha) ended up in the water. This would equate to less than 0.5% out of the approximate 15,000 baits applied over that area ended up in the sea. Using a similar percentage of bait that could bounce off the cliffs and ended up in the sea in the LHI REP situation, a more likely predicted environmental concentration in the marine environment would be in the order of 0.01ug/L. This concentration would still be three nautical miles from the Commonwealth marine environment.

It is possible for marine organisms to absorb Brodifacoum through their gills or skin (Empson and Miskelly 1999), and Brodifacoum is considered to be toxic to aquatic organisms, but at concentrations in their environment many orders of magnitude greater than those that could be associated with the small amount of bait that may be deposited in the sea as the result of rodent baiting operations conducted on nearby land. Even the 0.2ug/L in the worst case scenario described above is still orders of magnitude below the known Lethal Concentrations (LC) for the most sensitive marine species. LC, referring to the concentration of a chemical in a medium such as air or water, is the measure of the toxicity of that chemical to a particular test subject. Typically it is defined as LC_{50} for exposure for a certain amount of time; the 50 indicating the concentration likely to kill 50% of those organisms exposed to it.

Table 14: Lethal Concentrations (Lc50 Mg/L) of Brodifacoum for a Range of Fish and Aquatic Invertebrates (from Broome *et al*, 2016)

SPECIES	LC50 mg/L	REFERENCES
Fish	Range: 0.02 - >10.0 mg/L	
Bluegill sunfish (*Lepomis macrochirus*)	0.12 (96-hour LC50)	USEPA (2005)
	0.165 (96-hour LC50)	Eason & Wickstrom (2001)
Crucian Carp (*Carassius carassius*)	>10.0 (24 hour LC50)	USEPA (2005)
	>10.0 (48 hour LC50)	USEPA (2005)
	1.0 (72 hour LC50)	USEPA (2005)
	1.0 (96 hour LC50)	USEPA (2005)
	1.0 (7 day LC50)	USEPA (2005)
	1.0 (14 day LC50)	USEPA (2005)

	0.1 (21 day LC50)	USEPA (2005)
Common carp (*Cyprina carpio*)	>10.0 (24 hour LC50)	USEPA (2005)
	>10.0 (48 hour LC50)	USEPA (2005)
	1 (72 hour LC50)	USEPA (2005)
	1 (96 hour LC50)	USEPA (2005)
Cyprinid (*Leucaspius delineatus*)	>10.0 (24 hour LC50)	USEPA (2005)
	>10.0 (48 hour LC50)	USEPA (2005)
	1.0 (72 hour LC50)	USEPA (2005)
	1.0 (96 hour LC50)	USEPA (2005)
	1.0 (7 day LC50)	USEPA (2005)
	0.1 (14 day LC50)	USEPA (2005)
	0.1 (21 day LC50)	USEPA (2005)
Rainbow trout (*Oncorhynchus mykiss*)	0.155 (24-hour LC50)	Eason & Wickstrom (2001)
	0.051 (96 hour LC50)	Eason & Wickstrom (2001)
	0.02 (96 hour LC50)	USEPA (2005)
	0.025 (96 hour LC50)	USEPA (2005)
	0.04 (96 hour LC50)	(Anonymous 2009)
Tench (*Tinca tinca*)	>10.0 (24 hour LC50)	USEPA (2005)
	>10.0 (48 hour LC50)	USEPA (2005)
	1.0 (72 hour LC50)	USEPA (2005)
	1.0 (96 hour LC50)	USEPA (2005)
	1.0 (7 day LC50)	USEPA (2005)
	0.1 (14 day LC50)	USEPA (2005)
	0.1 (21 day LC50)	USEPA (2005)
Aquatic Invertebrates	Range: 0.34 - >10.0 mg/L	
Daphnia (*Daphnia magna*) 1st instar	1.0 (24 hour LC50)	Eason & Wickstrom (2001)
	0.34 (48 hour LC50)	Eason & Wickstrom (2001)
Adult	0.98 (48 hour LC50)	USEPA (2005)
Tubificid worm (*Tubifex tubifex*)	>10.0 (24 hr LC50)	USEPA (2005)

	>10.0 (48 hr LC50)	USEPA (2005)
	>10.0 (72 hr LC50)	USEPA (2005)
	1.0 (96 hr LC50)	USEPA (2005)
Mosquito larvae (*Aedes aegypti*)	8.23 (24hr LC50)	Jung & Moon (2011)

The accidental spillage of 360g of Brodifacoum into the sea in New Zealand from a single-point discharge of 18 tonnes of bait was not associated with any long-term adverse effects on the marine environment (see Section 7-2.3.3). This incident represents an extreme example of Brodifacoum contamination. Although 18 tonnes of bait, almost half the total proposed to be applied to the whole of the LHIG, was deposited into the sea at one point, the overall effect was small and localised (Primus *et al.* 2005). There were no report of damage to the surrounding reefs (Primus *et al*. 2005), and what effect there was on the local marine life was limited in extent and transient (*ibid*). Although it is possible that, as a consequence of the aerial baiting of the LHG, some pellets will land in the ocean, the number of such pellets will be small. In an aerial baiting programme conducted on a U.S. island where baits were dispersed at a higher application rate then that proposed for the LHG, the average number of pellets landing per 500 metres of coastline was only 72 (Howald *et al*. 2005). If nine million pellets deposited at one point resulted in a limited and transient effect on the marine environment within a 100 metres of the spill-site (Primus *et al.* 2005) then, intuitively, 14 pellets in 100 metres (Howald *et al.* 2005) would have negligible effect on the marine environment of LHI.

Other baiting operations using similar methods to the one proposed for LHI have not caused harm to marine organisms (Howald *et al.* 2005; Samaniego-Herrera *et al.* 2009), even though the bait application rates in those operations were up to double that proposed for LHI, and the bait more concentrated (i.e. 50ppm compared to 25 ppm on LHI).

Pollution of water within the Commonwealth marine environment is therefore considered extremely unlikely considering:

- The use of specialised equipment on the bait hopper will ensure minimal bait entry to the water.
- The amount of bait that may bounce off the cliffs to fall into the sea will be minimal (Howald *et al.* 2005; Samaniego-Herrera *et al.* 2009);
- Brodifacoum is practically insoluble, particularly in cold seawater (Primus *et al.* 2005) such as will be found off LHI in August, therefore extremely little Brodifacoum will dissolve out from the baits and remain suspended in the water. This, coupled with the significant dilution factor, will mean that the amount of Brodifacoum assimilated into the marine environment will be many orders of magnitude lower than the concentrations known to be toxic to fish (Empson 1996); and
- the three nautical mile distance of the REP bait distribution from the Commonwealth marine environment
- Baiting other islands using similar methods, although sometimes using significantly more bait, has not resulted in adverse effects on the marine environment a s a whole.
- Any potential impacts are likely to be very localised and temporary in nature.

Primary or Secondary Poisoning of Marine Organisms

Marine invertebrates
Because many marine invertebrates scavenge or graze on items on the sea bottom or in intertidal areas, it is possible that a few may pick up bait pellets or pellet fragments prior to the pellets breaking down in the water. Breakdown of a pellet would likely take only a few minutes, especially if the water is rough (Empson and Miskelly 1999). However, evidence against the existence of a significant dietary-exposure pathway for invertebrates comes from field sampling of marine invertebrates following an actual rodenticide application (Howald *et al*. 2005) where no Brodifacoum was detected in invertebrate species. Sampling undertaken after a spill of 18 tonnes of 0.002% (20 ppm) Brodifacoum bait in New Zealand in 2001 (Primus *et al*. 2005,) also demonstrated that even when extremely large amounts of Brodifacoum enter the sea, the effect on the marine environment is transient and localised. Therefore baiting of the Lord Howe Island Group poses negligible risk to local marine invertebrates.

Corals
The rodent eradication will not pose a risk to coral because:

1) the pellets and most pellet fragments are too big for the filter-feeding coral polyps to eat;
2) the solubility of Brodifacoum in water is poor and the amount of rodenticide in pellets (20 ppm) is low to begin with, thus the risk of corals absorbing dissolved Brodifacoum is negligible; and
3) there is no known physiological mechanism by which vertebrate anticoagulants can affect invertebrates.

Fish

If in sufficient quantity, it is possible for fish to absorb Brodifacoum through their gills or skin (Empson and Miskelly 1999). However, the proposed baiting of the LHIG is likely to result in only a small number of baits landing in the sea. Because i) Brodifacoum is practically insoluble in water, ii) the total amount of Brodifacoum is minute, and iii) the dilution factor is great, the risk of fish absorbing Brodifacoum is negligible.

Whilst there is a possibility that individual fish will ingest sufficient pellets to consume a lethal dose, impacts to the values of the Commonwealth Marine Environment are very unlikely. Similarly the likelihood of secondary poisoning is also considered unlikely.

Turtles
It is very unlikely that Green Turtles *Chelonia mydas* could be exposed to rodenticides by consuming baits directly or prey items that have ingested rodenticides. Adult Green Turtles feed exclusively on various species of seagrass and seaweed. Plants have not been documented to take up and store anticoagulants; therefore no effect on adult Green Turtles is expected to occur from ingestion of rodenticide in their food.

Juvenile Green Turtles and the other four species of turtle (Flatback Turtle *Natator depressus*, Hawksbill Turtle *Eretmochelys imbricata*, Leatherback Turtle *Dermochelys coriacea* and Loggerhead Turtle *Caretta caretta*) that may be encountered in the marine park are carnivorous, and will eat soft corals, shellfish, crabs, sea urchins and jellyfish. However, it is unlikely that these turtles will encounter marine invertebrates that may have been contaminated with Brodifacoum as a result of aerial baiting the LHIG with Pestoff® 20R. Evidence against the existence of a significant dietary exposure pathway for invertebrates is outlined in Marine invertebrates (above). No turtle nesting occurs on the LHIG.

Marine mammals
There is no realistic pathway by which marine mammals can be significantly exposed to rodenticide at the LHIG as a result of the proposed aerial baiting with Pestoff® 20R. The combination of Brodifacoum being practically insoluble in water, the infinitesimal amount of Brodifacoum that may land in the sea and the huge dilution factor preclude any significant effect upon marine mammals.

In summary, the proposed baiting of LHI does not pose a threat to the marine life (Cetaceans, seals, turtles, fish or invertebrates, including coral) or the conservation values of the Lord Howe Island Marine Park because:

- The use of specialised equipment on the bait hopper will ensure minimal bait entry to the water. The amount of bait that may bounce off the cliffs to fall into the sea will be minimal (Howald *et al.* 2005; Samaniego-Herrera *et al.* 2009);
- The breakdown of baits that do land in the sea will be rapid (Empson and Miskelly 1999), therefore the opportunity for fish to take baits will be limited;
- Fish have shown a lack of interest in baits (Samaniego-Herrera *et al.* 2009, U.S. Fish and Wildlife Service and Hawai'i Department of Land and Natural Resources 2008), so it is unlikely that many fish will take baits;
- The possible death of those few fish that find and eat enough baits to prove fatal does not pose a threat at the population level;
- Baiting other islands using similar methods, although sometimes using significantly more bait, has not resulted in adverse effects on the marine environment
- Any potential impacts are likely to be very localised and temporary in nature.

Attachment 7 contains a number of hypothetical examples where the contamination levels resulting from that bait spill have been assumed to exist off the LHIG, and involve representatives of some of the fauna that may be found in the area. This analysis demonstrates that the risks to marine species around the Lord Howe Island Group are negligible, and, accordingly, marine species are not affected species. It also contains a summary of attraction of fish to bait pellets from testing undertaken on Lehua Island, Hawai'i, in 2004 (U.S. Fish and Wildlife Service, 2008).

3.1 (g) Commonwealth land

(If the action is on Commonwealth land, complete 3.2(d) instead. This section is for actions taken outside Commonwealth land that may have impacts on that land.)

Description
If the action will affect Commonwealth land also describe the more general environment. The Policy Statement titled *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* provides further details on the type of information needed. If applicable, identify any potential impacts from actions taken outside the Australian jurisdiction on the environment in a Commonwealth Heritage Place overseas.

The LHIG group is NSW Crown land and there is no Commonwealth land within the LHIG. The LHIG is approximately 500 km from the Australian mainland.

Nature and extent of likely impact

Address any impacts on any part of the environment in the Commonwealth land. Your assessment of impacts should refer to the *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* and specifically address impacts on:

- ecosystems and their constituent parts, including people and communities;
- natural and physical resources;
- the qualities and characteristics of locations, places and areas;
- the heritage values of places; and
- the social, economic and cultural aspects of the above things.

No impact is expected to Commonwealth land.

3.1 (h) The Great Barrier Reef Marine Park

Description

Not applicable. The southern boundary of the Great Barrier Reef Marine Park is more than 900km away from where the proposed action would take place.

Nature and extent of likely impact

Address any impacts on any part of the environment of the Great Barrier Reef Marine Park.

Note: If your action occurs in the Great Barrier Reef Marine Park you may also require permission under the *Great Barrier Reef Marine Park Act 1975* (GBRMP Act). If so, section 37AB of the GBRMP Act provides that your referral under the EPBC Act is deemed to be an application under the GBRMP Act and Regulations for necessary permissions and a single integrated process will generally apply. Further information is available at www.gbrmpa.gov.au

No impacts are expected to the Great Barrier Reef Marine Park.

3.1 (i) A water resource, in relation to coal seam gas development and large coal mining development

Description

If the action is a coal seam gas development or large coal mining development that has, or is likely to have, a significant impact on water resources, the draft *Policy Statement Significant Impact Guidelines: Coal seam gas and large coal mining developments—Impacts on water resources* provides further details on the type of information needed.

Not applicable. The proposed action is not a coal seam gas development or large coal mining development.

Nature and extent of likely impact

Address any impacts on water resources. Your assessment of impacts should refer to the draft *Significant Impact Guidelines: Coal seam gas and large coal mining developments—Impacts on water resources*.
N/A

3.2 Nuclear actions, actions taken by the Commonwealth (or Commonwealth agency), actions taken in a Commonwealth marine area, actions taken on Commonwealth land, or actions taken in the Great Barrier Reef Marine Park

You must describe the nature and extent of likely impacts (both direct & indirect) on the whole environment if your project:

- is a nuclear action;
- will be taken by the Commonwealth or a Commonwealth agency;
- will be taken in a Commonwealth marine area;
- will be taken on Commonwealth land; or
- will be taken in the Great Barrier Reef marine Park.

Your assessment of impacts should refer to the *Significant Impact Guidelines 1.2 - Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies* and specifically address impacts on:

- ecosystems and their constituent parts, including people and communities;
- natural and physical resources;
- the qualities and characteristics of locations, places and areas;
- the heritage values of places; and
- the social, economic and cultural aspects of the above things.

3.2 (a)	**Is the proposed action a nuclear action?**	X	No.
			Yes (provide details below)

If yes, nature & extent of likely impact on the whole environment

N/A

3.2 (b)	**Is the proposed action to be taken by the Commonwealth or a Commonwealth agency?**	X	No.
			Yes (provide details below)
If yes, nature & extent of likely impact on the whole environment			
N/A			

3.2 (c)	**Is the proposed action to be taken in a Commonwealth marine area?**	X	No. The Australian Economic Exclusion Zone, Territorial Sea and Lord Howe Commonwealth Marine Reserve occur 3 Nautical miles from the proposed action.
			Yes (provide details below)
If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(f))			

3.2 (d)	**Is the proposed action to be taken on Commonwealth land?**	X	No
			Yes (provide details below)
If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(g))			

3.2 (e)	**Is the proposed action to be taken in the Great Barrier Reef Marine Park?**	X	No. The southern boundary of the GBRMP is more than 900km away from where the proposed action would take place
			Yes (provide details below)
If yes, nature & extent of likely impact on the whole environment (in addition to 3.1(h))			

3.3 Other important features of the environment

Provide a description of the project area and the affected area, including information about the following features (where relevant to the project area and/or affected area, and to the extent not otherwise addressed above). If at Section 2.3 you identified any alternative locations, time frames or activities for your proposed action, you must complete each of the details below (where relevant) for each alternative identified.

3.3 (a) Flora and fauna

The LHIG supports a diverse terrestrial flora and fauna with a high degree of endemic species and communities. Many biogeographical relationships are discernible, with components of the terrestrial flora and fauna exhibiting affinities with eastern Australia, New Zealand, Norfolk Island and New Caledonia (DECC, 2007).

Flora

There are currently believed to be approximately 240 native species of vascular plants in the LHIG (DECC, 2007). While the vegetation has affinities with the flora of northern New South Wales, southern Queensland, New Zealand, Norfolk Island and New Caledonia, there is a high level of endemism (113 species (47%)). The high degree of endemism is illustrated not only at the species level, but also at the generic level, where there are five endemic vascular plant genera including three endemic palms (DECC, 2007).

Approximately 270 species of vascular flora have naturalised (introduced species that are reproducing in the wild) on the LHIG since settlement.

The non-vascular flora of terrestrial and freshwater habitats (bryophytes, lichens and freshwater algae) is less well known, but is also considered to be diverse with many endemic species. For example, 105 species of mosses are known, 21 (20%) of which are endemic.

Fauna

Birds
Similar to other oceanic islands, the terrestrial fauna of the LHIG is dominated by birds. The LHIG forms one of the major seabird breeding sites in the Tasman Sea and is thought to be home to the most diverse and largest number of seabirds in Australia (DECC, 2010). Many of these species are believed to have important breeding populations on the LHIG; they are the only major breeding locality for the Providence Petrel, and contain one of the world's largest breeding concentrations of Red-tailed Tropicbird.

182 species have been recorded from the LHIG of which 20 are resident land birds, 14 are breeding seabirds, 17 are regular visitors and 120 are vagrants (DECC, 2010). 34 species have been recorded as regularly breeding on the islands. Many of the breeding seabirds found on the islands are listed migratory species.

The LHIG is the only known breeding locality in the Australasian region for the grey ternlet and Kermadec petrel, and is the southernmost breeding locality in the world for the masked booby, the sooty tern and common noddy.
Endemic land birds on the islands include the Woodhen, Lord Howe, Lord Howe golden whistler and Lord Howe currawong. Nine land birds and two sea birds are believed extinct, most of which have been at least partially attributed to the presence of rats.

Mammals
The only known native mammal on the LHIG is the large forest bat (*Vespadelus darlingtonii*) (DECC, 2010). The Lord Howe Long-eared Bat (*Nyctophilus howensis*) is thought to be extinct (DECC, 2007).

Reptiles
There are two native reptiles, the LHI skink and LHI gecko (DECC, 2010). Both are now severely reduced in their range and abundance on the main island due to predation by rats; however both are present on Blackburn Island, the Admiralty group, Mutton Bird Island and Balls Pyramid. Until recently it was believed that both species also occurred on Norfolk Island, although recent genetic work indicates they are separate species.

Invertebrates
The LHIG has a very complex and biogeographically interesting invertebrate fauna, characterised by relatively high species richness (>1600 species recorded) and high endemism (DECC, 2010). This includes 157 land and freshwater snails, 464 beetles, 27 ants, 183 spiders, 21 earthworms, 137 butterflies and moths and 71 springtails. The rate of discovery of new species remains high, indicating that numerous endemic species are yet to be discovered (DECC, 2007).
Of particular note are the Lord Howe Island phasmid, which was previously thought to be extinct, the wood-feeding cockroach, and the darkling beetle which are no longer found on the main island, but are restricted to outlying, rat-free islands (DECC, 2007).

There are more than 50 endemic species of land snails found in the island group. One large species, *Epiglypta howinsulae*, has already become extinct and another large species, the Lord Howe placostylus (*Placostylus bivaricosus*), is endangered with one of its subspecies presumed extinct (DECC, 2010). A new species of Phasmid *Davidrentzia validus* was discovered in 1988, with only 12 records of the species been detected since then. The species is considered at risk from predation by rodents.

It is believed that numerous invertebrate extinctions have occurred including one endemic ant and ten endemic beetles (DECC, 2007).

Freshwater Fishes
Three species of freshwater fish (two eels and a galaxias) occur on the LHIG (DECC, 2007).

3.3 (b) Hydrology, including water flows

A small number of ephemeral streams are found on LHI. It is anticipated that a small amount of pellets may fall into these streams as part of the aerial distribution where they will sink and disintegrate rapidly. The Brodifacoum from these pellets will settle and bind strongly to sediments. The low-moderate application rate of Brodifacoum (0.4 g/ ha) for the LHI REP and one off eradication means that any environmental contamination would be of a sufficiently low magnitude as to not present a significant risk. Any potential impacts are likely to be very localised and temporary in nature.

3.3 (c) Soil and Vegetation characteristics

The LHIG is a volcanic remnant characterised by volcanic basalt outcrops and sedimentary calcarenite (mostly coral fragment) formations in the low slopes and low lying areas. Soil profiles are limited across the island.

Soil on the island is unlikely to be impacted by the proposal. Fate of the bait and the toxin in soil is described in Section 2. The pellet will degrade in approximately 100 days. Manner of use of Brodifacoum baits and physical and chemical properties of Brodifacoum suggests little accumulation of Brodifacoum in soil, with concentrations of Brodifacoum in soil predicted to be negligible/low and occurring only sporadically according to bait treatment timings. Brodifacoum is strongly bound to soil particles, and radio-labelled Brodifacoum was found to be effectively immobile (i.e. not leached) in four soil types (World Health Organisation 1995). It is broken down by soil micro-organisms to its base components, carbon dioxide and water, the half-life being 12-25 weeks (Soil Degradation for 50% of the compound (DT_{50}) – typical 84 days: Field – 157 days; Shirer 1992). Any potential impacts are likely to be very localised and temporary in nature. The rodent eradication project is likely to lead to an overall reduction in rodenticide use in the long term.

Over thirty vegetation communities have been described from the LHIG and many of these are endemic or have highly restricted distributions. Eighteen of these communities are considered to be of particular conservation concern (DECC, 2007).

Brodifacoum is strongly bound to soil particles and practically insoluble in water, therefore it is not likely to be transported through soils and into plant tissues. Sampling of grasses (Poaceae) collected 6 months following application of Brodifacoum cereal baits at 15 kg/ha on Anacapa Island in California during 2001 and 2002 found no detectable residues in the six samples tested (Howald *et al* 2010).

A literature search failed to find published or verified unpublished data regarding plant uptake or persistence. It is considered unlikely that the proposal would impact plants.

The proposed REP is unlikely to have a significant impact on vegetation on the island. Conversely the eradication of rodents is likely to have significant benefits to a range of individual plant species and many vegetation communities through increases in the abundance of plants, seeds and seedlings, thereby enhancing the process of forest regeneration.

3.3 (d) Outstanding natural features

Outstanding natural features are considered in the World Heritage and National Heritage sections (3.1 a) and b)) above. No impact is expected to outstanding natural features.

3.3 (e) Remnant native vegetation

Most of the island (87%) is considered remnant vegetation (DECC, 2007). Closed forest is the most extensive remnant vegetation, covering over half of the main island and extending from the lowlands to the mountain tops. The remaining natural vegetation cover consists of scrubs, herbfields, grasslands and the vegetation of exposed cliff and littoral terrains. Thirty four vegetation communities are defined for the LHIG (DECC, 2007) and many of these are endemic or have highly restricted distributions. Eighteen of these communities are considered to be of particular conservation concern (DECC, 2007) due to threatening processes that are causing, or likely to cause their decline including impacts from introduced rodents.

The proposal is unlikely to impact on remnant vegetation. In contrast, if the proposal proceeds and rodents are eradicated, significant improvement is expected for remnant vegetation communities.

3.3 (f) Gradient (or depth range if action is to be taken in a marine area)

The LHIG is a sea mount chain. The lagoon, which is approximately 6 kilometres by 1.5 kilometres at its widest point, has an average depth of just 2–3 metres, although its deeper holes can be up to 10 metres deep. The lagoon fringing reef is pierced by four principal passages: Erscotts Passage, South Passage and Erscotts Blind Passage to the south; and North Passage, the latter constituting the main entrance and being 4–6 metres deep (Allen *et al* 1976). On the seaward edge of the lagoon, the shoreline drops off steeply to depths of 15–20 metres and then gradually slopes to deeper water (Allen *et al* 1976). Around other parts of the island, the shorelines are steep, with rocky cliffs extending to the water's edge adjacent to water depths of 10–20 metres (MPA, 2010).

3.3 (g) Current state of the environment

Include information about the extent of erosion, whether the area is infested with weeds or feral animals and whether the area is covered by native vegetation or crops.

The LHIG is a World Heritage property and is often considered pristine. The LHIG however has not escaped significant impacts due to human activity and introduced species. Current and historical key threats (DECC, 2007) include:

- habitat clearing and modification particularly for accommodation and farmland in the settlement area

- vegetation windshear and associated canopy dieback
- trampling, browsing and grazing from introduced cattle and horses and historically goats
- weed invasion from 270 plant species that have become naturalised including 68 declared noxious weeds
- predation by rodents
- predation and competition from other introduced animals including:
    - 18 land bird species and five sea bird species that have established populations on the LHIG since human settlement
    - Cats, goats and pigs that have now been eradicated
    - African Big-headed Ant *Pheidole megacephala*. Number on the island have been significantly reduced and an eradication program is well commenced (expected eradication 2018)
    - Approximately 100 other species of introduced invertebrates
    - Bleating Tree Frog *Litoria dentata* and Grass Skink *Lampropholis delicate*

Other threats include sea bird ingestion of plastic, bycatch from fishing, traffic impacts to shearwaters and woodhens, *Phytopthora* infestation, habitat fragmentation and climate change.

Threats are managed under the LHI Biodiversity Management Plan (DECC, 2007) and through significant investment tin conservation from the LHIB and numerous funding partners.

3.3 (h) Commonwealth Heritage Places or other places recognised as having heritage values

The LHIG is not a Commonwealth Heritage Place.

3.3 (i) Indigenous heritage values

No indigenous groups or indigenous heritage values are found on the LHIG.

3.3 (j) Other important or unique values of the environment

Describe any other key features of the environment affected by, or in proximity to the proposed action (for example, any national parks, conservation reserves, wetlands of national significance etc).

Approximately 75% of LHI plus all outlying islands, islets and rocks above the high water mark are protected under the Permanent Park Preserve (PPP), which has similar status to that of a national park. The PPP area is managed by the LHIB.

3.3 (k) Tenure of the action area (e.g. freehold, leasehold)

The LHIG is NSW Crown Land with three lease types available; perpetual leases, permissive occupancy leases and special leases. Lease boundaries are shown in Attachment 1.5.

3.3 (l) Existing land/marine uses of area

A settlement of approximately 350 inhabitants occurs in the northern section of LHI and covers about 15% of the island; approximately 400 hectares. The settlement area is used predominantly for residential, pastoral/agricultural and commercial uses.

Ocean waters from the high water mark to three nautical miles offshore are protected under the NSW Lord Howe Island Marine Park (approximately 47,000 hectares) and are the responsibility of the New South Wales Marine Park Authority.

Tourism is the most significant industry and major source of income on the Island and is heavily focused around the world heritage values of both the marine and terrestrial environments. Key tourism activities include:

- Marine activities in the Marine Parks such as beach and reef walking, swimming, snorkelling, scuba diving, fish feeding, surfing, underwater photography, windsurfing, sea-kayaking, fishing, sightseeing cruises and eco tours, and other water sports and beach activities
- Terrestrial activities such as hiking, bird watching, golf, walking, bike riding, sightseeing and eco tours, lawn bowls.

Export of the Lord Howe Kentia Palm and to a lesser extent, three other palm species endemic to LHI, has been a major industry since the late 1800s. The species is now one of the most popular decorative palms in the world. Seed is collected from natural forest and plantations and then germinated in soil-less media and sealed from the atmosphere to prevent contamination. After testing, they are picked, washed (bare-rooted), sanitised and certified then packed and sealed into insulated containers for export.

3.3 (m) Any proposed land/marine uses of area

No significant changes to the proposed land and marine uses of the area are known.

4 Measures to avoid or reduce impacts

Note: If you have identified alternatives in relation to location, time frames or activities for the proposed action at Section 2.3 you will need to complete this section in relation to each of the alternatives identified.

Provide a description of measures that will be implemented to avoid, reduce, manage or offset any relevant impacts of the action. Include, if appropriate, any relevant reports or technical advice relating to the feasibility and effectiveness of the proposed measures.

For any measures intended to avoid or mitigate significant impacts on matters protected under the EPBC Act, specify:

- what the measure is,
- how the measure is expected to be effective, and
- the time frame or workplan for the measure.

Examples of relevant measures to avoid or reduce impacts may include the timing of works, avoidance of important habitat, specific design measures, or adoption of specific work practices.

Provide information about the level of commitment by the person proposing to take the action to achieve the proposed environmental outcomes and implement the proposed mitigation measures. For example, if the measures are preliminary suggestions only that have not been fully researched, or are dependent on a third party's agreement (e.g. council or landowner), you should state that, that is the case.

Note, the Australian Government Environment Minister may decide that a proposed action is not likely to have significant impacts on a protected matter, as long as the action is taken in a particular manner (section 77A of the EPBC Act). The particular manner of taking the action may avoid or reduce certain impacts, in such a way that those impacts will not be 'significant'. More detail is provided on the Department's web site.

For the Minister to make such a decision (under section 77A), the proposed measures to avoid or reduce impacts must:

- clearly form part of the referred action (e.g. be identified in the referral and fall within the responsibility of the person proposing to take the action),
- be must be clear, unambiguous, and provide certainty in relation to reducing or avoiding impacts on the matters protected, and
- must be realistic and practical in terms of reporting, auditing and enforcement.

If a proposed action is determined to be a controlled action, the Department may request further details to enable application of the *Outcomes-based Conditions Policy 2016* (http://www.environment.gov.au/epbc/publications/outcomes-based-conditions-policy-guidance), including information about the environmental outcomes to be achieved by proposed avoidance, mitigation, management or offset measures, details of baseline data, milestones, performance criteria, and monitoring and adaptive management to ensure the achievement of outcomes. If this information is available at the time of referral it should be included in the description of the proposed measures.

More general commitments (e.g. preparation of management plans or monitoring), commitments to achieving environmental outcomes and measures aimed at providing environmental offsets, compensation or off-site benefits CANNOT be taken into account in making the initial decision about whether the proposal is likely to have a significant impact on a matter protected under the EPBC Act. (But those commitments may be relevant at the later assessment and approval stages, including the appropriate level of assessment, if your proposal proceeds to these stages).

Measures used to mitigate potential environmental harm are summarised below:

Bait selection

Baits dyed green are often avoided by birds. This has been verified in trials conducted on LHI in 2007 with non-toxic Pestoff® pellets (LHIB, 2007). In that trial the Emerald Dove ate red pellets and brown pellets when offered to it, but ignored completely the green pellets. Baits to be used for the rodent eradication will be green.

The lower concentration of Brodifacoum in the bait, namely 20 parts per million, also reduces the possibility of non-target kills while still being highly lethal to rodents. Baiting on LHI currently involves the use of bait containing 50 parts per million of Brodifacoum which is 250% as toxic as that proposed for the eradication.

Pestoff® Rodent Bait 20R pellet product breaks down more quickly than most commercial rodenticides which tend to contain waxes and other compounds aimed at extending bait life in the field. This would extend unacceptably, the period of non-target risk. The more rapid physical bait breakdown rate for Pestoff® Rodent Bait 20R and its lower toxicity provide an effective compromise between maintaining target animal efficacy and reducing non-target risk.

Timing of baiting

The eradication is proposed to occur in June – August. It is at this time of year that most migratory seabirds are absent from the LHI Group. Even though seabirds are unlikely to eat baits and rodents, conducting the baiting when they are not present eliminates the already negligible risk to them.

The risk of collision with helicopter to the several seabird species that are present during the baiting will be reduced by taking advantage of the diurnal movements of seabirds. In this way sections of LHI will be baited when those birds are foraging at sea and away from their roosting grounds. To reduce disturbance to those species that are present throughout the day, baiting height for the helicopters will be set at an altitude that does not unduly disturb roosting or nesting birds.

Minimising Bait Entry in the Water

Baiting around the coast line will occur above the mean high water mark to minimise bait entry into the marine environment. A deflector arm can be attached to the spreader bucket to restrict the arc of the swathe to 180^{o} and will be used particularly when baiting the edge of buffer zones and to minimise bait entry into the marine environment when baiting coastal areas.

The Lagoon foreshore and some other beaches will be hand baited.

Captive Management

Woodhen and currawongs are highly susceptible to poisoning; the former from eating baits and poisoned rodents, the latter from preying on poisoned rodents. A large proportion of the population of the woodhen (80-85%) and currawongs (50-60%) will be taken into captivity to mitigate the risk of poisoning from the proposed baiting.

The period of captivity will start from approximately two months before baiting commences until baits and rodent carcasses have broken down (or for a total period of up to nine months). The time that baits are available is estimated to be 100 days although the rate of bait breakdown will be monitored (as described in Section 2.1) to ensure birds are not released at a time which may put them at risk.

Significant experience has been gained in managing woodhen populations in captivity on LHI. During a recovery program for the species (1981-1983), protocols for capturing and housing woodhens were established (Gillespie, 1993). The highly successful captive breeding and release program resulted in the release of 82 birds bred from just three breeding pairs originally captured (NPWS, 2002). Prior to the commencement of the program it was estimated that only 37 individuals remained in the wild.

In preparation for the LHI REP, a captive management pilot study was conducted in 2013 for woodhen and currawongs on LHI (Taronga Conservation Society Australia, 2014) has also added significant knowledge on the captive management of the two species. The pilot study showed that woodhens and currawongs could be held in large groups for prolonged periods with no observable impact. All 20 woodhens and 10 currawongs were successfully released at their individual capture sites. The trial report is included in Attachment 2.

Bird capture

Only experienced staff will be involved in the capture of both species. These include rangers on LHI who are involved in the capture of woodhen for banding as part of the annual monitoring of the population and Office of Environment and Heritage (OEH) scientific officers (with assistance from the LHIB rangers) that have been catching and banding currawongs since 2005 to determine their population status and movements. Hand-nets will be used to capture woodhen, and clap-traps will be used for currawongs. Upon capture, birds will be placed into cloth bags or ventilated cardboard boxes (one bird per bag or box) and taken to the holding facility where they will be checked by a veterinarian. A veterinarian with bird experience will be on site during all capture and release operations.

Birds will be collected from across the island including Mt Gower which will be accessed by helicopter to minimise stress to the birds. The Woodhen Survey Manual (Harden, 1999) provides details around how to capture woodhens.

Captive Housing Design and Location

The design plans for the holding pens used for each species during the 2013 trial were prepared by an experienced aviculturist from Taronga Zoo considering knowledge gained from previous facilities built to house these birds (both at Taronga Zoo and on LHI) as well as advice from New Zealand where the Weka, a species similar to the woodhen, had been kept in captivity during rodent-eradication operations undertaken in that country. These, together with recommendations from the pilot study will be used to inform the detailed design of the larger facility needed during the REP.

Indicative plans from the 2013 pilot study are attached to this referral in Attachment 2.
The captive management facilities will be constructed by modifying existing facilities at the Nursery, where the facilities for the pilot study were built. If required, expansion may occur on previously cleared land at the nursery Site (See Attachment 1.6).

Woodhens will held in enclosed paddocks 14 m by 14 m (see Figures in Attachment 2), holding approximately 20 birds each. For the currawongs, aviaries 1.4m wide x 3m high x 6m long aviaries, will be constructed, holding approximately 8 birds .

Guiding principles used in designing and determining the location of aviaries have included

- Locating the aviaries away from areas frequented by people;
- Providing adequate shade and protection from inclement weather and avian predators;
- Ensuring the birds feel secure by the provision, if need be, of screens between pens containing antagonistic co-specifics;
- Providing cover within pens in which the birds can shelter;
- Ensuring the pens can be effectively cleaned;
- Ensuring drainage is adequate;
- Ensuring internal structures are without sharp surfaces and pointed edges.

A Construction Management Plan for construction of the aviaries was developed in 2013 and will be updated to consider the expansion required for the REP. The 2013 Construction Management Plan is attached to this referral as part of Attachment 2.

Captive Husbandry and Disease Management

At the commencement of the captive period each bird will be examined by a veterinarian from Taronga Zoo who is experienced in avian medicine. The initial health status of individual birds will be determined by detailed physical examination together with body weight measurement and faecal examination for intestinal parasites. While in captivity on LHI, the birds will be under the care and authority of Taronga Zoo. A team of aviculturists will be employed to manage the holding facility for the period that the birds are held.

During the captive period the birds' behaviour and food intake will be monitored daily by experienced keepers and body weight will be monitored regularly. Parasite loads will be monitored by faecal examination.

At the end of the captive period each bird will undergo another physical examination by a veterinarian to ensure that it is fit for release.

Previous health assessments conducted on the Lord Howe Woodhen and other avian species on the island have not identified infectious diseases causing illness. The most likely disease or injury scenarios that may arise in the captive trial period include trauma due to con-specific aggression, parasitism especially coccidiosis, and outbreak of stress induced disease due to opportunistic environmental organisms such as salmonellosis and aspergillosis.

Facilities will be available for isolation of sick birds. Basic veterinary diagnostic investigation of any ill birds will be undertaken on the island while samples for more detailed diagnostic testing including histopathology and more complex haematology and serum biochemistry will be sent to Taronga Zoo for processing

A scientific licence issued by the NSW Office of Environment and Heritage (OEH) under Section 132C of the National Parks and Wildlife Act 1974 is required to capture woodhen and currawongs on Lord Howe Island. Additionally, all aspects of the capture of these birds will need to be approved by the OEH Animal Care and Ethics Committee.

The capture or housing of birds can result in the injury or death to individuals. Measures taken to reduce the likelihood of injury or death to birds in the program are:

- Experienced staff will be involved in the capture of both species
- A bird-specialist veterinarian will be on site during capture and release operations
- Experienced aviculturists from Taronga Zoo have designed the holding facilities to be sited on LHI
- Experienced aviculturists from Taronga Zoo will manage and care for birds through their period in temporary captivity
- Advice on captive management has been sought from, and will continue to be refined with, specialist aviculturists. Central to this process has been the examination of the successful captive-breeding programme for woodhen undertaken on LHI in the 1980s, the 2013 pilot study, as well as captive trials undertaken in New Zealand with Weka (a species similar to the Woodhen)
- Exclusion of rodents from the facility
- If the holding facilities are found to be inadequate after birds have been taken, attempts will be made to rectify any problems. As a last resort, should the welfare of the birds be at serious risk, the birds can be released back into the wild until deficiencies in the procedure are rectified.

Notwithstanding these precautions, a small number of birds (~ 3) are likely to die in captivity due to natural mortality (e.g., due to old age) because birds captured for the trial will reflect the age structure and general health of birds on LHI.

Monitoring

An extensive monitoring program will be conducted during and after the REP. This includes

- Monitoring of weather in the lead up to and during the REP.

- Monitoring breakdown of baits after distribution. Bait breakdown will be monitored at random sites using the Craddock Condition Index described above at approximately 30 day intervals until complete disintegration.
- Soil Monitoring after distribution. Post operational soil samples will be collected to monitor residues of Brodifacoum in the soil. Representative samples will be collected from directly below some toxic bait and at control sites away from bait pellets. Soil samples will be collected approximately 30 days after bait disintegration and approximately every two months (if required, dependant on results). All tests will be conducted at a NATA accredited analytical laboratory.
- Random sampling will be conducted on water bodies on the island to monitor Brodifacoum levels after the bait drop. Water samples will be collected within 2 days of each bait drop and approximately weekly 30 (if required, dependant on results). All tests will be conducted at a NATA accredited analytical laboratory. Rain water tanks will be sampled if requested by residents.
- Monitoring for ill and dead non target species. Ill individuals will be treated with Vitamin K where possible. Carcasses of rodents and non target species will be collected if found.
- Analysis of milk samples post baiting.

5 Conclusion on the likelihood of significant impacts

Identify whether or not you believe the action is a controlled action (i.e. whether you think that significant impacts on the matters protected under Part 3 of the EPBC Act are likely) and the reasons why.

5.1 Do you THINK your proposed action is a controlled action?

	No, complete section 5.2
X	Yes, complete section 5.3

5.2 Proposed action IS NOT a controlled action.

Specify the key reasons why you think the proposed action is NOT LIKELY to have significant impacts on a matter protected under the EPBC Act.

5.3 Proposed action IS a controlled action

Type 'x' in the box for the matter(s) protected under the EPBC Act that you think are likely to be significantly impacted. (The 'sections' identified below are the relevant sections of the EPBC Act.)

	Matters likely to be impacted
	World Heritage values (sections 12 and 15A)
	National Heritage places (sections 15B and 15C)
	Wetlands of international importance (sections 16 and 17B)
X	Listed threatened species and communities (sections 18 and 18A)
	Listed migratory species (sections 20 and 20A)
	Protection of the environment from nuclear actions (sections 21 and 22A)
	Commonwealth marine environment (sections 23 and 24A)
	Great Barrier Reef Marine Park (sections 24B and 24C)
	A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E)
	Protection of the environment from actions involving Commonwealth land (sections 26 and 27A)
	Protection of the environment from Commonwealth actions (section 28)
	Commonwealth Heritage places overseas (sections 27B and 27C)

Specify the key reasons why you think the proposed action is likely to have a significant adverse impact on the matters identified above.

In the absence of mitigation, a significant impact to LHI woodhens and currawongs is likely to occur from the LHI REP. With the proposed mitigation in place, it is considered possible that the REP will still have a significant impact on currawongs through disruption of a breeding cycle, although it is unlikely that a long term population decrease will occur.

6 Environmental record of the responsible party

NOTE: If a decision is made that a proposal needs approval under the EPBC Act, the Environment Minister will also decide the assessment approach. The EPBC Regulations provide for the environmental history of the party proposing to take the action to be taken into account when deciding the assessment approach.

		Yes	No
6.1	**Does the party taking the action have a satisfactory record of responsible environmental management?** **Provide details** The Lord Howe Island Board has a proven record of responsible environmental management of Lord Howe Island. The LHI Board is a statutory body established under the LHI Act, 1953. The Board is charged with the responsibility of administering the affairs of the Island and has the responsibility to: "manage, protect, restore, enhance and conserve Lord Howe Island in a manner that recognises the World Heritage values in respect of which the Island is inscribed on the World Heritage List". Examples of environmental projects implemented by the LHIB include the eradication of cats, pigs & wild goats, eradication of African Big-headed Ants (in progress), recovery of the endemic Woodhen through a captive breeding programme, captive management of the LHI Phasmid, planning the rodent eradication and over the past 10 years implementing an island wide weed eradication program targeting 68 invasive species.	X	
6.2	**Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?** **If yes, provide details**		X
6.3	**If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?** **If yes, provide details of environmental policy and planning framework**		X
6.4	**Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?** **Provide name of proposal and EPBC reference number (if known)** Pilot Study for captive management of LHI woodhen and LHI currawong EPBC Ref: 2013/6847 Lowering of Blinky Beach Sand Dune, Lord Howe Island, NSW. EPBC Ref: 2012/6599	X	

7 Information sources and attachments

(For the information provided above)

7.1 References

- List the references used in preparing the referral.
- Highlight documents that are available to the public, including web references if relevant.

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7.2 Reliability and date of information

For information in section 3 specify:

- source of the information;
- how recent the information is;
- how the reliability of the information was tested; and
- any uncertainties in the information.

References cited above include:

- peer reviewed and published scientific literature
- Commonwealth and State government reports and website references

- unpublished reports prepared specifically for the proposed LHI REP undertaken by appropriately qualified and experienced LHIB, NSW Office or Environment and Heritage staff or consultants
- unpublished reports from a range of similar eradication projects undertaken around the world.

7.3 Attachments

Indicate the documents you have attached. All attachments must be less than three megabytes (3mb) so they can be published on the Department's website. Attachments larger than three megabytes (3mb) may delay the processing of your referral.

		✓ attached	Title of attachment(s)
You must attach	figures, maps or aerial photographs showing the project locality (section 1)	✓	Attachment 1.1
	GIS file delineating the boundary of the referral area (section 1)		Attachment 8
	figures, maps or aerial photographs showing the location of the project in respect to any matters of national environmental significance or important features of the environments (section 3)		Attachments 1.2-1.6
If relevant, attach	copies of any state or local government approvals and consent conditions (section 2.5)		N/A
	copies of any completed assessments to meet state or local government approvals and outcomes of public consultations, if available (section 2.6)		N/A
	copies of any flora and fauna investigations and surveys (section 3)	✓	Attachment 2
	technical reports relevant to the assessment of impacts on protected matters that support the arguments and conclusions in the referral (section 3 and 4)	✓	Attachment 2-7
	report(s) on any public consultations undertaken, including with Indigenous stakeholders (section 3)	✓	Attachment 4

8 Contacts, signatures and declarations

NOTE: Providing false or misleading information is an offence punishable on conviction by imprisonment and fine (s 489, EPBC Act).

Under the EPBC Act a referral can only be made by:

- the person proposing to take the action (which can include a person acting on their behalf); or
- a Commonwealth, state or territory government, or agency that is aware of a proposal by a person to take an action, and that has administrative responsibilities relating to the action[1].

Project title: Lord Howe Island Rodent Eradication Project

8.1 Person proposing to take action

This is the individual, government agency or company that will be principally responsible for, or who will carry out, the proposed action.

If the proposed action will be taken under a contract or other arrangement, this is:

- the person for whose benefit the action will be taken; or
- the person who procured the contract or other arrangement and who will have principal control and responsibility for the taking of the proposed action.

If the proposed action requires a permit under the Great Barrier Reef Marine Park Act[2], this is the person requiring the grant of a GBRMP permission.

The Minister may also request relevant additional information from this person.

If further assessment and approval for the action is required, any approval which may be granted will be issued to the person proposing to take the action. This person will be responsible for complying with any conditions attached to the approval.

If the Minister decides that further assessment and approval is required, the Minister must designate a person as a proponent of the action. The proponent is responsible for meeting the requirements of the EPBC Act during the assessment process. The proponent will generally be the person proposing to take the action[3].

1. Name and Title:	Mr Andrew Walsh Project Manager – Rodent Eradication Project
2. Organisation (if applicable):	Lord Howe Island Board Organisation name should match entity identified in ABN/ACN search
3. EPBC Referral Number (if known):	
4: ACN / ABN (if applicable):	33 280 968 043
5. Postal address	PO Box 5, Lord Howe Island, NSW 2898
6. Telephone:	02 65632066
7. Email:	Andrew.walsh@lhib.nsw.gov.au
8. Name of proposed proponent (if not the same person at item 1 above and if applicable):	

[1] *If the proposed action is to be taken by a Commonwealth, state or territory government or agency, section 8.1 of this form should be completed. However, if the government or agency is aware of, and has administrative responsibilities relating to, a proposed action that is to be taken by another person which has not otherwise been referred, please contact the Referrals Gateway (1800 803 772) to obtain an alternative contacts, signatures and declarations page.*

[2] *If your referred action, or a component of it, is to be taken in the Great Barrier Reef Marine Park the Minister is required to provide a copy of your referral to the Great Barrier Reef Marine Park Authority (GBRMPA) (see section 73A,* EPBC Act*). For information about how the GBRMPA may use your information, see http://www.gbrmpa.gov.au/privacy/privacy_notice_for_permits.*

9. ACN/ABN of proposed proponent (if not the same person named at item 1 above):

COMPLETE THIS SECTION ONLY IF YOU QUALIFY FOR EXEMPTION FROM THE FEE(S) THAT WOULD OTHERWISE BE PAYABLE

I qualify for exemption from fees under section 520(4C)(e)(v) of the EPBC Act because I am:

□ an individual; OR

□ a small business entity (within the meaning given by section 328-110 (other than subsection 328-119(4)) of the *Income Tax Assessment Act 1997*); OR

☒ not applicable.

If you are small business entity you must provide the Date/Income Year that you became a small business entity:

Note: You must advise the Department within 10 business days if you cease to be a small business entity. Failure to notify the Secretary of this is an offence punishable on conviction by a fine (regulation 5.23B(3) *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth)).

COMPLETE THIS SECTION ONLY IF YOU WOULD LIKE TO APPLY FOR A WAIVER

I would like to apply for a waiver of full or partial fees under Schedule 1, 5.21A of the EPBC Regulations. Under sub regulation 5.21A(5), you must include information about the applicant (if not you) the grounds on which the waiver is sought and the reasons why it should be made:

☒ The LHIB is directly responsible to the NSW Minister for the Environment and forms part of the NSW Government. The primary objective of the proposed action is to protect or conserve the environment consistent with the objectives of the EPBC Act. The activity is to be carried out primarily for a non-commercial purpose and is considered to be interests of the Australian public,

Declaration

I declare that to the best of my knowledge the information I have given on, or attached to this form is complete, current and correct.
I understand that giving false or misleading information is a serious offence.
I agree to be the proponent for this action.
I declare that I am not taking the action on behalf of or for the benefit of any other person or entity.

Signature 

Date 11 May 2016

8.2 Person preparing the referral information (if different from 8.1)

Individual or organisation who has prepared the information contained in this referral form.

Name	
Title	
Organisation	Organisation name should match entity identified in ABN/ACN search
ACN / ABN (if applicable)	
Postal address	
Telephone	
Email	
Declaration	I declare that to the best of my knowledge the information I have given on, or attached to this form is complete, current and correct. I understand that giving false or misleading information is a serious offence.
Signature	Date

REFERRAL CHECKLIST

NOTE: This checklist is to help ensure that all the relevant referral information has been provided. It is not a part of the referral form and does not need to be sent to the Department.

HAVE YOU:

- ☒ Completed all required sections of the referral form?
- ☒ Included accurate coordinates (to allow the location of the proposed action to be mapped)?
- ☒ Provided a map showing the location and approximate boundaries of the project area?
- ☒ Provided a map/plan showing the location of the action in relation to any matters of NES?
- ☒ Provided a digital file (preferably ArcGIS shapefile, refer to guidelines at Attachment A) delineating the boundaries of the referral area?
- ☒ Provided complete contact details and signed the form?
- ☒ Provided copies of any documents referenced in the referral form?
- ☒ Ensured that all attachments are less than three megabytes (3mb)?
- ☒ Sent the referral to the Department (electronic and hard copy preferred)?

Attachment A

Geographic Information System (GIS) data supply guidelines

If the area is less than 5 hectares, provide the location as a point layer. If the area greater than 5 hectares, please provide as a polygon layer. If the proposed action is linear (e.g. a road or pipeline) please provide a polyline layer.

GIS data needs to be provided to the Department in the following manner:

- Point, Line or Polygon data types: ESRI file geodatabase feature class (preferred) or as an ESRI shapefile (.shp) zipped and attached with appropriate title
- Raster data types: Raw satellite imagery should be supplied in the vendor specific format.
- Projection as GDA94 coordinate system.

Processed products should be provided as follows:

- For data, uncompressed or lossless compressed formats is required - GeoTIFF or Imagine IMG is the first preference, then JPEG2000 lossless and other simple binary+header formats (ERS, ENVI or BIL).
- For natural/false/pseudo colour RGB imagery:
    - If the imagery is already mosaiced and is ready for display then lossy compression is suitable (JPEG2000 lossy/ECW/MrSID). Prefer 10% compression, up to 20% is acceptable.
    - If the imagery requires any sort of processing prior to display (i.e. mosaicing/colour balancing/etc) then an uncompressed or lossless compressed format is required.

Metadata or 'information about data' will be produced for all spatial data and will be compliant with ANZLIC Metadata Profile. (http://www.anzlic.org.au/policies_guidelines#guidelines).

The Department's preferred method is using ANZMet Lite, however the Department's Service Provider may use any compliant system to generate metadata.

All data will be provide under a Creative Commons license (http://creativecommons.org/licenses/by/3.0/au/)

Lord Howe Island Rodent Eradication Project

Captive Management Plans

Contents:

Supporting documents:

Attachment 1: 2013 Captive Trials Final Report

Attachment 2: Woodhen Building 3 Drawings

Attachment 3: Woodhen Building 4 Drawings

Attachment 4: Currawong Building 2 Drawings

Attachment 5: Lord Howe Island Animal Care Guideline

Attachment 6: LHI Woodhen Husbandry Manual

Attachment 7: LHI Pied Currawong Husbandry Manual

Attachment 8: LHI Woodhen Diet Sheet

Attachment 9: LHI Pied Currawong Diet Sheet

Attachment 10: Procedure for Euthanasia of Embroynated Avian and Reptile Eggs

Attachment 11: Risk Register and Matrix

Attachment 12: Disease Profile LHI Woodhen

Attachment 13: Husbandry and Vet Risk Assessment

Attachment 14: Secondary and Offshore Population Management Options Overview

Attachment 15: Veterinary Decision Making Tree

1. Project summary

The Lord Howe Island (LHI) Woodhen and Pied Currawong are identified as being at risk from primary and/or secondary poisoning during the LHI Rodent Eradication Project. As a result, a large proportion of the population need to be held in captive management for the duration that rodent carcases and bait is expected to persist in the environment.

Taronga has been engaged by the LHI Board as a contractor as the organisation has the requisite technical and captive management expertise to provide high quality avian husbandry services and captive management of these two species until they are able to be released.

A purpose built facility at Lord Howe Island is proposed to hold 200-230 Woodhen in 11 pens at a density of 20-25 birds per pen, held in family groups, and 100-120 Currawong in 78 aviaries, held in pairs. This comprises approximately 80-85% and 50-60% of the respective estimated total population of each species. It is considered that Currawongs are at a lower risk of poisoning than the Woodhen hence the lower percentage of population proposed to be taken into captivity.

The birds will be held under Taronga's management for an anticipated 3-4 month period, or 100 days from the second bait drop. Currawongs may be held for a shorter period due to the main risk for secondary poisoning being the presence of rodent carcasses which are not likely to persist for 100 days.

Taronga will be providing housing, husbandry and health care for the birds and population management services using a team of 7 Taronga staff who will be based full time on the island on a rotational schedule (approx 6-8 weeks), including a unit supervisor (or equivalent senior level position), experienced bird keepers and staff with vet nursing experience. A veterinarian will be onsite for key components of the project as well as on call 24hours by telephone and available to attend site within 24 hours (or first available flight) if required at other times.. The birds will come into Taronga's care as they are received on site at the captive management facility and are assessed by veterinary staff. At project completion, the birds will undergo a final veterinary assessment before being handed back to OEH Scientific Officers for transfer and release at their wild site of capture.

Taronga will employ their standard policies and procedures for husbandry, with special modifications to reflect the working environment and based on learnings from the 2013 trails. The captive management facility design proposed has evolved over time from several iterations with veterinary and animal husbandry expert input. Protocols for emergencies on the island will be followed as per usual LHIB procedures and Emergency Response Plans have been developed for the safe guarding of an 'insurance population' to hedge against risks from any catastrophic threats to the population.

2. Taronga's recommendation

In the development and consultation of this strategy, multiple management options have been explored, risk assessments conducted and experts consulted from a variety of agencies over a 3 month period between September – November 2016. Three options were put to the LHIB and Taronga's expert advice to the LHIB and the assessors is to hold the entire captive population onsite at Lord Howe Island, noting the design and management approach addressed the key threats from disease and Emergency Response Plans for catastrophic weather events, which do not have a history of occurring at Lord Howe Island.

3. Background: 2013 Trials

A captive trial was conducted on Lord Howe Island in 2013 in which 22 Woodhen and 10 Currawong were held to test assumptions of behaviour of the two species and determined the best methods of maintaining and caring for the birds in captivity during the eradication project.

Bird behaviour and health was closely monitored while holding the Woodhen in higher than normal density with the group managed as a whole and Currawong housed in pairs. Both species were closely observed and husbandry notes recorded to guide future management. The report from the captive trial highlights key learnings which have been adopted into revised management, operational and veterinary practices for the full project (Attachment 1). No other species have been identified as required to be held in captivity for the term of the eradication project.

The trial was successful in increasing knowledge of the management and handling of both species, with no fatalities, no arising issues of disease or infections, refining husbandry routines and testing the aviary designs, all of which have guided the development of the management plan for the full scale project.

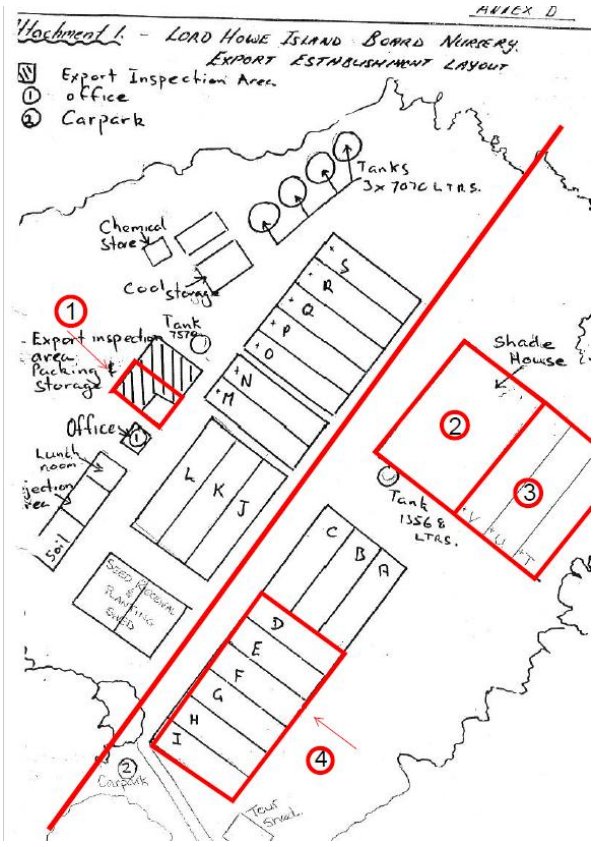
4. Overview of proposed approach

Taronga's recommended approach is to hold the entire captive population at the purpose built facility on Lord Howe Island. The facilities can be managed separately and have been designed with multiple features to mitigate risks of communicable diseases and Emergency Response Plans are in place in the case of any catastrophic weather events.

4.1 Captive Management Site

The operational site will consist of (refer to drawing);

- Three separate buildings with one housing Currawong (#2), two housing Woodhen (#3 and #4)
  To note, buildings 2 and 3 are not connected, there is approximate 5 metres between the perimeter walls and approximately 20m between the two Woodhen buildings #3 and #4
- Office and storage room with access to computer and landline
- Kitchen area and lunch room
- Dedicated bird food prep and vet care room (#1)



The buildings housing the birds have been carefully designed to allow for greater airflow following adjustments from findings in the original trial in 2013. This will be monitored carefully on an ongoing basis through careful observation and tests such as the smoke test. A variety of approaches can be employed to improve ventilation such as opening the side walls on the domes, incorporating shade cloth into the roof panels, installation and use of portable fans.

For each building supplementary heating is available if required in the pens and aviaries with the installation of portable heat lamps which will be available onsite. Hospital cages which will be used for housing single sick birds for intensive treatment are designed to allow the use of heat lamps which will be held in stock on the Island.

Each building will have its own set of husbandry tools and equipment for daily routines. There is no external fencing for the site, however the structures can be locked to prevent any unauthorised entry. Surveillance cameras will also be utilised.

Taronga staff will oversee the management of bait stations around the facility to ensure consistency with the overall baiting program and monitor activity to ensure no rodents (rats or mice) breach the rodent proof Currawong aviaries and Woodhen pens.

Access to the site by local wildlife is prevented through this design, with roof structures protecting against potential aerial attacks from predatory birds and fences/closed doors to the pens. The risk of contact with free ranging poultry or wild fowl was considered but note is not a concern due to inability to access the birds onsite.

4.2 Woodhen pens

There are two Woodhen holding facilities as per the detailed drawings (Attachments 2 and 3). The enclosures consist of several internal pens surrounded by a common rodent proof perimeter fence made from maxirib colourbond, a smooth metal sheeting that rats cannot climb up or chew through. The maxirib sheeting is buried a minimum of 600mm into the ground as this is recognised and was trialled in 2013 as the depth that rodents will not persist with digging. As well as the deep maxirib perimeter, a white sand perimeter along the outside walls will provide further evidence of presence of rodents trying to dig and will be monitored daily as part of husbandry rounds. If necessary CCTV will be used to monitor and record overnight activity around external areas of the enclosure that prove to be “hot spots”.

The threshold of the entry doors to the facility will stand at 400mm high, which is higher that the rodents would be able to climb and no gap in the enclosure will be greater than 6.5mm x 6.5mm to ensure the building is rodent proof. Each pen will be fitted with an individual water tap, to enable barrier nursing routines if required. As the perimeter is rodent proof, the flooring inside the building will be natural substrate.

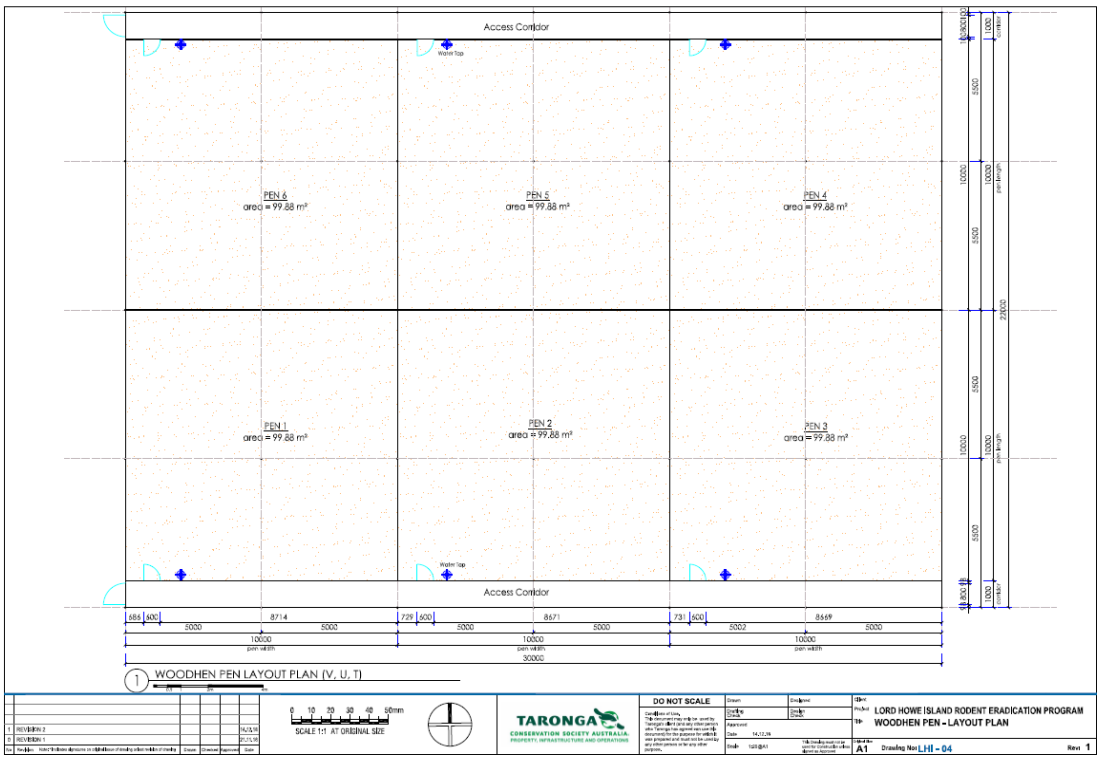
The distance of approximately 20m between the two Woodhen pens allows them to be managed as two independent populations, with 10 individual groups that are all able to be isolated to a sufficient extent as to mitigate risk associated with disease transmission.

Both buildings have an access corridor(s) with individual entry points into each pen. There are separate water points and the internal walls are 1.5h to contain the birds and also minimise any transfer of airborne vectors.

Building 4 has been designed to have 6 separate smaller enclosures that will be used if necessary for keeping birds isolated from the larger group. Reasons for this separation could range from non-transmissible disease, injury or time out due to cage mate aggression.

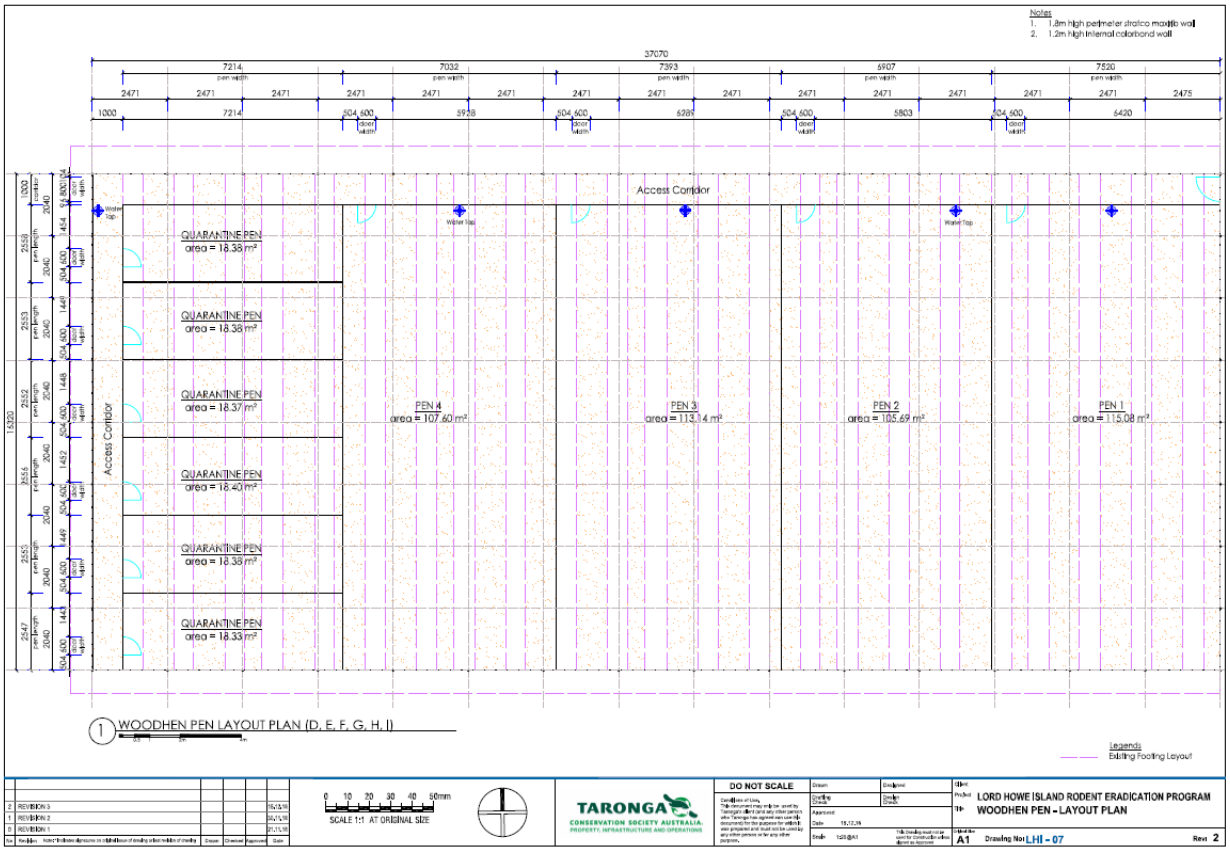
Building 3 layout

Low res, detailed drawings attached



Building 4 layout

Low res, detailed drawings attached



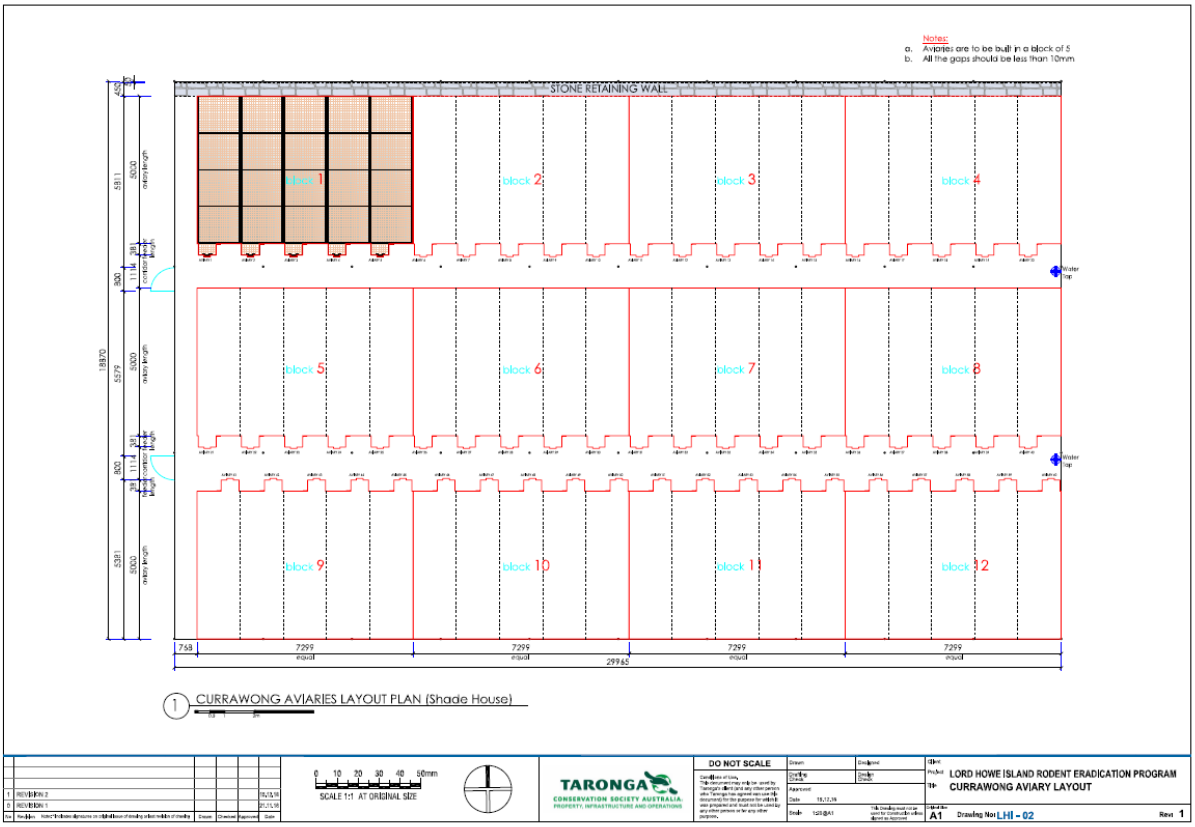
The Currawong aviaries (Attachment 4) are a modular design that is constructed in banks of five modules that sit side by side to form three rows of twenty aviaries. Rolls of mouse proof mesh 6.5 x 6.5 x 6mm thick will be laid down on the ground prior to construction of the aviaries. The mouse mesh will form the floor of the aviary and will have a 150mm overlap around the perimeter of the aviary that will be folded and sandwiched between the aviary frames. Taronga has worked with the contractor to develop a way of folding the mouse mesh over with steel strip reinforcement at any joins to prevent any gaps where the aviary mesh overlaps itself. The enclosure has also been designed with a 400mm high galvabond sheet to prevent rodents being able to climb onto the structure. The door threshold is also at a height of 400mm to prevent rodents from entering through a door gap and all other gaps are a maximum of 1.2cm x 1.2 cm

Each aviary has a feed station by the door, extending out from the aviary to allow feed to fall into the hallway for ease of cleaning and removes the chance of uneaten food falling into the enclosure to attract rodents in. This also reduces the need for keepers to enter the aviaries and disrupt the birds, which is then only required for spot cleaning and catch ups. This also reduces the risk of transmission of communicable diseases by minimising activity and contact within each aviary. The likelihood of diseases of most concern is increased by stress, therefore minimising keeper intrusion into the birds space is a key mitigating strategy to reduce this risk.

The facility has been designed to keep birds in pairs which reduce the number of birds at risk of diseases that are transmissible by faecal-oral exchange and ten extra aviaries will be located outside of building 2 (not connected to any other building) to enable separation and isolation of sick or injured Currawongs if required.

Building 2

Low res, detailed drawings attached



4.4 Construction of facilities

An extensive tender process was undertaken in late 2016 to identify a reliable and experienced contractor to manufacture and install the aviaries and pens. Each contractor was required to build a prototype to demonstrate their ability to complete works, adhering to strict drawings and specifications, within a tightly specified deadline and was inspected by a team consisting of construction, bird and project management experts.

The construction contract has been developed to include milestones during the construction and installation phase to ensure tolerances for rodent proofing are strictly adhered to, which will be signed off by Taronga construction staff and bird experts.

5. Husbandry

Facility and animal management procedures have been developed specifically for this project, guided by standard operation procedures at Taronga and the captive trials in 2013. Daily routines have been established with clear guidelines and parameters when working with and around animals and associated facilities, ensuring work practises are safe and efficient.

The Lord Howe Island Animal Care Guideline (Attachment 5) outlines the general care and husbandry procedures. Both species have dedicated husbandry manuals detailing specific information on behaviour, health requirements, nutrition and feeding regimes (Attachments 6 and 7).

Staff will have the resources, training, skills and experience necessary to satisfy their roles and responsibilities, with the roster designed to maintain staffing levels that enable the program to be effectively delivered with ample time dedicated to care and observation duties.

Each building will have its own set of equipment to mitigate risk of illness or disease transmission and where required, strict barrier nursing will be adopted, with dedicated staff for each building.

5.1 Bird Observations

Bird observations are a critical component of husbandry activities, providing keepers valuable insights into the ongoing health and wellbeing of the birds. Procedures around observations have been developed to ensure consistency in observing and recording for signs of ill health, condition of faeces, moulting, aberrant or aggressive behaviour and reproductive activity (see Attachment 5). Information is recorded in the daily report, as per usual procedure for Taronga animal populations. All staff are trained in bird husbandry and the recognition of signs of disease in birds. Birds will be monitored several times per day to allow early detection of illness.

5.2 Nutrition

Diets for both species were trialled in 2013 and have been refined and improved to provide the necessary dietary and nutritional requirements while referencing their wild diets. These have been developed and will be adjusted, if required, in consultation with Taronga vets and zoo nutritionist (Attachments 8 and 9). The amount fed per bird will be approximately 35g which is less than 8% of average woodhen weight based on trial period and where eggs are included as a component of the diet, they will be cooked.

A subset of birds from each pen will be weighed on a rotating roster and will be tracked. Food provided will be adjusted as necessary. Initial amounts fed during trial period was greater in order to ensure that all individuals were getting access to food while we determined whether group housing would alleviate territorial aggression. Accurate records will be maintained, as per usual procedure, on diet, health and weight of individual birds.

5.3 Food prep and storage

Taronga is committed to providing quality, hygienic food and water of the highest standards for all collections. Staff are trained on hygienic food storage, handling and preparation. Food is provided by existing suppliers and/or suppliers of human grade food (see also 6.6). It is important to note that risk of disease from food, food preparation or water is the same for all insurance population options.

Food preparation and storage areas, food and water containers, utensils and equipment used in the preparation and provision of food will be maintained to a hygienic standard as per standard Taronga procedures.

Dishes can be washed and sanitized using a two-compartment sink. In this method, dishes are washed and rinsed in the first sink, sanitized in the second sink, and dried on a drying rack or board. Commercially available liquid disinfectant

will be used an appropriate sanitizer. A washing machine has been considered, however we feel we can manage with thorough cleaning of dishes using detergent and water in suitable sink, then rinse and disinfected. Disinfectant F10SC can be increasingly used if bio-security measures are required to be stepped up (e.g. if infectious organism identified in a healthy bird(s), or if birds are unwell).

All food waste will be removed as soon as food prep is finalised daily to prevent attracting rodents.

Dry food will be stored in sealed pest proof containers, such as green sealed rubbish bins with lids, or the like. Fresh and perishable food will be stored in fridge or freezer on site.

Where possible food will be transported to the island fortnightly on the Island Trader barge so that bulk storage is not necessary.

Where pens or buildings are isolated, additional measures will be in place to further reduce risks of transmission through adoption of barrier nursing techniques.

A variety of food delivery methods will be used to allow staff to employ different options that are best suited to the type of food being fed and to provide enrichment to birds and all feeding options will be conscious of oral faecal exchange and will be changed daily. In the 2013 trials stainless steel bowls were successfully utilised that were placed inside tubs to prevent birds standing in them and tipping food, and feeder trays will also available to use.

5.4 Breeding season – Egg Management

The scheduled delivery of the project may have the potential to impact the start of the normal Woodhen breeding season. Allowing the establishment of nests would exacerbate aggressive and territorial behaviours which presents significant risk to individuals.

Egg laying has been recorded to occur between August and January, with higher reproductive output reported to be higher in the warmer lowlands of the island and where there is greater food availability[1].

There is a possibility that attempted nesting may occur during the captive management period. It is our strong recommendation that any nests be dismantled by hand before completion to reduce territorial behaviours and aggression and also reducing the opportunity for egg laying. Where birds still lay eggs they would be removed before incubation and euthanised according to standard Taronga procedures (Attachment 10). The facility is not designed to incubate and rear hatchlings and there will not be sufficient staff resources to accommodate this. It is not Taronga's place to comment on the potential impact of the normal breeding season for 2018, although anecdotally our advice would be that we do not anticipate it to be a risk to the population who have shown healthy annual recruitment and steadily increasing population trend from the LHIB Woodhen Surveys over the last 10 years. We note that potential impacts to the breeding season and population are discussed in the Public Environment Report (PER).

Taronga has no concerns to note regarding the breeding seasons for the Currawong.

5.5 Bird release

The proposed plan is for the birds to be held for up to 100 days following the second bait drop, with Currawongs anticipated to be held for a shorter period of time. The release date for each species is to be determined based on the rate of degradation of rodent carcasses (secondary poisoning risk for Currawong) and the bait (primary and secondary risk for Woodhen). Environmental monitoring will be conducted by the Office of the Environment and Heritage with reports scheduled for 30, 60 and 90 days following the second bait drop.

Taronga will be advised by the monitoring team regarding the status of carcasses and bait presence and status of wild bird populations, noting if there have been any rodenticide related deaths in the remaining wild populations of Woodhen and Currawong.

[1] http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=87732

Staged releases may be planned to assess the reintroduction success, with birds released at their wild site of capture. Monitoring will be conducted by OEH Scientific Officers and LHIB Rangers. Decisions regarding the release strategy will be determined in consultation with all partners and is outlined in 6.5.1 and 6.5.2 of the PER.

6. Management and operations

6.1 Waste Management

The LHIB will provide waste management services, including waste storage on site and removal three times per week, to ensure the health, safety and functionality of the operations site. Requests for additional waste removal will be negotiated directly with the LHIB on a by-need basis.

6.2 Storage

Lockable storage will be available for the office and staff equipment. Veterinary supplies will also be kept in a locked, secure location in accordance with NSW Department of Health requirements for Schedule 4 (S4D) drugs.

6.3 Security

The site will not be fully secure as this is not deemed necessary. Notification will be given to the community that the area will have restricted access for the duration of the eradication project and security cameras will be installed to monitor activity in the area. The site is located nearby a thoroughfare so it is possible for people to approach the area, however all access points to the enclosures will be locked. Both Woodhen buildings have 1.8m high fencing around the perimeter with lockable entry points, with one building being fully enclosed within the white sheeting. This prevents clear observation and access to the facility and the birds in Taronga's care.

The Currawong building is enclosed in shade cloth, minimising visibility from outside the building and is also able to be locked.

Security risks are increased by having multiple populations on island populations.

6.4 Transport

A LHIB car will be made available to Taronga staff for the duration of the project, to be used for movement and collection of supplies and other facility related activities.

6.5 Equipment

Equipment required for the project will be purchased and transferred to the captive management site. This includes all husbandry equipment for each building, feeding supplies, veterinary equipment and medicines as well as other materials required to carry out day to day operations.

6.6 Food shipments

Shipments of fresh food will be made fortnightly via barge from the IGA or Woolworths in Port Macquarie. These are the same food suppliers for all resident and visitor food on the island and is human grade and will provide the basis for all fresh food components of the bird's diets.

Regular shipments mitigate risk of food related illness from contamination and the operation site will have refrigeration and ample storage facilities to manage fortnightly shipments.

Dry feed will be shipped as required and stored in air tight drums to avoid contamination. Select live food will be flown in via plane as required and has been approved by LHIB as meeting bio-security import standards.

Any concerns about food spoilage will result in the removal of stock causing concern. Additional supplies will be kept on-hand to manage any accidental spoilage.

6.7 Substrate

LHIB have committed to providing and storing mulch in secure, dry, rodent proof skip bins to avoid contamination in the months leading up to the project. Recommended volumes will be provided to LHIB by Taronga staff to allow for appropriate planning and storage. Where possible during the project, mulch will be provided weekly by LHIB (dried cut palm fronds/wood chip mulch) and additional appropriate substrate will be sourced from the mainland. Any imports must comply with any LHIB bio-security regulations. In the event an alternate substrate is introduced, it will be trialled in one pen first to ensure there are no arising issues before rolling out use to all pens.

Substrate changes are scheduled once per week for each pen, with approximately 50-100mm new material on the top layer and will be monitored by staff daily.

6.8 Water

Rainwater will be available onsite from dedicated water tanks, similar to what all island residents and visitors use as a drinking water supply. This will include first flush and sediment filter devices. Each Woodhen pen has a water access point to support barrier nursing conditions and each row of Currawong aviaries has water points for ease of undertaking husbandry activities.

6.9 Staff housing

Taronga staff will be housed in nearby accommodation at Leandelai Apartments, located approximately 400m from the captive management facility, allowing quick, easy access to the operational site 24/7.

7. Bird pathology and health monitoring

7.1 Check in process

Birds will be delivered over a 3-4 week catch period by OEH Scientific Officers and LHIB staff and will come into Taronga's care as they arrive on site at the captive management facility. They will be received by an experienced Taronga vet, vet nurse and pathologist who will conduct a health assessment and testing on each individual, including;

- Physical examination to include weight, age, sex, body condition, feather condition, presence of ectoparasites, and note any abnormalities. Currawongs- trachea transilluminated to examine for *Syngamus trachea (*tracheal worms*)*
- Blood smear for haemoparasites and basic white blood cell differential.
- A subset of birds (30Woodhen and 30 Currawong) will undergo general anaesthesia for examination as above together with disease screening: Newcastle disease (ND), Avian influenza (AI), West Nile virus (WNV) and Chlamydia PCR on choanal/cloacal swabs, and microbial culture and sensitivity testing on faecal swabs for enteric bacterial pathogens, and blood collection for haematology and biochemistry.
- A subset of birds (5 samples per Woodhen enclosure and 1 pooled sample per Currawong enclosure) will undergo faecal parasitology (wet prep and flotation) screening for internal parasites.
- Any bird that shows signs of disease on arrival will be isolated and investigated. This may include anaesthesia, haematology and biochemistry, diagnostic sample collection and testing, euthanasia and necropsy as indicated.

Enteric pathogens included in the faecal screening panel: Salmonella, Campylobacter, Yersinnia, Shigella, Vibrio. Additional faecal cultures may be undertaken during the time birds are in care if indicated (indications **could** include e.g. a bird becomes unwell, or healthy carrier bird(s) are identified on arrival and the prevalence of carrier birds during

captive phase is to be monitored). This will provide Taronga vets with baseline health information about each individual which will assist in guiding the management and care of all birds held in captivity.

Taronga vets note that faecal Zn stain for mycobacteria is not a sensitive test. Additional cost associated with PCR testing for *M.genovense* on a single sample was not considered warranted for the project, though samples may be banked. Furthermore, avian polyomavirus is seen in captive birds in Australia but no reports could be found of disease in wild (free-living)birds.

During this process, 50 Woodhen will be identified and marked that are demographically representative of the overall population as part of the Emergency Response Plan. The IDs and location of these individuals will be recorded and on display for staff in the event the Emergency Response Plans plan is required (see 8.2). Up to 40 will be removed, however 50 identified to account for any mortality or other issues with birds identified.

7.2 Routine health management

During the period of care, routine health assessments will include;

- Pooled faecal samples from each enclosure will be examined weekly for the first three weeks (Woodhens) to monitor enteric parasite shedding. Thereafter at least monthly, depending on prior results.

- Currawong aviaries will be monitored for enteric parasite shedding every 2 weeks for the first month (half the aviaries each week) and then as dictated by prior results.

- Any bird that is unwell will be investigated. Isolation facilities are available if needed for sick birds. Diagnostic samples will be collected and sent to the mainland for testing as indicated. Euthanasia and necropsy investigation of a sick bird may be pursued in order to inform flock health management if infectious disease is suspected.

7.3 Sick bird procedures

Taronga staff are highly experienced in managing large numbers of birds held in intensively managed captive conditions and the facility is designed to be able to effectively isolate and quarantine sick or injured animals so they can receive specialist care and minimise transmission risks to other individuals. All pens including the six isolation pens have their own entry to allow staff to employ strict barrier nursing protocols when needed.

Staff with veterinary nurse qualifications and experienced in nursing, treatment, preventative health strategies, sample collection and infection control measures will be part of the on island team. Taronga will have a fully stocked pharmacy to cover likely/possible scenarios will be maintained on the island. There is the option to fly out additional pharmacy items as required.

Each morning all pens and aviaries will have visual checks, bird counts and morning observation conducted. Where a bird is presenting a physical injury, it will be observed and monitored throughout the day to determine if the injury is minor or if it requires intervention and catch up for inspection and weighing (a good indicator of illness). Catch ups are completed with the use of an entomological net, a common method used regularly by the bird staff at Taronga which is quick and painless for the bird. It allows the bird to be secured and taken to a quiet space for assessment. Staff with vet nursing qualifications will be onsite throughout the project, along with experienced bird keepers with ample experience in catching, assessing and managing minor physical injuries. Minor injuries are recorded in the daily reports which are monitored by Taronga vets daily. Discussions may be held with vets if the minor injury persists and the individual and/or its family group may be separated if it is deemed that special treatment is required.

Where a bird is presenting with clinical illness, signs of lethargy, feather loss, shedding, coughing, sneezing or other symptoms suggesting illness, the site supervisor will be notified for observation, assessment and if required, catch up.

The vet nurse and/or the Taronga vets will be consulted to discuss first aid treatment and determine the best course of action based on the symptoms presented, which may include isolating a pen, an individual, or an entire family group.

Where a pen is required to be isolated, barrier nursing protocols will be implemented including the use of foot baths for entry/exit of pens, dedicated footwear, equipment and prophylactic clothing.

Taronga's veterinarian will have daily and emergency contact with nursing and keeping staff and is available at short notice to attend the site as indicated.

In the event of a mortality, husbandry staff on the Island will be trained in conduction of necropsies and the collection of suitable samples for testing in the case of no veterinarian on site. It is intended that the veterinary nurse will undertake any necropsy exams however at least one other senior bird keeper present at any one time will be trained for this. Arrangements will also be in place for early transportation of dead birds to TZ for post mortem examination and samples for laboratory diagnostics. Specimens will be kept in an appropriate environment to ensure they are suitable for accurate diagnostics.

7.4 Decision Making Tree

Taronga will employ the use of a decision making tree to guide responses to the detection of an infectious disease in an apparently healthy bird or birds, outlined in attachment 13.

8. Emergency Procedures

8.1 Emergency plans

Taronga will follow the existing emergency procedure guidelines on Lord Howe Island. The team will liaise with LHIB in the event of emergency and follow existing emergency response protocols previously noted.

8.2 Emergency Response Plans for catastrophic events

Additional plans have been developed to accommodate for extreme scenarios: to temporarily remove up to 40 individuals to a secondary location on the island as an emergency response plan in the event of extreme weather risk only..

50 individuals will be selected (extra birds identified as a precaution) at the commencement of the project that represent a genetically and demographically robust representation of the wild Woodhen population. Birds will be selected that were captured from different locations on the island to maximise heterogeneity, in various age ranges, which will form the basis of an insurance population in the unlikely scenario of a catastrophic weather event. To note, there is no historical record of cyclones, extreme wind storms, electrical storms or bush fire at Lord Howe Island however recognise that a stochastic weather event could be possible.

Multiple safety houses will be identified and selected for use based on the type and location of the threat and could include (but not limited to) the State Emergency Services building, located near the LHIB office, The LHIB office space, the Community Hall, the golf course building/storage rooms or staff housing.

Where a risk is evident, staff will implement the Emergency Response Plan as follows;

- Liaise with LHIB, the local Bureau of Meteorology and local authorities such as the State Emergency Service and Rural Fire Service on the identified threat. LHIB general emergency procedures to be followed.
- Supervisor to notify all Taronga staff on island, brief on the situation and action plan, allocate tasks and timeline for completion and reporting back.
- Supervisor to confirm ID and location of birds for catch up. Pet packs prepared and ready to receive birds.

- Food for birds to be prepared and placed in clearly marked containers, ready for transport to safe house. Safe house will have access to fridges for maintaining fresh food, however noting the birds would be able to sustain on dry feed mix for multiple days.
- Staff paired and allocated to pens to catch up birds and settle into pet packs in preparation for transport.
- Checklist of equipment, food and basic vet supplies to taken to the safe house finalised for transport.
- Transport birds in van(s) to allocated safe house. Supervisor and two staff to stay with the birds to monitor and tend to any arising needs. Rotation of staff if required to stay overnight.
- Remaining staff to secure the operational site, equipment packed away into each building, check perimeter for any debris and secure the facility. If safe and deemed necessary, staff to remain onsite to monitor birds on rotating shifts.
- Ongoing liaison with LHIB to monitor the situation and determine timing regarding safe return to the facility.
- Once returned, additional monitoring of the birds as they are placed back into pens to ensure smooth transition into their original groups.

If the Emergency Response Plan is implemented, it would be possible to house the birds in these conditions for a period of up to 1 week without compromising health and welfare.

Taronga are confident this approach allows for the safe transport and management of a robust subset of the Woodhen population which will serve as mitigation to major risks to the main captive population. A detailed Emergency Response Plan will be further developed once the proposed captive management plan is endorsed.

Taronga staff involved in this project collectively has more than 100 years of bird keeping and conservation experience. Taronga has designed every aspect of this program with the highest level risk mitigation in mind. In the 2013 captive management trials we experienced no ill health of mortality with 100% of birds in our care returned to the wild. However this is unlikely to be repeated as we anticipate age related mortality will be present when housing 80% of the entire population.

Due to the low likelihood of a catastrophic event and the multiple risk management strategies in place to manage risk, Taronga has determined there is little benefit identified in holding an offshore population for the duration of the project and has ruled out this option for the following reasons;

- The disease risk remains the same or likely increases on mainland Australia, with potential for exposure to other elements not present at LHI
- Logistical challenges with transport limited to a few birds at a time via plane, increasing stress on the birds
- A risk of euthanasia of healthy birds if they are not able to be returned to Lord Howe Island
- Mainland holding facility having very limited (if any) Woodhen husbandry knowledge and experience.

More information regarding the offshore population proposal can be found in Attachment 14.

9. Risk Analysis

9.1 Captive Management Risk Register

The Risk Register covers risks identified for all captive management activities and a separate risk register has been developed to go into further detail for the veterinary and husbandry component (see 9.3). The full document is provided (Attachment 11) and covers risks, existing controls and mitigation strategies for;

- Staff resources
- Workplace injury
- Husbandry failure
- Facility failure
- Information failure
- Financial failure
- Loss of community support
- Extended holding periods
- Holding an offshore population

9.2 Disease profile

The disease profile conducted in 2007 (Attachment 12) indicated little evidence for infectious diseases affecting Woodhen. This is supported by lack of historical evidence for disease as cause of mortality in Woodhen. Migratory seabirds are considered low risk for introducing infectious disease to the Island. Birds on the Island will remain isolated from risk of novel disease introduction from the mainland during their time in care.

The disease risk profile would not change for a secondary on island population and actually increases for an off island population due to potential exposure of mainland diseases not found on Lord Howe Island.

9.3 Veterinary and Husbandry Risk and Risk Register and Management Overview

Despite lack of evidence for Woodhen carrying common infectious diseases it remains likely that they are at greater risk of disease due to common environmental or enteric organisms that may build up in numbers and overwhelm birds under stress e.g. salmonellosis, coccidiosis, mycobacteriosis during the period in care.

A risk assessment has been undertaken (Attachment 13) to identify additional management procedures to mitigate this risk of holding the birds in an intensively managed captive environment, and the below table supports this by highlighting the various approaches that would be adopted where a disease risk is present;

Disease	Transmission	Details	Trigger for implementing actions	Management Actions
Exotic avian viral diseases e.g. Highly pathogenic Avian influenza, Newcastles disease, flaviviruses	Low likelihood of transmission from migratory visitor birds to LHI	These viruses are exotic to Australia. Highly unlikely that would be first identified on LHI without detection in other parts of Australia first.	Detection of infection in subset of sampled birds on arrival into care.	Notifiable diseases- action dictated by DAWR

Endemic (known to be present in Australia) viral diseases, e.g. Avian circovirus (Beak and feather disease); Avian polyomavirus; avian paramyxovirus ;avian poxvirus	Direct contact with infected birds. (vector for-poxviruses)	No evidence of viral disease in Woodhen based on 2007 disease screening and historical records. Beak and feather disease mainly psittacines and mainly causing disease in young birds. Polyomavirus affects juvenile psittacines. Clinical disease, caused by virulent (or highly pathogenic) strains of APMV-1, has not been identified in Australian wild birds	These viruses considered very low risk for disease outbreak during captive management.	
Chlamydiosis *C. psittaci*	Ingestion and inhalation are thought to play the major role in transmission in wild birds. Persistent infections and extending shedding may occur from both gastrointestinal tract and nasal mucosa.	Can infect a range of species-presumably including LHI Woodhen. None detected in 2007 health assessment though non-specific test used. No reports of disease from LHI. Prevalence of avian chlamydiosis in wild birds in Australia is relatively low.	Subset of birds will be screened by PCR on arrival into care. Daily health monitoring for signs of disease, isolation of sick birds.	Option for in-water treatment of flock, or individual bird treatment if indicated based on PCR results.
Pasteurella multocida (avian Cholera)	Close bird-to-bird contact, inhalation or ingestion of contaminated materials. May cause mass mortality in densely housed birds based on overseas findings).	Outbreaks in species other than water birds are uncommon. Not common in wild birds in Australia, has been associated with mortality in wild waterfowl in Victorian wetlands. May cause outbreaks in commercial poultry. No history of outbreaks of disease in birds on LHI. Considered unlikely cause of illness on LHI.	Daily health monitoring for signs of disease, isolation of sick birds.	Maintain clean environment for birds with regular substrate changes, Prompt investigation and isolation of sick birds, full necropsy of dead birds including culture for organism. Option for individual or flock based antibiotic treatment.
Mycobacteriosis	Environmental (soil) contamination-not transmitted directly bird to bird	Mycobacteria including M avium and M genovense found in soil. Potential for build- up of large numbers of organisms in substrate with sick bird	Screening by faecal smear for Zn stain in subset of birds on arrival. Daily health monitoring for signs of disease, regular substrate changes	Isolate sick birds. Maintain infection control measures between enclosures.
Salmonellosis	Faecal/oral route. Carrier birds possible	None detected in 2007 screening. Potential for carrier birds to shed bacteria when brought into care. Outbreak of disease possible.	Screening of subset of birds on arrival into care. Daily health monitoring for signs of disease, isolation of sick birds.	Regular substrate change, spot cleaning of faeces. Enclosure treatment to eliminate shedding directed by results of faecal culture.

Other enteric bacteria (*E.coli, E. albertii, Campylobacter spp*.)	Faecal/ oral route	Carrier state possible, potential for disease outbreak.	Screening of subset of birds on arrival into care. Daily health monitoring for signs of disease, isolation of sick birds	Regular substrate change, spot cleaning of faeces Enclosure treatment to eliminate shedding directed by results of faecal culture
Coccidiosis	Faecal/oral. Potential for rapid build-up of infection with densely housed birds- can be fatal.	Identified in low numbers in 2005 and 2013 faecal screening	Faecal screening of each pen of birds on arrival and regularly through time in care. Regular substrate changes and spot cleaning for faeces	Preventative treatment of flock, regime based on faecal screening results
Other internal parasites (eg strongyles, roundworms, tapeworms, capillaria	Faecal/oral route. Some may have intermediate hosts e.g. insects	Strongyles seen in Woodhen in 2005 and 2013	Faecal screening of each pen of birds on arrival and regularly through time in care. Regular substrate changes and spot cleaning for faeces	Treatment based on faecal parasitology.
Ectoparasites (lice, biting flies etc)	Bird to bird during close contact. Single population means unlikely to introduce novel parasites	None identified in Woodhen historically or during disease risk assessment in 2007.Heavy burden may indicate unwell bird. Ectoparasites themselves unlikely to cause disease.	Heavy burden noted on arrival into care	Regular inspection to monitor infestation. Option for individual bird treatment if considered necessary.

10. Alternative Options Explored

As part of the consultation process, including discussions with LHIB, Taronga bird experts, DPI, conservation partners and other project stakeholders, a number of options were explored in determining the best approach for managing a captive population of Woodhen. This included maintaining all the birds on island, potential of multiple sites on island, as well as a temporary offshore population.

10.1 Secondary onshore facility

Details: Identify a secondary location to hold a small subset of birds.

Pros:

- Greater distance between the captive populations, theoretically decreasing risk of disease transmission via airborne vectors or catastrophic weather event. However in our risk assessment framework the extreme weather and disease risk profiles are the same as for a single on island population.

Cons:

- No significant benefit in managing disease risks within the individual pens, as all birds are exposed to similar conditions including pen size ratios, risk of cagemate trauma, non transmissible disease.
- Separation distance does not necessarily reduce the disease risk in a direct ratio as much as might reasonably be imagined i.e. 2km separation does not necessarily mean greater protection than 20m.
- Security concerns as it is extremely difficult to develop a secure site and ensure the safety of the birds.
- Considerable resource costs in identifying, building and staffing a secondary site.
- Logistical challenges with only one veterinary and food prep area on the island, resources required to move between sites daily and in carrying out routine health checks increases pressure on limited resources.
- One of the best way to prevent stress related disease is to have lengthy and in depth animal observations. Interactions and behaviour demonstrate how birds are coping and can show keepers early warning signs. This will be much harder to manage with two separate sites.
- The required husbandry staff resources with appropriate experience and expertise are not available for this option as Taronga has other bird conservation programs running at the same time as the REP.

10.2 Temporary offshore population

Details: Holding up to 40 birds, representative of a genetically robust population on the mainland at a purpose built facility for the duration of the project. This is to provide a temporary 'insurance' population in the case of a catastrophic event. Bio-security measures can be put in place to manage disease risks and to allow the birds to be returned to the island following the completion of the project.

Pros:

- Separation theoretically decreases risk of disease transmission or catastrophic weather event. However in reality disease risk profiles arising from captive handling are the same the island population and additional exposure to other diseases is possible.
- Additional Bio-security concerns can be effectively managed by holding the birds in conditions similar to quarantine to mitigate risk of avian diseases of concern.

Cons:

- Trials conducted in 2013 to test assumptions of holding Woodhen in captivity in higher than usual densities as a risk mitigation strategy, to minimise the need for individual birds having to be removed from the island.

- A minimum of 20 birds would be required in a perfectly healthy genetic population, however these birds have already once passed through a serious genetic bottleneck reducing their numbers down to 20 in the past. A minimum number of 40 is recommended to ensure a genetically robust population to avoid a population bottleneck. With a total estimated population of approximately 280 individuals, this means removing up to 15% of the total population with the risk of not being able to return them.
- Removing 20-40 birds from the island as a last ditch effort to save the population in the event of a serious catastrophic event on the island is seemingly a great plan for mitigation however, birds surviving two serious genetic bottle necks have the real risk of increased genetic problems, disease risk, infertility and failure to thrive, genetic mutations or worse.
- Birds held off island in the same conditions (stocking density, husbandry protocol etc,) share the same risk of fatality as those on the island.
- Many of the diseases of concern are not found on the island and by holding them on the mainland this presents opportunity for exposure, however quarantine conditions can mitigate this.
- Historical records do not show tsunami or cyclone whilst major storms, or fire risks to Lord Howe Island are very low. LHI have emergency procedures to accommodate such risks and an on island emergency program has been developed to relocate 40 birds to a safe house location on the island in the unlikely event of this occurring.
- As no space is available at Taronga Zoo nor appropriate avian husbandry resources at Dubbo, the mainland population would need to be held by another institution who have limited knowledge of the species and no husbandry experience which presents a significant risk. As described above detailed observation by experienced husbandry specialist id the best way to identify and manage disease, illness and injury.
- Birds need to be transported via plane with is a logistical challenge with only a few able to fly at a time and being costly. This is likely to increase bird stress and also presents husbandry challenges in introducing the birds into the temporary facility, as they need to be introduced all at the same time to avoid territorial and aggression issues. This may require chartering a plane to transport the birds all in one day.
- The required husbandry staff resources with appropriate expertise are not available for this option as Taronga has other bird conservation programs running at the same time as the REP.
- Significantly increased costs from current project budget.

10.3 Permanent offshore population

Details: Similar to the temporary mainland population plan, however would require a minimum of 40 Woodhen (20 males and 20 females) (to allow for improved genetic representation) to be sent to multiple, reputable mainland zoos.

Pros

- Aligns with Species Recovery Plans for the Woodhen.

Cons:

- This option is significantly different to a temporary population and presents different housing and husbandry requirements involving multiple institutions to house the birds either on or off public display in pairs, with natural habitat aviaries to accommodate natural behaviours including breeding and management of offspring by the host institutions.
- It is standard practice for more than one institution to house a permanent population. For 20 birds it would normally be 2-3 pairs at one institution, 5-6 maybe at another and 1-2 at another. There needs to be a stud book and a studbook keeper managing movements to ensure genetic diversity.
- This option will also require ongoing supply of new birds from LHI to be introduced regularly to maintain genetic diversity.
- Requires significant financial investment, planning, infrastructure, establishment of partnerships, consultation on display and potential exhibits, ownership, husbandry training, development of long term management

plans and breeding programs which are considered beyond the scope of the REP and have not been developed as part of the REP captive management program.

- There are also challenges in securing commitments from institutions to establish and maintain such populations, particularly in the time frame for the REP.
- Several Zoos consulted including Taronga and Melbourne have declined interest in this option.

Taronga's expert recommendation is to hold the captive population at the main facility which has been designed with bio-security measures and operating under strict husbandry practices to mitigate the key risks identified in relation to disease. An Emergency Response Plan has been established in response to events that are deemed unlikely due to historical trends, however note these may be possible and recommend that this approach enables the team to provide a high level of health, welfare, safety and protection for the birds.

The secondary onshore population doesn't effectively mitigate risks and presents additional challenges from a security, resource and husbandry perspective that deems it inefficient in terms of outcome verses benefits and is not recommended by Taronga.

A temporary offshore population has the benefit of mitigating against the unlikely catastrophic weather events and major disease outbreak, but these are again able to be managed onsite through the implementation of the mitigation strategies and facility designs that have been proposed in the recommended approach. The secondary onshore and temporary offshore share all of the same risks identified for the on island population but include additional risks relating to stress, exposure, bio-security, available avian expertise and the return of healthy birds back to LHI.

A permanent population is strongly recommended against as part of this project. It is recognised that this action is included in the species recovery plan however requires considerable planning, investment and agreement between multiple organisations and should be considered a separate project outside the scope of the REP.

Comments on Disease Risk Associated with the Temporary Captive Housing Proposal of the Lord Howe Island Woodhen and Lord Howe Pied Currawong during the Rodent Eradication Program

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Wildlife Health and Conservation

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Introductory Comments

I have read all of the material provided by the Taronga Conservation Society Australia. It is clear that a great deal of thought has been put into planning of this significant undertaking and, with the experience gained as the result of the preliminary housing trials, it is likely that this will be a successful undertaking with a relatively low risk for a major disease impact. However, I do have some suggestions that I feel will reduce this risk further.

Disease in captive animals is often the result of management practices. Suboptimal management practices may not be avoidable as in captive situations it is necessary to bring birds into closer contact and higher densities then they would ever be in the wild and it is difficult if not impossible to completely duplicate their natural environment and diet. Diseases that might arise from suboptimal husbandry include both infectious diseases and non-infectious diseases.

Infectious Diseases

Screening: The proposal includes a detailed approach to determining whether the wild birds coming into the temporary housing facility are well at the time of arrival and to rule out the possibility that they are carrying potential pathogens that could result in a disease outbreak. I consider this to be a measured and appropriate approach. I would, however, suggest that additional detail be provided regarding which enteric pathogens they will be testing for. Also, with any testing program, one needs to be prepared for what will happen if an animal is found to be positive for any of these pathogens. There are so many potential pathogens in this case it would be difficult to provide scenarios that would cover all eventualities. However, it might be helpful if a decision making process was outlined on how the veterinary staff would respond to the detection of an infectious disease in an apparently healthy bird or birds. Examples would be the isolation of Salmonella from a faecal culture or a bird that was PCR positive for *Chlamydia psittaci*. The results from several of these tests will only be available a week or more after the birds are put into their group pens so that needs to be included in a decision making tree.

Lessons from the Takahe: Another gallinaceous species that has been intensively managed is the New Zealand Takahe. A review of the diseases seen in this species can be found in McLelland, JM; Gartrell, BD; Roe, WD, A retrospective study of post-mortem examination findings in takahe (*Porphyrio hochstetteri*). New Zealand Veterinary Journal, Volume 59, Number 4, July 2011, pp. 160-165(6). Infectious diseases that have impacted this program are predominately bacterial and include *Escherichia coli*, *Erysipelas rhusiopathiae*, *Salmonella enterica* serovar *Typhimurium*, and

Pseudomonas aeruginosa. Some of these pathogens are diseases of poultry. Therefore, it should be recommended that the biosecurity protocols be reviewed to make sure that feral or semi-domestic chickens cannot gain access to the site. The woodhen diet does not contain raw eggs, but it is suggested that the currawongs be fed raw eggs and I would recommend against this. If eggs are to be fed, they should be cooked first. Another point to consider is how that woodhens will be fed. If they are fed on trays and provided water in shallow bowls, it would seem that there would be a good opportunity to faecal contamination of the food and water. Poultry feeders with multiple openings, as used for growing chickens, and poultry waterers might be considered (see images at the end of the document). *Pseudomonas aeruginosa* results from bacterial build up in moist environments. Dishwashers are particularly effective at disinfecting food and water dispensers and might be considered for these facilities.

Response to disease in an individual bird or multiple birds: I am concerned that the hospital facilities and the kitchen are in the same building. There needs to be a separate facility where sick or injured birds can be examined and treated that is separate from the food preparation facility. The smaller pens that will be built to temporarily house birds that need to be separated from the other birds are important. However, if there is a very sick or badly injured bird, a hospital cage with supplementary heat will also be needed. It is not stated what medical supplies will be left on the island, but the carers need to have appropriate antibiotics and pain medications, as well as, the necessary supplies for supportive care on the Island so that treatment can begin immediately once it is deemed necessary following remote veterinary consultation. Also, the plan to take dead birds off the Island for post-mortem examination should be changed. Shipping fresh or frozen birds off the island will make then less than suitable diagnostically. Instead, one or more of the staff should be trained to do a post-mortem examination collecting specimens for testing as well as formalin fixed tissues for histopathology.

There is currently a plan in place for the eventuality of a catastrophic weather event, where preselected birds will be caught up, placed in temporary portable enclosures, and moved to other facilities for short term housing. This plan is also to be put in place in the event of an infectious disease outbreak. I am not comfortable with this plan for a number of reasons. Depending what the disease outbreak is, it may have a significant incubation period and thus infected, but apparently healthy birds could be caught up and moved to the temporary emergency facilities possibly spreading the disease. Also, it is stated that the temporary housing facilities can be used for up to 7 days and not impact the birds and that by 7 days veterinarians should be able to determine the problem and make an appropriate plan. It is unlikely that the cause of a disease outbreak and the appropriate control efforts could be identified and instituted in one week. Therefore, I feel that the response to a disease outbreak needs to be reconsidered. There are so many possibilities as to what might cause an outbreak that it would be very hard to plan for all of them. However, I think some basic recommendations should be developed for responding to an outbreak of disease that includes keeping the birds *in situ* and how additional biosecurity protocols could be implemented to minimize the chance of the movement of disease between enclosures. Movement of birds off site should only be considered as an absolute last resort and it might be that it would be only possible to move some birds off site and not all, as some may already be exposed to the disease agent.

Aspergillus: One of the lessons learned from the previous housing trials was that it was difficult to get the pens to dry out. Adequate ventilation is going to be essential to prevent moisture build up

and mould growth in the enclosures. If ventilation is not adequate then aspergillosis is likely to be a problem for both species of birds. I do not know what extra measures are being considered to improve ventilation, but opening the aviaries as much as possible to take advantage of natural ventilation and the use of fans should be considered. A practical test of the effectiveness of ventilation in the enclosures would be to see how quickly small amounts of smoke are cleared from the enclosure. It should be a matter of a few minutes maximally.

It is unclear to me how densely planted the woodhen enclosures will be. While I see the value of natural plantings, they will also increase the amount of moisture needed in the environment as they will need to be watered and will result in retention of moisture in the environment. Therefore, if natural plants are to be used, it is recommended that increased ventilation be used to compensate for the increased moisture that may be associated with them.

Substrate: I cannot recommend that straw from the mainland be used as a substrate. It has been associated with aspergillosis in other species of birds. It is unclear to me how often and how much of the substrate in the woodhen enclosures will be changed. I would like to see this point clarified.

Minor points: Faecal screening for mycobacteria will be done as part of the disease surveillance component of this proposal. The sensitivity of this type of screening for mycobacterial infections is very low. So while it is fine to do this screening, it is very unlikely to detect infected birds. Also, it is stated in the proposal that pathogenic stains of avian polyomavirus are not present in Australia. This is not true, the disease occurs regularly in hand-raised parrots in Australia every year. This is just an information point as this virus should not impact either species.

Non-infectious Diseases

I have reviewed the feeding recommendations for these birds. While the diets seem sensible based on the feeding characteristics of the bird, the amount of food being offered is large, with the daily amount being fed to each bird representing approximately 50% of the bird's weight. Obesity is likely to be a problem with this amount of food on offer. It is therefore essential that weights on individual birds be carefully tracked and the amount of food that is being offered adjusted accordingly. If amount of food offered is reduced, this could also result in competition with dominate animals eating more and subordinate animals getting insufficient amounts, which is why monitoring weights of multiple birds in the enclosures will need to be done.

Comments on Offshore Housing

I would not recommend offshore housing under any circumstances. The opportunities for insect borne infectious (particularly parasitic) diseases are too high and animals from offshore facilities could not safely be returned to Lord Howe Island.

Comments on Second Onshore Housing Facility

Without going into detail, I believe that having a second onshore facility to mitigate potential disease impacts has some potential value. It would, however, significantly increase the cost as one would need to duplicate all of the support structures. It might also be necessary to increase the number of staff as it would be best to have staff only working at one site on the day that they work.

Given that disease outbreaks are considered to be relatively low risk, very close attention to work flow and hygiene may be the most important consideration for disease prevention and the cost benefit of having a second housing site may not merit one.

Conclusion

Overall, the proposal submitted by the Taronga Zoological Society for the temporary captive housing of the Lord Howe Island woodhen and the Lord Howe pied currawong are well thought out and are designed to minimise the chance of infectious and management related diseases. I have made some suggestions that I hope will be considered.

Images of feeders that could be substituted for trays when feeding the woodhens

Attachment M Lord Howe Island Group: Statement of Outstanding Universal Value

Brief synthesis

The Lord Howe Island Group is an outstanding example of oceanic islands of volcanic origin containing a unique biota of plants and animals, as well as the world's most southerly true coral reef. It is an area of spectacular and scenic landscapes encapsulated within a small land area, and provides important breeding grounds for colonies of seabirds as well as significant natural habitat for the conservation of threatened species. Iconic species include endemics such as the flightless Lord Howe Woodhen (Gallirallis sylvestris), once regarded as one of the rarest birds in the world, and the Lord Howe Island Phasmid (Dryococelus australis), the world's largest stick insect that was feared extinct until its rediscovery on Balls Pyramid.

About 75% of the terrestrial part of the property is managed as a Permanent Park Preserve, consisting of the northern and southern mountains of Lord Howe Island itself, plus the Admiralty Islands, Mutton Bird Islands, Balls Pyramid and surrounding islets. The property is located in the Tasman Sea, approximately 570 kilometres east of Port Macquarie. The entire property including the marine area and associated coral reefs covers 146,300 hectares, with the terrestrial area covering approximately 1,540 hectares.

Criterion (vii): The Lord Howe Island Group is grandiose in its topographic relief and has an exceptional diversity of spectacular and scenic landscapes within a small area, including sheer mountain slopes, a broad arc of hills enclosing the lagoon and Balls Pyramid rising abruptly from the ocean. It is considered to be an outstanding example of an island system developed from submarine volcanic activity and demonstrates the nearly complete stage in the destruction of a large shield volcano. Having the most southerly coral reef in the world, it demonstrates a rare example of a zone of transition between algal and coral reefs. Many species are at their ecological limits, endemism is high, and unique assemblages of temperate and tropical forms cohabit.

The islands support extensive colonies of nesting seabirds, making them significant over a wide oceanic region. They are the only major breeding locality for the Providence Petrel (Pterodroma solandri), and contain one of the world's largest breeding concentrations of Red-tailed Tropicbird (Phaethon rubricauda).

Criterion (x): The Lord Howe Island Group is an outstanding example of the development of a characteristic insular biota that has adapted to the island environment through speciation. A significant number of endemic species or subspecies of plants and animals have evolved in a very limited area. The diversity of landscapes and biota and the high number of threatened and endemic species make these islands an outstanding example of independent evolutionary processes.

Lord Howe Island supports a number of endangered endemic species or subspecies of plants and animals, for example the Lord Howe Woodhen, which at time of inscription was considered one of the world's rarest birds. While sadly a number of endemic species disappeared with the arrival of people and their accompanying species, the Lord Howe Island Phasmid, the largest stick insect in the world, still exists on Balls Pyramid. The islands are an outstanding example of an oceanic island group with a diverse range of ecosystems and species that have been subject to human influences for a relatively limited period.

Integrity

The boundary of the property includes all areas that are essential for maintaining the ecosystems and beauty of the property. It includes all of the above water remains of the ancient shield volcano and surrounding reefs and a substantial proportion of the Lord Howe Island and Balls Pyramid seamounts. The island component of the property is largely Permanent Park Preserve (PPP) and the surrounding waters are Marine Parks. The land area not included in the PPP is managed to ensure that the property's values are maintained. The inscribed property would be strengthened by the inclusion of the entire Commonwealth Marine Park.

At time of inscription concern was raised with respect to a proposal to construct four telecommunications masts without thorough assessment by way of an Environmental Impact Statement. These were then built, although today no longer exist. Other potential threats to the integrity of the property include development pressures, introduced plants and animals and visitor / tourism pressures. Since inscription, a programme improving the conservation status of the Lord Howe Woodhen, and the successful eradication of feral pigs, cats and almost eradication of goats has contributed significantly to the enhancement of World Heritage values beyond their status at listing.

Protection and management requirements

The property is subject to a comprehensive protection, management and monitoring regime which is supported by adequate human and financial resources.

All World Heritage properties in Australia are 'matters of national environmental significance' protected and managed under national legislation, the Environment Protection and Biodiversity Conservation Act 1999. This Act is the statutory instrument for implementing Australia's obligations under a number of multilateral environmental agreements including the World Heritage Convention. By law, any action that has, will have or is likely to have a significant impact on the World Heritage values of a World Heritage property must be referred to the responsible Minister for consideration. Substantial penalties apply for taking such an action without approval. Once a heritage place is listed, the Act provides for the preparation of management plans which set out the significant heritage aspects of the place and how the values of the site will be managed.

Importantly, this Act also aims to protect matters of national environmental significance, such as World Heritage properties, from impacts even if they originate outside the property or if the values of the property are mobile (as in fauna). It thus forms an additional layer of protection designed to protect values of World Heritage properties from external impacts.

In 2007 the Lord Howe Island Group was added to the National Heritage List in recognition of its national heritage significance.

On-ground management of the terrestrial component of the property is by the Lord Howe Island Board under the statutory framework of the Lord Howe Island Local Environment Plan (2010), which emphasises World Heritage values. Planning for the Permanent Park Preserve is the responsibility of the New South Wales Department of Environment, Climate Change and Water. Management of the marine areas (both State and Commonwealth waters) is the responsibility of the New South Wales Marine Park Authority.

Key threats requiring ongoing attention include fishing, tourism, invasive animals, plants and pathogens, and anthropogenic climate change. Visitor numbers are limited to control impacts and new Marine Park management and zoning plans are being developed for state and Commonwealth waters. Measures are being taken to prevent the introduction of new invasive plant species while significant resources are being directed towards the management and eradication of weeds. A proposal to eradicate introduced rodents is being developed.

Commonwealth of Australia **Gazette**

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SPECIAL

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Australian Government

Department of the Environment and Water Resources

Environment and Heritage Legislation Amendment Act (No. 1) 2003

DETERMINATION REGARDING INCLUDING WORLD HERITAGE PLACES IN THE NATIONAL HERITAGE LIST

In accordance with the provisions of item 1A of Schedule 3 of the *Environment and Heritage Legislation Amendment Act (No.1) 2003* (the Act), I, Malcolm Bligh Turnbull, Minister for the Environment and Water Resources, determine that the World Heritage properties set out in the Schedule to this instrument (the Schedule), being properties included in the World Heritage List, shall be included in the National Heritage List for those world heritage values that the World Heritage Committee has identified the property as having.

In accordance with subitem 1A(3) of the Act, each world heritage value that each place has because it meets the world heritage criterion listed in the Schedule is taken to cause the relevant World Heritage property to meet a National Heritage criterion corresponding to that world heritage value. These corresponding National Heritage criteria for each place are identified in the Schedule.

Dated 15/05/2007

[signed]

Malcolm Bligh Turnbull
Minister for the Environment and Water Resources

Cat. No. S9907
ISSN 1032-2345

SCHEDULE

World Heritage properties included in the National Heritage List

Place	Location	World Heritage Values*	Corresponding National Heritage Criteria*
Lord Howe Island Group	Lord Howe Island, NSW	(vii), (x)	(a), (b), (c), (e)
Willandra Lakes Region	Balranald, NSW	(iii), (viii)	(a), (b), (c), (g)
Greater Blue Mountains Area	Katoomba, NSW	(ix), (x)	(a), (b), (c), (d)
Central Eastern Rainforest Reserves	Lismore, NSW	(viii), (ix), (x)	(a), (b), (c), (d)
Great Barrier Reef	Townsville, Qld	(vii), (viii), (ix), (x)	(a), (b), (c), (d), (e)
Fraser Island	Eurong, Qld	(vii), (ix)	(a), (c), (d), (e)
Wet Tropics of Queensland	Cairns, Qld	(vii), (viii), (ix), (x)	(a), (b), (c), (d), (e)
Australian Fossil Mammal Sites (Riversleigh)	Gregory Downs, Qld	(viii), (ix)	(a), (c), (d)
Australian Fossil Mammal Sites (Naracoorte)	Naracoorte, SA	(viii), (ix)	(a), (c), (d)
Purnululu National Park	Halls Creek, WA	(vii), (viii)	(a), (c), (e)
Shark Bay, Western Australia	Denham, WA	(vii), (viii), (ix), (x)	(a), (b), (c), (d), (e)
Macquarie Island	Southern Ocean, Tas	(vii), (viii)	(a), (c), (d), (e)
Tasmanian Wilderness	Strathgordon, Tas	(iii), (v), (vi), (vii), (viii), (ix), (x)	(a), (b), (c), (d), (e), (g)
Kakadu National Park	Darwin, NT	(i), (vi), (vii), (ix), (x)	(a), (b), (c), (d), (e), (f), (g), (i)
Uluru - Kata Tjuta National Park	Yulara, NT	(v), (vi), (vii), (ix)	(a), (b), (c), (d), (e), (g), (i)
Heard and McDonald Islands	Southern Ocean	(viii), (ix)	(a), (c), (d)

* The World and National Heritage criteria are listed below.

World Heritage Criteria

(i) to represent a masterpiece of human creative genius;
(ii) to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;
(iii) to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;
(iv) to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;
(v) to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;
(vi) to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria);
(vii) to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
(viii) to 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) to 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) to 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.

National Heritage Criteria

(a) the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history;
(b) the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history;
(c) the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history;
(d) the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:
    (i) a class of Australia's natural or cultural places; or
    (ii) a class of Australia's natural or cultural environments;
(e) the place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
(f) the place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period;
(g) the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
(h) the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history;
(i) the place has outstanding heritage value to the nation because of the place's importance as part of indigenous tradition.

Attachment O Link to Marine Bioregional Plan for the Temperate East Marine Region

https://environment.gov.au/system/files/pages/1e59b6ec-8b7e-42a8-9619-b5d728f878b2/files/temperate-east-marine-plan.pdf

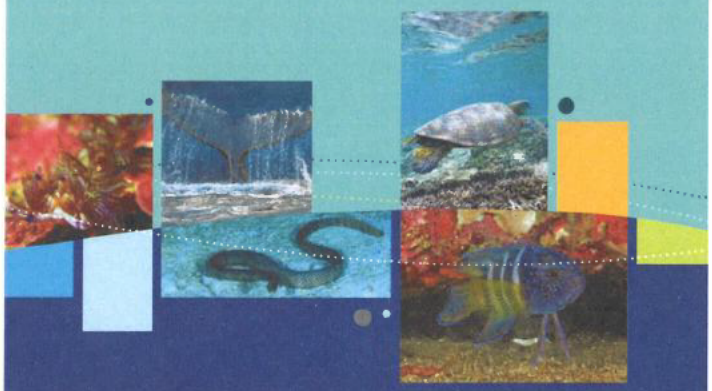
s11C(1)(a)

[redacted]

3.8.1

Australian Government

Department of Sustainability, Environment, Water, Population and Communities



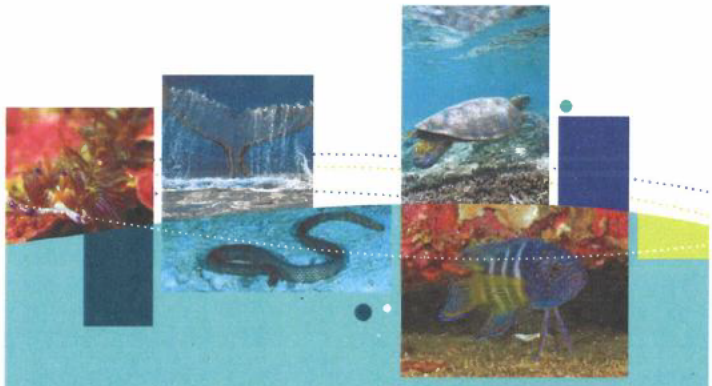
Marine bioregional plan for the Temperate East Marine Region

prepared under the *Environment Protection and Biodiversity Conservation Act 1999*

Images:
A Green turtle swims in shallows over reef top – GBRMPA, Blue Devil – D Harasti, Nudibranch – M Lawrence, Dubois' Sea Snake – GBRMPA, Whale tail – D Paton, Olive sea snake searching for food over coral and algae – GBRMPA, Flesh-footed shearwater and Bells Pygmied – I Hutton, Ruins wreck on Middleton Reef – Director of National Parks, Black-browed Albatross – M Double, Acropora species – R Chesher Ph.D, Red Sea Star – M Lawrence

Australian Government

Department of Sustainability, Environment, Water, Population and Communities



Marine bioregional plan for the Temperate East Marine Region

prepared under the *Environment Protection and Biodiversity Conservation Act 1999*

MINISTERIAL FOREWORD

Temperate East Marine Bioregional Plan

For generations, Australians have enjoyed a unique relationship with the sea.

Our oceans play a massive role in Australian life – they provide us with fish to eat, a place to fish, business and tourism opportunities and a place for families to enjoy.

Australians know, better than anyone, how important it is that our oceans remain healthy and sustainable.

Right now, our iconic marine environment is coming under more and more pressure from industry, from pollution and, increasingly, from climate change.

That is why the Australian Government has committed to creating a network of Commonwealth marine reserves around the country. We will protect our precious ecosystems in our oceans as we have done on land with our national parks.

The Temperate East Marine Region runs from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, and includes the waters surrounding Lord Howe and Norfolk Islands.

It is home to the critically endangered east coast population of grey nurse shark and has important offshore reef habitat at Elizabeth and Middleton Reefs and Lord Howe Island that support the threatened black cod.

It includes the southern-most extent of many reef-building coral species. A number of seamount chains run parallel to the coast in this region, and scientists have recently discovered that these features support hundreds of species, including some previously unknown to science.

These plans have been developed under the *Environment Protection and Biodiversity Conservation Act 1999* and backed by the best available science.

During the statutory consultation period, submissions were received from a wide range of stakeholders in the Temperate East Marine Region. The comments and information provided by communities and industries have informed the finalisation of the plan.

Our oceans contain a diversity of species and ecosystems which deserve protection. In this Temperate East Marine Bioregional Plan, you will find information about this extraordinary array of marine life and ecosystems.

Tony Burke
Minister for the Environment

CONTENTS

1 THE TEMPERATE EAST MARINE BIOREGIONAL PLAN

1.1 Introduction to Marine Bioregional Planning

Australia has one of the largest marine jurisdictions of any nation in the world. Australian waters cover 14.7 million square kilometres, including waters around the external territories of Cocos (Keeling), Christmas, Heard and McDonald Islands as well as waters adjacent to Australia's Antarctic Territory. Within that area, Commonwealth waters surrounding the Australian continent and Tasmania cover 7.4 million square kilometres. The biodiversity of Australia's vast marine jurisdiction has been recognised as globally significant. Australia's oceans provide a home to a diverse array of marine species including marine mammals and reptiles, more than 4000 species of fish and tens of thousands of species of invertebrates, plants and micro-organisms. Many of Australia's marine species are endemic, and therefore occur nowhere else in the world. Others utilise Australian waters as part of their global migrations.

As well as being home to an amazing diversity of marine environments, Australia's oceans support a range of marine industries, providing a significant contribution to the national economy. These industries include commercial fishing and aquaculture, petroleum and mineral exploration and production, shipping, ports, recreational and charter fishing, and tourism.

With 80 per cent of Australia's population living in the coastal zone, the marine environment has important social and cultural values, including recreational opportunities, amenity, cultural heritage, conservation and scientific significance. Many Aboriginal and Torres Strait Islander peoples have a close, long-standing relationship with coastal and marine environments and continue to rely on these environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies.

Marine bioregional planning is about improving the way Australia's marine environment is managed and helping our oceans to remain healthy and productive. Marine bioregional plans have been prepared under section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the South-west, North-west, North and Temperate East marine regions in Commonwealth waters around Australia (Figure 1.1) and relate to a number of matters of national environmental significance (Box 1.1).

A draft marine bioregional plan was released for the Temperate East Marine Region in November 2011 for a 90 day statutory consultation period. This final plan has been informed by comments received from a range of stakeholders including Commonwealth and state government agencies, industry, recreational and conservation organisations and members of the public. The Australian Government will work with stakeholders to achieve the objectives of the plan.

The preparation of marine bioregional plans represents an important step towards a genuine "ecosystem approach" (Box 1.2) to biodiversity conservation and marine resource management. The plans provide a basis for the recognition and valuation of the many essential and largely irreplaceable ecosystem services provided by the Australian marine environment, including food production, waste management, climate stabilisation and recreation.

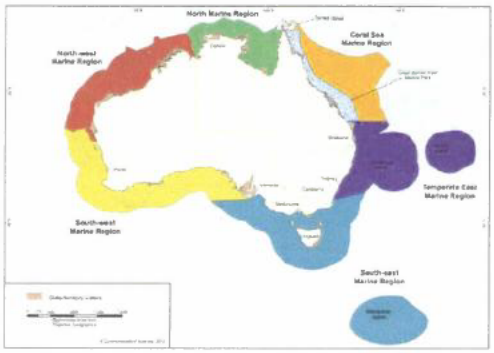


Figure 1.1: Australia's Marine Regions

Box 1.1 Matters of national environmental significance

Under the EPBC Act actions that have or are likely to have a significant impact on matters of national environmental significance require approval by the environment minister. There are currently eight matters of national environmental significance protected under the EPBC Act:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species (except those listed as extinct or conservation dependent) and ecological communities (except those listed as vulnerable)
- migratory species protected under international agreements
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- nuclear actions, including uranium mines.

Box 1.2 The ecosystem approach

What is it?

The ecosystem approach is one of the most important principles of sustainable environmental management. Essentially, it recognises that all elements of an ecosystem are interconnected and requires that the effects of actions on the different elements of an ecosystem be taken into consideration in decision-making.

Why do we do it?

Ecosystems are complex and interconnected—what affects one species or habitat will have cascading and possibly unpredictable implications for other species or habitats. In addition, different activities within a marine environment may affect different parts of the interconnected whole or amplify the impacts on particular parts of the natural system.

We wish to prevent problems rather than react to them. This is why we want to address the drivers of biodiversity loss, rather than their symptoms. A focus on building and maintaining the resilience of ecosystems is more efficient and effective than trying to address problems after they have occurred.

1.2 Goal and objectives of the plan

The Temperate East Marine Bioregional Plan aims to strengthen the operation of the EPBC Act in the region to help ensure that the marine environment remains healthy and resilient. The plan will be used by government and industry to improve the way the marine environment is managed and protected.

Consistent with the objectives of the EPBC Act, and in the context of the principles for ecologically sustainable development as defined in the Act, the plan sets the following objectives for the region:

- conserving biodiversity and maintaining ecosystem health
- ensuring the recovery and protection of threatened species
- improving understanding of the region's biodiversity and ecosystems and the pressures they face.

The marine bioregional plan will contribute to these objectives by:

- supporting strategic, consistent and informed decision-making under Commonwealth environment legislation in relation to Commonwealth marine areas
- supporting efficient administration of the EPBC Act to promote the conservation and ecologically sustainable use of the marine environment and its resources
- providing a framework for strategic intervention and investment by government to meet its policy objectives and statutory responsibilities.

The Temperate East Marine Bioregional Plan describes the marine environment and conservation values of the region, identifies and characterises the pressures affecting these conservation values, identifies regional priorities and outlines strategies to address them, and provides advice to decision-makers and people planning to undertake activities in the Temperate East Marine Region in relation to some of the region's conservation values.

1.3 Application of the plan

This plan is for the Temperate East Marine Region, which covers the Commonwealth marine area (Box 1.3) extending from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, as well as the waters surrounding Lord Howe and Norfolk islands (Figure 1.2). The plan does not cover state or territory waters but, where relevant, does include information about inshore environments and the way they interact with species and habitats of the Commonwealth marine area.

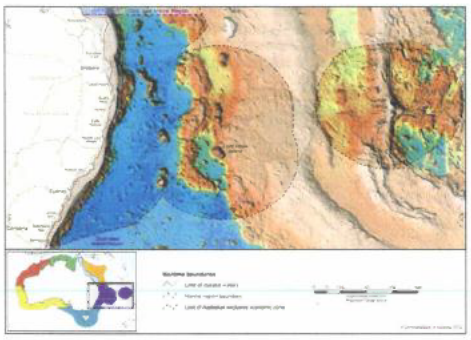


Figure 1.2: Temperate East Marine Region

Under section 176 of the EPBC Act, once a bioregional plan has been prepared, the minister responsible for the environment must have regard to it when making any decision under the Act to which the plan is relevant. The plan does not alter the scope of the minister's statutory responsibilities or narrow the matters the minister is required to take into account or may wish to take into account in making decisions. The EPBC Act provides that this plan is not a legislative instrument. This plan will commence six weeks after it is approved by the minister.

Box 1.3 Commonwealth marine areas

The Australian Government is responsible for the Commonwealth marine area (also known as Commonwealth waters) as defined in section 24 of the EPBC Act (glossary www.environment.gov.au/marineplans). The Commonwealth marine area extends beyond the outer edge of state/territory waters, generally some 3 nautical miles (or 5.5 kilometres) from the coast, to the boundary of Australia's exclusive economic zone, generally around 200 nautical miles (or 370 kilometres) from shore (Figure 1.3). In this plan, the Commonwealth marine environment refers to the environment in a Commonwealth marine area.

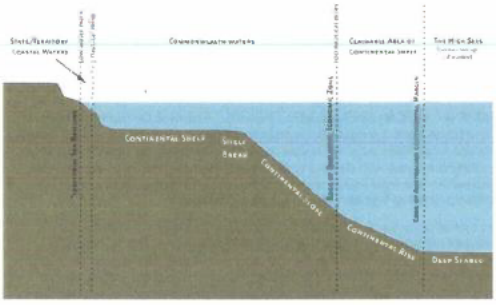


Figure 1.3: Australia's maritime zones

1.4 Key elements of the plan and supporting information

There were five key steps in the preparation of this marine bioregional plan.

1. Characterisation of the marine region

Currently available scientific and other information were used to describe the bio-physical environment and socio-economic characteristics of the marine region and its conservation values, including key ecological features, protected places and species and species groups protected by the EPBC Act. This information was combined in a Bioregional Profile for the region.

2. Regional analysis of the conservation values

The pressures potentially affecting conservation values were identified and characterised against a scale of *concern* in relation to their impacts on the values. The regional pressure analysis was informed by peer reviewed scientific literature, and its findings subject to external review by experts in the relevant fields. The outcomes of the regional pressure analysis are described in schedule 1 and informed both the identification of regional priorities (Part 4) and regional advice on matters of national environmental significance (Schedule 2).

3. Development of regional priorities

The regional pressure analysis assisted in the identification of conservation values that were, or potentially were, adversely affected by multiple pressures, as well as pressures that were impacting on multiple conservation values. Where warranted by the level of *concern*, these conservation values or pressures have been identified as regional priorities and consideration given to the strategies required to address them (Part 4).

4. Development of regional advice

The regional pressure analysis has also informed the development of regional advice in relation to matters of national environmental significance. This advice has been developed to assist people planning to undertake activities in Commonwealth marine areas to better understand and comply with their obligations under the EPBC Act, including helping them to decide whether to refer their proposed activity and determine what information would most usefully accompany any referral.

5. Public consultation on the draft marine bioregional plan

This marine bioregional plan was released in draft form for a 90 day public consultation period. The comments received have been taken into account in finalising this plan.

The plan is made up of a number of parts and is supported by a suite of information resources.

The plan

Part 1 (this part) of the plan provides context about marine bioregional plans. Part 2 of the plan describes the conservation values of the Temperate East Marine Region. Part 3 presents a summary of the analysis of pressures affecting conservation values in the region, undertaken to inform the development of regional priorities. Part 4 introduces the regional priorities and outlines strategies and actions to address them.

Schedules

Schedule 1 of the plan presents a full description of the pressures on conservation values of the Temperate East Marine Region that have been assessed as being *of concern* or *of potential concern*. Schedule 2 provides specific advice on matters of national environmental significance in the region. This regional advice will assist people who plan to undertake activities in, or potentially impacting on, the Commonwealth marine environment to better understand and meet their obligations under the EPBC Act. It will also assist in deciding whether a proposed action should be referred to the minister for assessment, and identify any information that is likely to be required as part of the referral.

Glossary

A glossary of terms used in this plan and relevant to marine bioregional planning is located at **www.environment.gov.au/marineplans**.

Conservation values report cards

The conservation values report cards contain comprehensive information about the conservation values of the Temperate East Marine Region. Conservation values include species and places protected under the EPBC Act and key ecological features. There are three types of conservation value report cards:

- protected species groups
- Commonwealth marine environment (including key ecological features)
- protected places.

The report cards support the information provided in this plan and are available at **www.environment.gov.au/marineplans/temperate-east**. They include:

- a description of the conservation values of the region
- an overview of the vulnerabilities and pressures on the conservation values (*of concern* and *of potential concern*)
- a list of relevant protection measures
- references.

Conservation Values Atlas

The Department of Sustainability, Environment, Water, Population and Communities, as the Australian Government department responsible for administering the EPBC Act, maintains a suite of interactive tools that allow users to search, find and generate reports on information and data describing matters of national environmental significance and other conservation values in the marine environment.

The Conservation Values Atlas is designed to provide a visual representation of the conservation values in each marine region. It shows the location and spatial extent of conservation values (where sufficient information exists) and is available at **www.environment.gov.au/cva**.

Other resources

A number of important reference documents for the Temperate East Marine Region are available at **www.environment.gov.au/marineplans**.

1.5 Who will use the plan?

People who have responsibility for, or interest in, management of marine based activities, environment protection and marine science

The Temperate East Marine Bioregional Plan is an important document for individuals and organisations with an interest in the region and the way national environmental law is administered within Commonwealth waters. The plan provides information that enables people to better understand the Australian Government's marine environment protection and biodiversity conservation responsibilities, objectives and priorities in the region.

People planning to undertake activities in Commonwealth waters, or planning to undertake activities that are likely to have a significant impact on the Commonwealth marine environment

The plan is not a legislative instrument and therefore does not alter the EPBC Act referrals process. People planning to undertake activities within the Temperate East Marine Region can use the plan and supporting information to help decide whether their proposal should be referred in accordance with the EPBC Act.

The minister and department administering the EPBC Act

The minister must have regard to the Temperate East Marine Bioregional Plan in making any decision under the EPBC Act to which the plan is relevant.

Other government agencies

The requirement to have regard to the Temperate East Marine Bioregional Plan in making decisions applies only to the Commonwealth minister administering the EPBC Act. However, the plan provides comprehensive information about the region that assists government decision-making relevant to the Commonwealth marine environment. The plan is underpinned by an ecosystem approach (Box 1.2). This approach requires government decision-makers to consider issues across jurisdictional, sectoral and disciplinary boundaries, so that actions are not considered in isolation from one another. The information provided in the plan assists decision-makers in the Australian Government and other jurisdictions to collaborate more effectively across jurisdictional and sectoral boundaries.

2 THE TEMPERATE EAST MARINE REGION AND ITS CONSERVATION VALUES

The Temperate East Marine Region comprises Commonwealth waters from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales. It also includes the waters surrounding Lord Howe and Norfolk islands (Figure 1.2). The region covers approximately 1.47 million square kilometres of temperate and subtropical waters and abuts the coastal waters of southern Queensland and New South Wales. It extends from shallow waters on the continental shelf, 3 nautical miles (5.5 kilometres) from shore, to the deep ocean environments at the edge of Australia's exclusive economic zone, 200 nautical miles from shore.

The main physical features of the region are:

- three seamount chains that run parallel to the East coast—the Tasmantid and Lord Howe seamount chains and the Norfolk Ridge
- the East Australian Current, which dominates the oceanography of the region. The East Australian Current brings warm waters from the Coral Sea south along the outer edge of the continental shelf until it moves offshore at approximately 33 degrees south (offshore from the central coast of New South Wales). Along its path, it gives rise to large eddy features that support important areas of enhanced productivity
- the Tasman Front, which forms between 20 and 30 degrees south and represents the meeting point for two distinct bodies of water—the warm, nutrient-poor Coral Sea and the cold, nutrient-rich Tasman Sea. Localised oceanographic processes along the Tasman Front trap nutrients and plankton, creating an important region of enhanced productivity and connectivity pathways
- the canyons of the eastern continental slope, which add critical habitat diversity to the region.

The remainder of this chapter describes the conservation values of the region, including the Commonwealth marine environment and its protected species and places.

2.1 Identification of conservation values

A range of conservation values have been identified in the Temperate East Marine Region. Conservation values are defined as those elements of the region that are:

- key ecological features of the Commonwealth marine area
- species listed under Part 13 of the EPBC Act that live in the Commonwealth marine area or for which the Commonwealth marine area is necessary for a part of their life cycle
- protected places including marine reserves, heritage places and historic shipwrecks in the Commonwealth marine area.

2.2 Conservation values—the Commonwealth marine environment

Biodiversity

The Temperate East Marine Region is characterised by a narrow continental shelf, significant variation in sea-floor features (including seamount chains and canyons), dynamic oceanography, and a unique mix of tropical and cold water reef systems. Temperate species dominate the southern parts of the region, and tropical species become progressively more common towards the north.

The region supports high levels of species richness and diversity, particularly among corals, crustaceans, echinoderms, molluscs, sea sponges and fish. Due to the latitudinal range of the region, this diversity includes both tropical and temperate species. Oceanography is a strong driver for the region's biodiversity. This is particularly true in places like Lord Howe Island and the Elizabeth and Middleton reefs where both warm and cold water species flourish alongside each other. These unusual communities are mainly supported by the tongue of warm water that is driven southwards by the East Australian Current, extending the geographic range of the tropical species.

Further offshore, the East Australian Current influences biodiversity by connecting remote communities, such as those found on the seamounts, through the transport of species between areas. Our understanding of these deeper areas is constantly developing; current data suggests that these areas support exceptional levels of species endemism (as high as 34 per cent) with little overlap in distribution across seafloor features. The varied sea-floor features in the region may function as isolated systems and could support species that may be new to science.

Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment in the Temperate East Marine Region that, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity.

The criteria used to identify KEFs in the region are:

- a species, group of species or community with a regionally important ecological role, where there is specific knowledge about why the species or species group is important to the ecology of the region, and the spatial and temporal occurrence of the species or species group is known
- a species, group of species or community that is nationally or regionally important for biodiversity, where there is specific knowledge about why the species or species group is regionally or nationally important for biodiversity, and the spatial and temporal occurrence of the species or species group is known
- an area or habitat that is nationally or regionally important for
  - enhanced or high biological productivity
  - aggregations of marine life
  - biodiversity and endemism
- a unique seafloor feature with ecological properties of regional significance.

KEFs were first described in the bioregional profile for each region and have since been modified as a result of further analysis and review by scientific experts.

Eight key ecological features have been identified in the Temperate East Marine Region (Figure 2.1 and Table 2.1). Further information on the KEFs can be found in the Commonwealth marine environment report card (**www.environment.gov.au/marineplans/temperate-east**). Understanding of KEFs may evolve as new scientific information emerges.

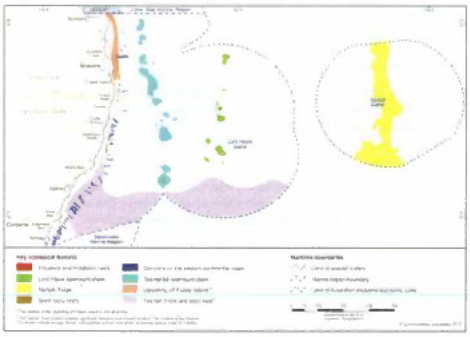


Figure 2.1: Key ecological features of the Temperate East Marine Region

Table 2.1: Key ecological features of the Temperate East Marine Region

Feature	Values	Description
Shelf rocky reefs	Unique sea-floor feature with ecological properties of regional significance	Along the continental shelf south of the Great Barrier Reef, communities associated with the shift from algae-dominated sea-floor communities to those dominated by attached invertebrates (including large sponges, moss animals and soft corals). This shift generally occurs at a depth of 45 m. These invertebrates create a complex habitat that supports a multitude of animals including crabs, snails, worms and starfish. The habitats also contain a diverse assemblage of bottom-dwelling fishes that show distinct patterns of association with shelf-reef habitats.
Canyons on the eastern continental slope	Unique sea-floor feature with ecological properties of regional significance	Canyon systems have a marked influence on the diversity and abundance of species, driven by the combined effects of steep and rugged topography, ocean currents, sea-floor types and nutrient availability. They significantly contribute to the overall habitat diversity of the sea floor, by providing hard surfaces in depth zones where soft sediment habitats prevail. Large benthic animals such as sponges and feather stars are abundant, with particularly high diversity found in the upper slope regions (150–700 m). Canyons also create localised changes in productivity in the water column above them, providing feeding opportunities for a range of species, many of which are commercially important or threatened.
Tasman Front and eddy field	High productivity; aggregations of marine life; biodiversity and endemism	The Tasman Front is a region of intermediate productivity that separates the warm, nutrient-poor waters of the Coral Sea from the cold, nutrient-rich waters of the Tasman Sea. The front is located between 27° S and 33° S, moving north during winter and south in summer. It is associated with warm-core eddies, a number of which are semipermanent features.
Upwelling off Fraser Island	High productivity; aggregations of marine life	In two areas near Fraser Island, upwellings of cold, deep waters mix with surface waters. Tides, wind and currents draw these nutrient-rich waters onto the shelf, where they generate blooms of phytoplankton that support animals higher in the food chain, including a number of commercially valuable and threatened species.
Tasmantid seamount chain	High productivity; aggregations of marine life; biodiversity and endemism	The Tasmantid seamount chain is a prominent chain of underwater volcanic mountains, plateaux and terraces that runs north–south at approximately 155° E, extending into the Tasman Basin. At the deepest point of the chain, features rise to a depth of 1400–900 m below sea level. At the northernmost extent, features rise to a depth of 400–150 m below sea level, with some breaking the surface to form islands. The Tasmantid seamount chain contains a range of habitats, from deep sea sponge gardens to near-pristine tropical coral reef systems. Collectively, these are biological hotspots with high species diversity. They are also known feeding and breeding grounds for a number of open ocean species (e.g. billfish, marine turtles, marine mammals) and have high species endemism.
Lord Howe seamount chain	High productivity; aggregations of marine life; biodiversity and endemism	The Lord Howe seamount chain runs for approximately 1000 km along the western margin of the Lord Howe Rise, extending from Lord Howe Island in the south to Nova Bank in the north. It supports tropical shallow coral reefs and deep cold water corals.

Feature	Values	Description
Norfolk Ridge	High productivity; aggregations of marine life; biodiversity and endemism	The Norfolk Ridge occurs in a region of remnant volcanic arcs, plateaux, troughs and basins. The ridge runs southward from New Caledonia to New Zealand, between the New Caledonia Trough to the west and the Norfolk Basin to the east. There are likely to be high levels of diversity in seamount communities, caused by relatively productive sea-floor habitats that support population densities far higher than surrounding areas. Benthic habitats along the Norfolk Ridge are also thought to act as 'stepping stones' for animal dispersal, connecting deep water species from New Caledonia to New Zealand.
Elizabeth and Middleton reefs	Aggregations of marine life; biodiversity and endemism	Elizabeth and Middleton reefs are small, isolated, oceanic platform reefs that occur on top of the volcanic seamounts of the Lord Howe seamount chain. The reefs are impacted by the East Australian Current, exposing the area to its warm waters as well as the surrounding cooler ocean. This key ecological feature supports tropical and temperate marine life, including both warm and cold water corals and over 300 fish species. The lagoons of both reefs are important areas for populations of black cod and the Galapagos shark.

2.3 Conservation values—protected species

The Temperate East Marine Region is an important area for protected species. Species listed under the EPBC Act are commonly referred to as protected species and can be listed as threatened species (critically endangered, endangered, vulnerable, conservation dependent), migratory species, cetaceans and marine species (see glossary for a full definition). An individual species may be listed under more than one category.

Threatened species are, in broad terms, those species that have been identified as being in danger of becoming extinct. Species may be listed in the following categories:

- conservation dependent
- vulnerable
- endangered
- critically endangered
- extinct in the wild
- extinct.

(see the glossary for further explanation of these categories).

Migratory species are those species that are listed under:

- the *Convention on the Conservation of Migratory Species of Wild Animals 1979* (CMS or Bonn Convention)
- the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA)
- the *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA)
- the *Agreement between the Government of Australia and the Government of the Republic Of Korea on the Protection of Migratory Birds 2007* (ROKAMBA)
- any other international agreement, or instrument made under other international agreements approved by the environment minister.

Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at **www.environment.gov.au/biodiversity/migratory/index.html**

Cetaceans (whales, dolphins and porpoises) are all are protected under the EPBC Act in the Australian Whale Sanctuary and, to some extent, beyond its outer limits.

Marine species belong to taxa that the Australian Government has recognised as requiring protection to ensure their long-term conservation (in accordance with sections 248–250 of the EPBC Act). (Refer to Table A in Schedule 2 for listed marine species in the region).

The lists of protected species established under the EPBC Act are updated periodically. This plan refers to the lists of protected species in the region and includes detailed information about species distribution and ecology in the Temperate East Marine Region. Species groups identified as conservation values in the Temperate East Marine Region are:

- bony fishes (10 species)
- cetaceans (9 species)
- marine reptiles (families Cheloniidae, Dermochelyidae, Hydrophilidae and Laticaudidae) (24 species)
- seabirds—(i.e. bird species that occur naturally in Commonwealth marine areas) (34 species)
- sharks (6 species).

Report cards describe the protected species (as of May 2012) and include detailed information about species distribution and ecology in the Temperate East Marine Region.

Biologically important areas have been identified for some of the region's protected species. These are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour such as breeding, foraging, resting or migration. They have been identified using expert scientific knowledge about species' distribution, abundance and behaviour in the region. The presence of the observed behaviour is assumed to indicate that the habitat required for the behaviour is also present. The selection of species for which biologically important areas have been identified was informed by the availability of scientific information, the conservation status of listed species and the importance of the region for the species. The range of species for which biologically important areas are identified will continue to expand as reliable spatial and scientific information becomes available.

The process for identifying biologically important areas involves mapping proposed areas digitally, based on expert advice and published literature, then obtaining independent scientific review of the maps and descriptions of the proposed areas.

Biologically important area maps and descriptions are available in the Temperate East Marine Region Conservation Values Atlas (**www.environment.gov.au/cva**).

2.4 Conservation values—protected places

Protected places are those places protected under the EPBC Act as matters of national environmental significance—places listed as World Heritage, National Heritage, or wetlands of international importance. Protected places may also include Commonwealth marine reserves and places deemed to have heritage value in the Commonwealth marine environment such as places on the Commonwealth heritage list or shipwrecks under the *Historic Shipwrecks Act 1976*.

Protected places in the region are shown in Figure 2.2 and described in Table 2.2.

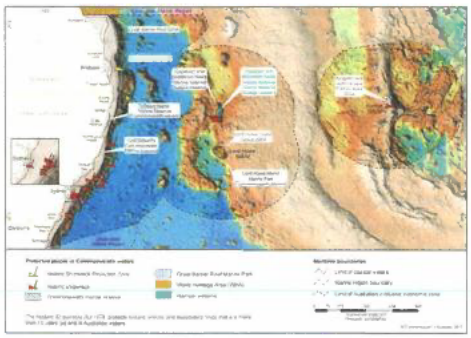


Figure 2.2: Protected places in the Temperate East Marine Region as of May 2012

Table 2.2: Protected places in the Temperate East Marine Region as of May 2012

Protected place	Protection measure	Relevant key ecological feature
Elizabeth and Middleton Reefs Marine National Nature Reserve	Commonwealth marine reserve Ramsar site	Elizabeth and Middleton Reefs
Solitary Islands Marine Reserve (Commonwealth waters)	Commonwealth marine reserve	
Cod Grounds Commonwealth Marine Reserve	Commonwealth marine reserve	
Lord Howe Island Marine Park (Commonwealth waters)	Commonwealth marine reserve World Heritage List National Heritage List	Lord Howe seamount chain

Commonwealth marine reserves are relevant in EPBC Act decision making on referred matters and explicitly referenced in the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines*.

3 PRESSURES AFFECTING CONSERVATION VALUES

3.1 Analysis of pressures on conservation values

The pressure analysis assessed present and emerging pressures affecting conservation values in the Temperate East Marine Region and the effectiveness of mitigation and management arrangements that are currently in place to address these pressures. The analysis enabled pressures to be categorised in terms of their relative importance or concern, and has informed the identification of regional conservation priorities and the development of regional advice. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values.

The analysis considered pressures affecting all key ecological features and protected places and a number of species belonging to the species groups bony fishes, cetaceans, reptiles, seabirds and sharks. Considerations used for selecting the species for analysis were specific to the biological characteristics of the species groups, but broadly centred on the relative significance of the region to the conservation of the particular species. In assessing the significance of the region for a species' conservation, key considerations included the species' conservation status, distribution, population structure within the region and life history characteristics, and the potential for the population(s) in the region to be genetically distinct from populations elsewhere. Table 3.1 lists and provides an explanation of the species selected for inclusion in the pressure analysis for the Temperate East Marine Region.

A range of pressures from a range of sources was considered in the pressure analysis. Table S1.1 in Schedule 1 provides a list of the type and source of pressures available for inclusion in the analysis. Not every type and source of pressure in this list was assessed against every conservation value. Only those pressures relevant to the conservation value being analysed were considered.

The analysis included a review of scientific and expert literature, and was informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion. The pressure analysis considered, for each selected conservation value, information derived from available reports and research about:

- the spatial location and intensity of the pressure(s), both current and anticipated
- the location of the conservation value—that is, its distribution and the location of areas important to it
- current understanding of impacts (at relevant scales) resulting from the interaction between the pressure(s) and the conservation value
- the effectiveness of current management and impact mitigation measures.

Table 3.1: Protected species selected for the pressure analysis

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Bony fishes	Species were selected on the basis of their occurrence in the region, their listing under the EPBC Act, and the importance of the region to their survival.	Eastern gemfish Orange roughy Black cod Big-bellied or pot-bellied seahorse Bullneck seahorse Duncker's pipehorse Great (Kellogg's) seahorse Hardwick's pipehorse Sad seahorse Weedy seadragon
Cetaceans	Species were selected on the basis of their occurrence in the region, their listing as threatened and/or migratory and/or cetacean species under the EPBC Act, and the importance of the region to their survival. The two inshore dolphin species selected, although generally coastal species, also occur in the Commonwealth marine environment of the Temperate East Marine Region. The Indo-Pacific humpback dolphin occurs in a variety of habitats, usually less than 20 m deep, including inshore reefs, tidal and dredged channels, mangroves and river mouths. The Indo-Pacific bottlenose dolphin occurs in riverine and coastal waters, shallow waters on the continental shelf and around oceanic islands.	Blue whale Dwarf minke whale Humpback whale Killer whale Fin whale Sei whale Southern right whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Marine Reptiles	Marine turtle species were selected on the basis of their occurrence in the region, their listing as threatened species under the EPBC Act, and the presence of important breeding or foraging areas for the species in and adjacent to the region. Sea snake species were selected on the basis of their occurrence in the region, and their listing under the EPBC Act as marine species.	Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Beaked seasnake Blue-lipped sea krait Colubrine sea krait Dubois' seasnake Elegant seasnake Horned seasnake Laboute's seasnake Little file snake Marbled or spine-tailed seasnake Olive-headed seasnake Olive seasnake Plain-banded seasnake Small-headed seasnake Spectacled seasnake Spotted seasnake Stokes' seasnake Turtle-headed seasnake White-bellied mangrove snake Yellow seasnake Yellow-bellied seasnake

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Seabirds	Seabird species were selected on the basis of their occurrence in the region, their listing as threatened and/or migratory and/or marine species under the EPBC Act, and the presence of important breeding or foraging areas for the species in and adjacent to the region. The Lord Howe Island group and Norfolk Island group support internationally and nationally significant breeding sites for a number of seabirds in the region.	Black noddy Common noddy Crested tern Roseate tern Sooty tern White tern Grey ternlet Flesh-footed shearwater Little shearwater Short-tailed shearwater Sooty shearwater Wedge-tailed shearwater Black petrel Black-winged petrel Gould's petrel Great-winged petrel Kermadec petrel Providence petrel White-bellied storm-petrel White-faced storm-petrel White-necked petrel Wilson's storm-petrel Northern giant-petrel Southern giant-petrel Antipodean albatross Black-browed albatross Campbell albatross Indian yellow-nosed albatross Salvin's albatross Wandering albatross White-capped albatross Little penguin Masked booby Red-tailed tropicbird

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Sharks	Shark species were selected on the basis that they were protected under the EPBC Act and have or are presumed to have important feeding, breeding or nursery areas within the region. They include species under consideration for listing under the EPBC Act known to occur in the Temperate East Marine Region.	Grey nurse shark Porbeagle shark Longfin mako shark Shortfin mako shark Whale shark White shark

3.2 Outcome of pressure analysis

Human pressures on marine ecosystems and biodiversity in the Temperate East Marine Region are, by global standards, low. However, the region is adjacent to the highly populated coasts of New South Wales and southern Queensland, and parts of the region closest to the coast will be subject to higher impact. These pressures are addressed, in part, by Australia's generally sound management of the marine environment.

A number of sources of pressures nevertheless exist in the region. The main drivers and sources of anthropogenic pressure on conservation values in the region are:

- climate change and associated large-scale effects, including shifts in major currents, rising sea levels, ocean acidification, and changes in the variability and extremes of climatic features (e.g. sea temperature, winds, storm frequency and intensity)
- extraction of living resources
- increasing urban and industrial development in areas adjacent to the region
- increasing shipping and port activities.

The findings of the pressure analysis are presented in Schedule 1 of the plan and in the Temperate East Marine Region conservation value report cards (**www.environment.gov.au/marineplans/temperate-east**).

4 REGIONAL PRIORITIES, STRATEGIES AND ACTIONS

4.1 Regional priorities

Regional priorities are key areas of focus that have been identified to inform decision-making about marine conservation and planning, as well as industry development and other human activities. The regional priorities provide context for implementing the government's statutory responsibilities, such as recovery planning for threatened species and the development and implementation of threat abatement measures. They also point to where future government initiatives and future investments in marine conservation, including in research and monitoring, would be best directed.

The identification of regional priorities for the Temperate East Marine Region has been guided by the outcomes of the pressure analysis. In identifying regional priorities, consideration has been given to the following:

- conservation values that are subject to
  - a pressure considered *of concern* for the conservation value, and
  - pressures that together are likely to result in cumulative impacts on the value, and/or
  - pressure(s) that are likely to increase substantially in intensity and extent over the next 5–10 years
- pressures that are considered *of concern* for multiple conservation values
- areas where better knowledge would improve the government's capacity to meet conservation and ecologically sustainable use objectives
- Australian Government policy priorities for the marine region.

Only a subset of conservation values and pressures assessed as being *of concern* or *of potential concern* has been identified as regional priorities. Generally, when a pressure affects multiple values and its effects are *of concern* for at least some of these values, then the pressure is identified as a regional priority. Similarly, if a conservation value is, or is likely to be, affected detrimentally by multiple pressures, and at least one of the pressures has been assessed as *of concern*, it is considered to be a regional priority. Other key considerations in determining pressure-based regional priorities included issues of scale, legislative responsibility, conservation status, effectiveness of existing management arrangements, and level of uncertainty about distribution, abundance and status of conservation values and the pressures acting on them.

Temperate East Marine Region priorities

This plan identifies 16 regional priorities for the Temperate East Marine Region: 12 conservation values and four pressures, which are further discussed in Tables 4.1 and 4.2 respectively. The strategies and actions to address these priorities are detailed in Section 4.2.

Building on the identification of regional priorities, available information and existing administrative guidelines, this plan provides advice to assist decision-makers, marine industries and other users to understand and meet the obligations that exist with respect to these priorities under the EPBC Act (Schedule 2).

Table 4.1: Conservation values of regional priority for the Temperate East Marine Region

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
1	**Inshore dolphins** Indo-Pacific humpback dolphin (EPBC Act listed as cetacean and migratory) Indo-Pacific bottlenose dolphin (EPBC Act listed as cetacean)	The Indo-Pacific humpback dolphin and Indo-Pacific bottlenose dolphin are known to occur in the Temperate East Marine Region. Both species are listed as cetacean while the Indo-Pacific humpback is also listed as migratory under the EPBC Act. The Tompots, Coal Mallow Region and adjacent waters are known breeding and foraging/feeding areas for both species. Dolphins are particularly vulnerable to impacts from human activities because of the overlap between their preferred inshore habitats and the highly populated coastal fringe. This vulnerability is compounded by biological characteristics such as late-age sexual maturation and low reproduction rates. Inshore dolphin species in the Temperate East Marine Region are subject to a number of pressures assessed as of concern: physical habitat modification (urban and coastal development), bycatch (commercial fishing) and bycatch (either protection). A further suite of pressures are of potential concern. These are: physical habitat modification (dredging and dredge spoil), climate change (ocean acidification, sea level rise, changes in sea temperature, changes in oceanography, changes in hydrological regimes), oil pollution (shipping), chemical pollution (onshore activities e.g. agricultural) and nutrient pollution (onshore activities e.g. agriculture), noise pollution (shipping, urban development), collision with the vessels and marine debris.	Strategy A: Action 3 and 6 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Action 1 and 5 Strategy E: Action 3

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
2	**Marine turtles** Green turtle Hawksbill turtle (EPBC Act listed as vulnerable, migratory and marine) Leatherback turtle Loggerhead turtle (EPBC Act listed as endangered migratory and marine)	Four of the world's seven marine turtles are known to inhabit the Temperate East Marine Region. All four species are listed as threatened under the EPBC Act. The region and adjacent areas are known to support important nesting and/or foraging areas for all four species. The varied use of the marine environment by marine turtles across different developmental stages (e.g. juvenile, young adult) means that they are exposed to a wide range of pressures. In the Temperate East Marine Region, marine turtles are subject to a number of pressures assessed as of concern and of potential concern, with differences in the two listings varying between the four species. For example, bycatch was assessed as of concern to green, loggerhead and leatherback turtles, and of *potential concern* to hawksbill turtles. Climate change, including sea level rise, changes in sea temperatures and sand temperatures was assessed as of concern to loggerhead turtles. Changes in sea temperatures and oceanography are of *potential concern* to green, hawksbill and leatherback turtles, while sea level rise is of potential concern to green turtles. Other pressures, such as chemical pollution/ contaminants, nutrient pollution, marine debris, light pollution, physical habitat modification, extraction of living resources, invasive species and oil pollution were rated *of potential concern* to one or more of the four species assessed. The conservation status of marine turtles, the significance of the Temperate East Marine Region to their recovery, and the pressures facing them in the region make this species group a priority for conservation effort.	Strategy A: Actions 2, 3 and 6 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Action 1 and 5 Strategy E: Actions 1 and 2 Strategy G: Action 1
3	**Grey nurse shark** (east coast population) (EPBC Act listed as critically endangered)	The Temperate East Marine Region and adjacent state waters are known to support aggregation, mating and pupping areas for the grey nurse shark. The Cod Grounds and Solitary Islands are also recognised as important areas for this species in Commonwealth waters. The eastern grey nurse shark population is subject to bycatch from both the commercial and recreational sectors; these pressures are assessed as of concern. Pressures of *potential concern* include climate change (changes in sea temperature, changes in oceanography) and human presence at sensitive sites. The grey nurse shark is a regional priority because of the species' conservation status, the importance of the region to the species and the pressures impacting the population in the region.	Strategy A: Actions 2 and 3 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Action 1 Strategy E: Actions 1 and 2

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
4	**White shark** (EPBC Act listed as vulnerable)	The Temperate East Marine Region and adjacent waters are known to support aggregations of the white shark. White sharks move seasonally along the coast between temporary residence areas which typically correspond to regions of high prey density. The Stockton Beach—Hawks Nest area and Fraser Island are recognised as aggregation areas. The white shark is vulnerable to a number of pressures. Bycatch from the recreational fishing sector is considered of concern, while a range of additional pressures are considered of *potential concern*. These include bycatch (commercial fishing), extraction of living resources (non-domestic commercial fisheries), extraction of living resources (illegal, unreported and unregulated fishing) and climate change (changes in sea temperature and oceanography). The white shark is a regional priority because of the species' conservation status, the importance of the region to the species and the pressures impacting the population in the region.	Strategy A: Actions 2, 3 and 6 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Action 1 Strategy E: Actions 1 and 2

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
5	**Seabirds breeding on islands in the Temperate East Marine Region** Tarns (including noddies) Black noddy Common noddy Crested tern Sooty tern White tern Grey-faced petrel Shearwaters Fleshi footed shearwater Little shearwater Short tailed shearwater Wedge-tailed shearwater Petrels Black-winged petrel	A number of islands across the region support globally important nesting sites, most notably the Lord Howe and Norfolk Island groups, as well as a series of smaller islands along the NSW coast, including Cabbage Tree, Broughton, Little Broughton and Montague islands. In addition to nesting activity, the surrounding waters support foraging areas for parents to provide food for chicks. Seabirds breeding in the region are subject to a range of pressures. Invasive species are considered to be of concern. Pressures rated of potential concern are: climate change (changes in sea temperature and oceanography: ocean acidification); oil and chemical pollution and contaminants (shipping); marine debris; light pollution (for selected petrel and shearwater species); bycatch (for selected shearwater species) associated with commercial and recreational fishing and human presence at sensitive sites. The analysis of these pressures varied across the twenty species, and these rating examples have not been applied uniformly. Breeding seabirds are a regional priority because of their conservation status, the importance of the region in the provisioning of young, the pressures impacting populations in the region, and their status as an Australian Government policy priority.	Strategy A: Actions 2, 3 and 6 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Actions 1 and 5 Strategy E: Actions 1 and 2 Strategy G: Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
5	Gould's petrel (EPBC Act listed as endangered) Kermadec petrel Providence petrel White-bellied storm-petrel (EPBC Act listed as vulnerable) White-faced storm-petrel White-necked petrel Other Little penguin Masked booby Red-tailed tropicbird	A number of islands across the region support globally important nesting sites, most notably the Lord Howe and Norfolk Island groups, as well as a series of smaller islands along the NSW coast, including Cabbage Tree, Broughton, Little Broughton and Montague islands. In addition to nesting activity, the surrounding waters support foraging areas for parents to provide food for chicks. Seabirds breeding in the region are subject to a range of pressures. Invasive species are considered to be of concern. Pressures rated of potential concern are: climate change (changes in sea temperature and oceanography: ocean acidification); oil and chemical pollution and contaminants (shipping); marine debris; light pollution (for selected petrel and shearwater species); bycatch (for selected shearwater species) associated with commercial and recreational fishing and human presence at sensitive sites. The analysis of these pressures varied across the twenty species, and these rating examples have not been applied uniformly. Breeding seabirds are a regional priority because of their conservation status, the importance of the region in the provisioning of young, the pressures impacting populations in the region, and their status as an Australian Government policy priority.	Strategy A: Actions 2, 3 and 6 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Actions 1 and 5 Strategy E: Actions 1 and 2 Strategy G: Action 1
6	**Shelf rocky reefs**	Shelf rocky reefs of the Temperate East Marine Region support a range of complex benthic habitats that, in turn, support diverse benthic communities. The ecosystem functioning and integrity of Temperate East shelf rocky reefs are subject to a number of pressures rated as of potential concern: bycatch and extraction of living resources (commercial fishing); physical habitat modification (fishing gear); climate change (ocean acidification, changes to sea temperature and oceanography) and marine debris. It has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A: Actions 3 and 4 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Actions 1 and 2 Strategy F: Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
7	**Canyons on the western continental slope**	The canyons on the eastern continental slope provide habitat (through changes in topography and productivity) that supports a diverse range of benthic, demersal and pelagic species. The ecosystem functioning and integrity of the canyons are subject to a number of pressures rated as of potential concern: physical habitat modification (bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and oil and chemical pollution/ contaminants (shipping). The canyons on the eastern continental slope have been identified as a regional priority on the basis of their important contribution to the region's biodiversity. This selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A: Actions 3 and 4 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Actions 1 and 2 Strategy F: Action 1
8	**Tasman Front and eddy field**	The Tasman Front and eddy field contains complex and dynamic oceanographic processes supporting transient patches of enhanced productivity that, in turn, attract aggregations of species across trophic levels, including top predators such as tuna and sharks. This feature also supports biological connectivity with seamount habitats further offshore. The ecosystem functioning and integrity of this key ecological feature is subject to a number of pressures rated as of potential concern: bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and shipping-related oil and chemical pollution/ contaminants. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A: Actions 3 and 4 Strategy B: Action 1 Strategy C: Action 3 Strategy D: Actions 1 and 2 Strategy F: Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
9	**Upwelling off Fraser Island**	The upwelling off Fraser Island provides nutrient-rich waters which support a range of species, including a number of commercially valuable and protected species. The ecosystem functioning and integrity of the upwelling are subject to a number of pressures rated as of potential concern: bycatch and extraction of living resources (commercial fishing); climate change (changes to sea temperature and oceanography); marine debris; and ship-related oil and chemical pollution. This upwelling has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A, Actions 3 and 4 Strategy C, Action 3 Strategy D, Actions 1 and 2 Strategy F, Action 1
10	**Tasmanid seamount chain**	The Tasmanid seamount chain supports aggregations of marine life, biodiversity and endemism. The feature supports a range of habitats in temperate and subtropical waters, significant demersal and pelagic diversity, important feeding and breeding sites for a number of open ocean species (e.g. billfish, marine turtles, marine mammals) and high levels of endemism. The ecosystem functioning and integrity of this key ecological feature is subject to a number of pressures rated as of potential concern: bycatch and extraction of living resources (commercial fishing), climate change (changes to sea temperature and oceanography), marine debris, and shipping-related oil and chemical pollution. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity and endemism. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A, Actions 3 and 4 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Actions 1 and 2 Strategy F, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
11	**Lord Howe seamount chain**	The Lord Howe seamount chain supports egg-bearing (brooding) and endemism. It provides important benthic habitat diversity and is thought to act as an important biological 'stepping stone' connecting deepwater fauna from New Caledonia to New Zealand. The ecosystem functioning and integrity of the seamount chain are subject to a number of pressures rated of potential concern: bycatch and extraction of living resources (commercial fishing activities); climate change (ocean acidification, changes to sea temperature and oceanography); marine debris; and shipping-related oil and chemical pollution. The Lord Howe seamount chain has been identified as a regional priority on the basis of its important contribution to the region's biodiversity and endemism. Its selection also acknowledges the need to prioritise research to further understand its ecological functioning.	Strategy A: Actions 3 and 4 Strategy B: Action 1 Strategy C: Action 2 Strategy D: Actions 1 and 2 Strategy F: Action 1
12	**Elizabeth and Middleton reefs**	The Elizabeth and Middleton reefs support aggregations of marine life, biodiversity and endemism. A small and isolated area, the reefs supports a diverse range of tropical and temperate marine life, including both warm water and cold water corals, and over 200 fish species. The lagoons of both reefs are strongholds for populations of black cod and the Galapagos shark. The ecosystem functioning and integrity of the reefs are vulnerable to climate change impacts, particularly changes in sea temperature and ocean acidification, pressures that have been rated as of concern. Pressures rated of potential concern are: sea level rise; changes in oceanography; marine debris; and shipping-related oil, chemical and light pollution. The Elizabeth and Middleton reefs are identified as a regional priority on the basis of their important contribution to the region's biodiversity and endemism. The pressures impacting on those values, and its status as an Australian Government priority as an existing Commonwealth marine reserve.	Strategy A: Actions 3 and 4 Strategy B: Action 1 Strategy C: Action 3 Strategy F: Action 1

Table 4.2: Pressures of regional priority for the Temperate East Marine Region

	Pressure	Rationale	Strategies and actions identified to address the priority (see section 4.2)
13	**Climate change**	Climate change-related pressures including changes in sea temperature and oceanographic processes, ocean acidification, sea level and storm intensity, are predicted to increase in the Temperate East Marine Region, with the potential to impact the region's conservation values (key ecological features and protected species) to varying extents. There is considerable variation in the ratings of concern and of potential concern across the conservation values. Overall, changes in sea temperatures and oceanography were considered of potential concern to many of the key ecological features and species, with ocean acidification of greater significance for deep and shallow water reef features, cetaceans and seabirds and sea level rise more important for habitats associated with inshore dolphins and some breeding seabirds. Increasing sand temperature was identified as a pressure for nesting marine turtles. Climate change has been identified as a priority because of the extent of predicted impacts on conservation values in the region, particularly the cumulative nature of these impacts. Its selection also acknowledges the need to prioritise research to further understand the nature and extent of climate change impacts in the region.	Strategy A: Action 3 Strategy B: Action 2 Strategy E: Action 1 Strategy G: Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
14	**Marine debris**	The EPBC Act lists 'injury and fatality to vertebrate marine life caused by the ingestion of, or entanglement in, harmful marine debris' as a key threatening process. Information on the extent and impact of marine debris in the Temperate East Marine Region is limited, however, a number of activities in and adjacent to the region increase the likelihood of the prevalence of marine debris, including commercial and recreational fishing, shipping, and urban and industrial development along the coast. In the Temperate East Marine Region, marine debris has emerged as a pressure with the potential to impact on many of the region's conservation values to varying extents. It has been assessed as of concern for marine turtles (green and loggerhead) and of potential concern for cetaceans, seabirds, school sharks and all key ecological features. Marine debris has been identified as a priority because of its interaction with a range of conservation values across the region, and its status as an Australian Government policy priority. Its selection also acknowledges the need to prioritise research to further understand the nature and extent of its impacts in the region.	Strategy A: Action 5 Strategy B: Action 2 Strategy E: Actions 1 and 4 Strategy G: Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
15	**Bycatch**	Bycatch associated with fishing activities is one of the most pervasive pressures on conservation values in the region. Bycatch refers to marine life that is accidentally caught during fisheries operations and cannot be retained, thereby impacting on species populations and the diversity associated with key ecological features. The Temperate East Marine Region supports a significant commercial fishing industry and bycatch from commercial fishing activities has been assessed as of concern for inshore dolphins, killer whale, marine turtles (green, loggerhead and leatherback), the grey nurse shark and foraging seabirds (selected petrel, albatross and shearwater species). It is considered of potential concern for narrowbill turtle, white shark, foraging seabirds (selected shearwater, albatross and petrel species) and a number of key ecological features (Tasman Front and eddy field, upwelling off Fraser Island, Norfolk Ridge, Tasmanid and Lord Howe seamount chains, shelf rocky reefs and canyons). Bycatch from recreational fishing has also been identified as of concern for grey nurse and white sharks, and of potential concern for the flesh-footed shearwater. In addition, bycatch from bather protection schemes is of concern for the Indo-Pacific (coastal) bottlenose dolphin and the Indo-Pacific humpback dolphin and bycatch from illegal fishing activities is of concern to four turtle species, and of potential concern for the humpback whale. Bycatch has been identified as a priority because of its interaction with a high number of priority conservation values across the region.	Strategy A: Action 5 Strategy B: Action 2 Strategy D: Action 1 Strategy E: Actions 1 and 4

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
18	Extraction of living resources	A number of conservation values in the Temperate East Marine Region are vulnerable to the extraction of living resources by commercial and recreational fishing and illegal, unregulated and unreported fishing. Commercial fishing effort overlaps with seven of the eight key ecological features in the region, and was assessed as of potential concern for these features. Currently, it is difficult to quantify the exact impacts of target and by-product species take at these features however, depending on the intensity of effort and composition of catch, the extraction of living resources from these key ecological features has the potential to affect trophic structure and ecological functioning. Extraction of living resources has been identified as a priority because it interacts with multiple conservation values, and because there is a limited understanding of risk/impacts on ecosystem function	Strategy A: Action 5 Strategy B: Action 2 Strategy D: Action 2 Strategy E: Action 1 and 4 Strategy G: Action 1

4.2 Strategies and actions

The Temperate East Marine Bioregional Plan includes seven strategies to address its priorities:

Strategy A: Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision-making.

Strategy B: Establish and manage a Commonwealth marine reserve network in the Temperate East Marine Region as part of a national representative system of marine protected areas.

Strategy C: Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act.

Strategy D: Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species.

Strategy E: Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government and state and territory agencies with responsibilities for the marine environment.

Strategy F: Improve monitoring, evaluation and reporting on ecosystem health in the marine environment.

Strategy G: Participate in international efforts to manage conservation values and pressures of regional priority.

Within each strategy, actions have been designed to address one or more of the regional priorities. A few actions are not linked directly to regional priorities but have been included as enabling actions—that is, they provide the necessary foundation and/or mechanisms for addressing the regional priorities in a coordinated, effective and efficient way.

Actions under the strategies are classified in terms of their implementation timeframe:

- **immediate actions** are those expected to be implemented within 6–12 months (these usually relate to priorities where the level of *concern* is high and management responses are either under way or expected to begin in the near future)
- **short-term actions** are those expected to be implemented within 2 years
- **medium-term actions** are those expected to be implemented within 3–5 years
- **long-term actions** are those expected to be implemented within 8–10 years, and usually relate to research into ecological effects that involves observational studies requiring long timeframes
- **ongoing actions** commonly cover routine administrative decision-making under the EPBC Act (e.g. administration of the fisheries assessment provisions).

The actions identified to address the Temperate East Marine Region's priorities are listed under each strategy (in no particular order) below:

Strategy A:
Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision-making

1. Improve existing mechanisms and establish new mechanisms to facilitate the uptake of marine research findings so that they can inform administrative and management decisions (short term).
2. Support research undertaken through relevant recovery plans for marine turtles, seabirds, white shark and grey nurse shark (regional priorities 2–5— short term).
3. Support research to improve information on the impacts of climate change on protected species and key ecological features, in particular, their vulnerability and adaptive capacity to predicted changes (regional priorities 1–13—medium to long term).
4. Improve knowledge of the processes driving biodiversity and ecosystem functioning of priority key ecological features of the Temperate East Marine Region (regional priority 6–12—medium to long term).
5. Improve knowledge on the pressures of marine debris, bycatch and extraction of living marine resources on conservation values in the Temperate East Marine Region (regional priorities 14–16—short to medium term).
6. Improve information on biologically important areas for protected species and species considered under pressure within the Temperate East Marine Region, with priority given to:
   - inshore dolphin (regional priority 1—short to medium term)
   - marine turtles (regional priority 2—short to medium term)
   - white shark (regional priority 4—short to medium term)
   - seabirds (regional priority 5—short to medium term).

Strategy B:
Establish and manage a Commonwealth marine reserve network in the Temperate East Marine Region as part of the national representative system of marine protected areas

1. Ensure that management arrangements for marine reserves contribute to the protection and conservation of the region's biodiversity and ecosystem function and integrity (regional priorities 1–8 and 10–12—medium to long term).
2. Ensure that management arrangements for the reserves minimise, where appropriate, the risk and impacts of pressures rated as being *of concern* or *of potential concern* in the Temperate East Marine Region (regional priorities 13–16—medium to long term).

Strategy C:
Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act

1. Improve access to information, particularly spatial data, on the region's key ecological features and protected species and the pressures on them (short to medium term).
2. Assess the need for—and, if appropriate, promote—strategic assessments under the EPBC Act of coastal and inshore marine environments adjacent to the region that are expected to experience rapid change and have the potential to increase pressure on the Commonwealth marine environment (short to medium term).
3. Provide regional advice to assist in assessing and determining the significance of potential impacts on the region's conservation values to the extent that they are (or are components of) matters of national environmental significance (see Schedule 2) (regional priorities 1–12—immediate).
4. Evaluate the role of the plan and its supporting information resources in streamlining the decision-making under the EPBC Act at all levels (i.e. the environment minister, the environment department, or persons proposing to take actions likely to impact on matters of national environmental significance in the Temperate East Marine Region (short to medium term).

Strategy D:
Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species

1. Collaborate with relevant fisheries management organisations and industry to support research, information exchange and the development of improved management initiatives to address bycatch of protected species—particularly marine turtles, inshore dolphins, grey nurse shark, white shark, killer whale and breeding seabirds—focusing on improving information on the cumulative effects of bycatch across multiple fisheries and the establishment of ongoing monitoring indicators (regional priorities 1–4, 6–11 and 15—short to medium term).
2. Collaborate with relevant fisheries management organisations and industry to support research into the impacts of the extraction of living marine resources on key ecological features and improve management initiatives where appropriate (regional priorities 6–11 and 16—short to medium term).
3. Collaborate with industry and research organisations to improve mechanisms for data collection, management and reporting of interactions between industries and biodiversity (short to medium term).
4. Pursue, where feasible, collaborative agreements authorising the shared use of industry-gathered marine information, particularly spatial data (short to medium term).
5. Collaborate with industry to improve understanding of the effects of vessel collision and marine debris on marine turtles; invasive species on breeding seabirds; and physical habitat modification arising from urban and coastal development on inshore dolphins (regional priorities 1, 2 and 5—short to medium term).

Strategy E:
Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government, state and territory agencies and coastal communities with responsibilities for the marine environment

1. Collaborate with relevant government agencies and coastal communities to implement mitigation measures to address the key pressures on marine turtles, seabirds, grey nurse and white shark, and assess their effectiveness in reducing the risk to the species' recovery (regional priorities 2–5, 13–15—short to medium term).
2. Collaborate with the Queensland and New South Wales governments and coastal communities to develop protection measures to limit disturbances during the nesting season for marine turtles and seabirds, the pupping season for grey nurse shark, and seasons of aggregation for white shark, focusing on areas in proximity to inhabited areas or areas where sources of disturbance exist or are emerging (regional priorities 2–5—short to medium term).
3. Collaborate with the Queensland and New South Wales governments to develop protection measures to minimise the impacts of bather protection programs on inshore dolphins (regional priority 1—short to medium term).
4. Increase information on the sources and impacts of marine debris, bycatch and extraction of living resources on the region's marine life and ecosystems, including supporting monitoring of these pressures at selected locations in and adjacent to the Temperate East Marine Region (regional priorities 14–16—short to medium term).

Strategy F:
Improve monitoring, evaluation and reporting on ecosystem health in the marine environment

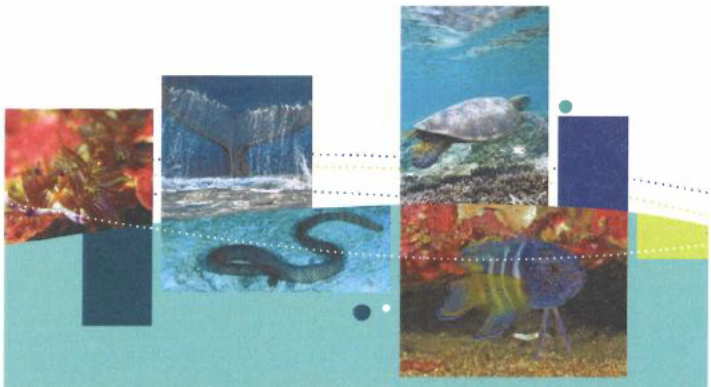
1. Collate information on the ecosystem components, functioning, pressures and potential cumulative impacts on key ecological features in the region and develop effective ecological indicators that will facilitate future monitoring, evaluation and reporting of marine ecosystem health (medium to long term).

   Key ecological features to be investigated are:
   - shelf rocky reefs (regional priority 6)
   - canyons on the eastern continental slope (regional priority 7)
   - Tasman Front and eddy field (regional priority 8)
   - upwelling off Fraser Island (regional priority 9)
   - Tasmantid seamount chain (regional priority 10)
   - Lord Howe seamount chain (regional priority 11)
   - Elizabeth and Middleton reefs (regional priority 12).

Strategy G:
Participate in international efforts to manage conservation values and pressures of regional priority

1. Collaborate with government and non-government organisations through regional and international initiatives to protect conservation values and address pressures of regional priority (regional priority 2, 5, 13, 14, 16—ongoing).

The Australian Government will work towards implementing these strategies and actions in order to address the regional priorities for conservation effort identified for the Temperate East Marine Region.



SCHEDULE 1

Analysis of pressures affecting conservation values of the Temperate East Marine Region

SCHEDULE 1
ANALYSIS OF PRESSURES AFFECTING CONSERVATION VALUES OF THE TEMPERATE EAST MARINE REGION

This schedule summarises the methods and findings of the regional pressure analysis undertaken for the Temperate East Marine Region.

S1.1 How were the pressures on conservation values analysed?

The pressure analysis process considered the impact of pressures on the region's conservation values, with a focused evaluation of the effectiveness of current mitigation and management arrangements in place to respond to those pressures. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values. Table S1.1 lists the type and source of pressures available for inclusion in the analysis. Only those pressures relevant to the conservation value being analysed were considered.

The analysis enabled pressures to be categorised in terms of their relative importance and has contributed to identification of regional priorities for the Temperate East Marine Region. Regional priorities are described in section 4.1 of the plan. The conservation values selected for the pressure analysis are discussed in Part 3 of the plan.

Table S1.1: Pressures and sources of pressures available for selection in the Temperate East Marine Region pressure analysis

Pressure	Source
Sea level rise	Climate change
Changes in sea temperature	Climate change
	Urban development
Changes in oceanography	Climate change
Ocean acidification	Climate change
Changes in terrestrial sand temperature	Climate change
Chemical pollution/contaminants	Shipping
	Vessels (other)
	Aquaculture operations
	Renewable energy operations
	Urban development (urban and/or industrial infrastructure)
	Agricultural activities
	Onshore and offshore mining operations
Nutrient pollution	Aquaculture operations
	Agricultural activities
	Urban development
Changes in turbidity	Dredging (spoil dumping)
	Land-based activities
	Onshore and offshore mining operations
	Climate change (changes in rainfall, storm frequency)
Marine debris[1]	Land-based activities
	Fishing boats
	Shipping
	Vessels (other)
	Oil rigs
	Aquaculture infrastructure
	Renewable energy infrastructure
	Urban development
Noise pollution	Seismic exploration
	Urban development
	Defence/surveillance activities
	Shipping
	Vessels (other)
	Aquaculture infrastructure
	Renewable energy infrastructure
	Onshore and offshore mining operations
	Onshore and offshore construction
Light pollution	Oil and gas infrastructure
	Fishing boats
	Vessels (other)
	Land-based activities
	Onshore and offshore activities
	Renewable energy infrastructure
	Onshore and offshore mining operations
Physical habitat modification	Fishing gear (active and derelict)
	Dredging (and/or dredge spoil)
	Shipping (anchorage)
	Defence/surveillance activities
	Telecommunications cables
	Offshore construction and installation of infrastructure
	Onshore and offshore construction
	Offshore mining operations
	Ship grounding
	Tourism (diving, snorkelling)
	Climate change (changes in storm frequency etc.)
	Urban/coastal development

Pressure	Source
Human presence at sensitive sites	Aquaculture operations
	Seismic exploration operations
	Tourism
	Recreational and charter fishing (burleying)
	Research
	Defence/surveillance activities
	Aircraft
Nuisance species[2]	Aquaculture operations
Extraction of living resources[3]	Commercial fishing (domestic or non-domestic)
	Recreational and charter fishing
	IUU fishing (domestic or non-domestic)
	Indigenous harvest
	Commercial fishing—prey depletion
	Commercial, recreational and charter fishing—fisheries discards
Bycatch[4]	Commercial fishing
	Recreational and charter fishing
	IUU fishing (domestic or non-domestic)
Oil pollution	Shipping
	Vessels (other)
	Oil rigs
	Onshore and offshore mining operations
Collision with vessels	Shipping
	Fishing
	Tourism
Collision/entanglement with infrastructure	Aquaculture infrastructure
	Renewable energy infrastructure
	Oil and gas infrastructure

Pressure	Source
Disease	Aquaculture operations
	Fishing
	Shipping
	Tourism
Invasive species	Shipping
	Fishing vessels
	Vessels (other)
	IUU fishing and illegal immigration vessels
	Aquaculture operations
	Tourism
	Land-based activities
Changes in hydrological regimes	Land-based activities
	Aquaculture infrastructure
	Renewable energy infrastructure
	Climate change (e.g. changes in rainfall, storm frequency)

IUU = illegal, unreported and unregulated

1 Marine debris is defined in the Threat Abatement Plan for the impacts of marine debris on vertebrate marine life May 2009 (**www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html**) and refers to 'land-sourced plastic garbage, fishing gear from recreational and commercial fishing (abandoned into the sea and ship-sourced, solid non-biodegradable floating materials disposed of at sea'. In concordance with International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), plastic material is defined as bags, bottles, strapping bands, sheeting synthetic ropes, synthetic fishing nets, floats, fibreglass, piping, insulation, paints and adhesives.

2 Nuisance species are opportunistic native species (e.g. seagulls) whose populations boom when humans modify the ecosystem by increasing food supply.

3 Extraction of living resources includes the removal of target and byproduct species.

4 Bycatch includes all non-targeted catch from fishing operations, including by-product, discards and gear interactions. By-product refers to the unintended catch that may be kept or sold by the fisher. Discards refer to the product that is returned to the sea. Gear interactions refer to all species and habitat affected by the fishing gear.

Levels of concern for the interactions between pressures and conservation values

Based on a review of scientific and expert literature, and informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion, the interaction between selected conservation values and each pressure was assigned a level *of concern*. The levels *of concern* are:

- *of concern*
- *of potential concern*
- *of less concern*
- *not of concern*.

A pressure is *of concern* for a conservation value when:

- there is evidence that it interacts with the conservation value within the region and there are reasonable grounds to expect that it may result in a **substantial impact** (Box S1.1), and
- there are no management measures in place to mitigate the impact(s), or there is inadequate or inconclusive evidence of the effectiveness of management measures within the region.

A pressure is *of potential concern* for a conservation value when:

- there is evidence that the conservation value is vulnerable to the type of pressure, although there is limited evidence of a **substantial impact** within the region, and
- the pressure is widespread or likely to increase within the region, and
- there are no management measures in place to mitigate potential or future impacts, or there is inadequate or inconclusive evidence of the effectiveness of management measures.

A pressure is *of less concern* for a conservation value either when:

- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that the impacts are unlikely to be substantial, or
- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that current management measures in place are effective in minimising or mitigating the impact.

A pressure is *not of concern* for a conservation value when:

- the pressure is rare or absent from the region, or
- there are reasonable grounds to expect that the impacts are minimal or the pressure does not interact with the conservation value, or
- there is evidence that the pressure is managed effectively through routine management measures.

In some instances, where a pressure operating outside of the region is having a substantial impact on a region's conservation value, consideration has been given to it.

Only those interactions between conservation values and pressures assessed as being *of concern* and *of potential concern* are described in this Schedule. Further information on the findings of the pressure analyses can be found in the conservation value report cards (**www.environment.gov.au/marineplans/temperate-east**).

Box S1.1 What is a substantial impact?

A pressure was considered likely to cause a substantial impact on a conservation value if there was a reasonable possibility that it would have any of the following effects:

- introduction of a known or potential pest or invasive species
- extensive modification, destruction, fragmentation, isolation or disturbance of habitat, which results in changes to community composition and/or trophic relationships and/ or ecosystem services
- modification, destruction, fragmentation, isolation or decline in availability of quality habitat important for a species of conservation value, to the extent that the species' conservation status is affected or its recovery is hindered
- substantial change in air or water quality, which may adversely impact biodiversity, ecological function or integrity, social amenity or human health
- introduction of persistent organic chemicals, heavy metals or potentially harmful chemicals, which adversely impact on biodiversity, ecosystem function or integrity, social amenity or human health
- change in community dynamics or structure that results in adverse impacts on biodiversity, ecological function or integrity, social amenity or human health
- increase in mortality of conservation values to an extent that may affect their conservation status or hinder recovery
- reduction in the area of occupancy of a species of conservation value, which may affect its conservation status or hinder recovery
- fragmentation of populations of conservation value
- reduced breeding success of a species or population of conservation value
- extensive or prolonged disturbance that affects the conservation status of a species or population of conservation value.

Note that the criteria above for defining substantial impact have been informed by *EPBC Act Policy Statement 1.1—Significant Impact Guidelines*.

S1.2 Findings of the analysis

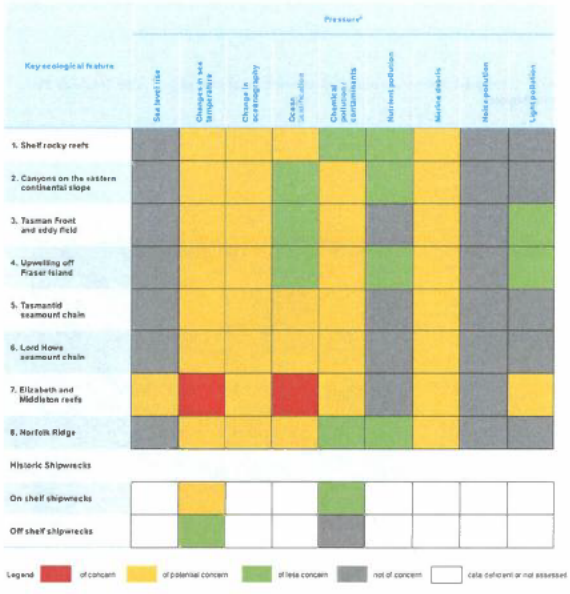
A summary of the pressure analysis findings on the key ecological features and historic shipwrecks of the Temperate East Marine Region is presented in Table S1.2. A summary of the pressure analysis findings on selected protected species in the Temperate East Marine Region is presented in Table S1.3.

A more detailed overview of the pressures assessed as *of concern* and *of potential concern* for these conservation values is presented in Tables S1.4–S1.14:

- Key ecological features of the Temperate East Marine Region
  - Pressures *of concern*—Table S1.4
  - Pressures *of potential concern*—Table S1.5
- Selected bony fish species
  - Pressures *of potential concern*—Table S1.6
- Selected cetacean species
  - Pressures *of concern*—Table S1.7
  - Pressures *of potential concern*—Table S1.8
- Selected marine reptile species
  - Pressures *of concern*—Table S1.9
  - Pressures *of potential concern*—Table S1.10
- Selected seabird species
  - Pressures *of concern*—Table S1.11
  - Pressures *of potential concern*—Table S1.12
- Selected shark species
  - Pressures *of concern*—Table S1.13
  - Pressures *of potential concern*—Table S1.14

Further information on the pressure analyses and their findings are provided in the conservation value report cards.

Table S1.2: Summary of pressures on key ecological features and historic shipwrecks of the Temperate East Marine Region



5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under *bycatch*. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, if *bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and heritage places can be found in the conservation value report cards.

Table S1.2 continued: Summary of pressures on key ecological features and historic shipwrecks of the Temperate East Marine Region

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Table S1.3: Summary of pressures on selected protected species in the Temperate East Marine Region

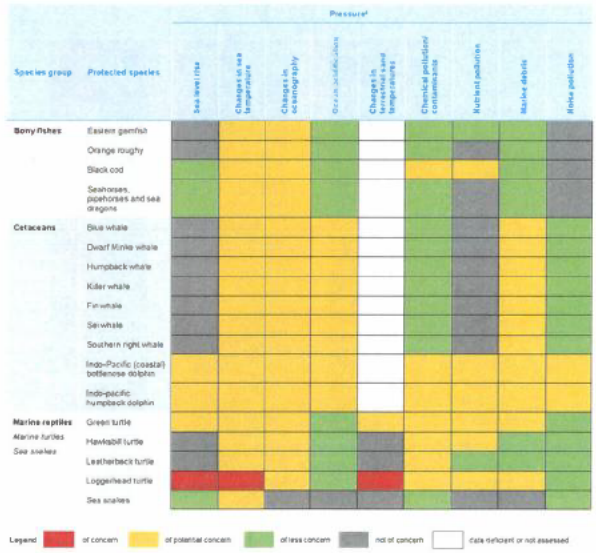

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Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

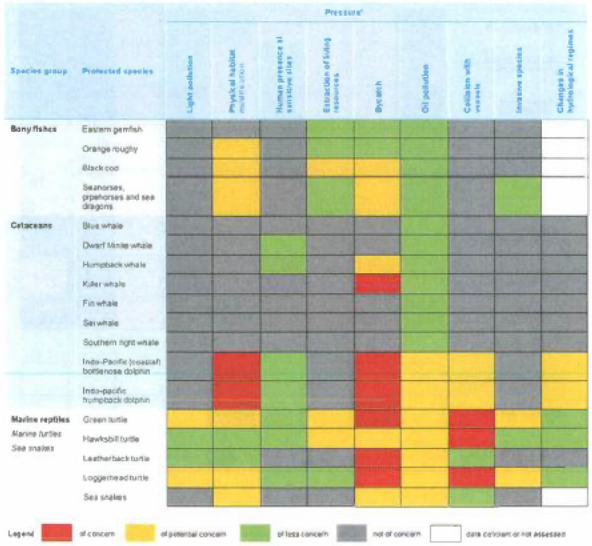

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Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

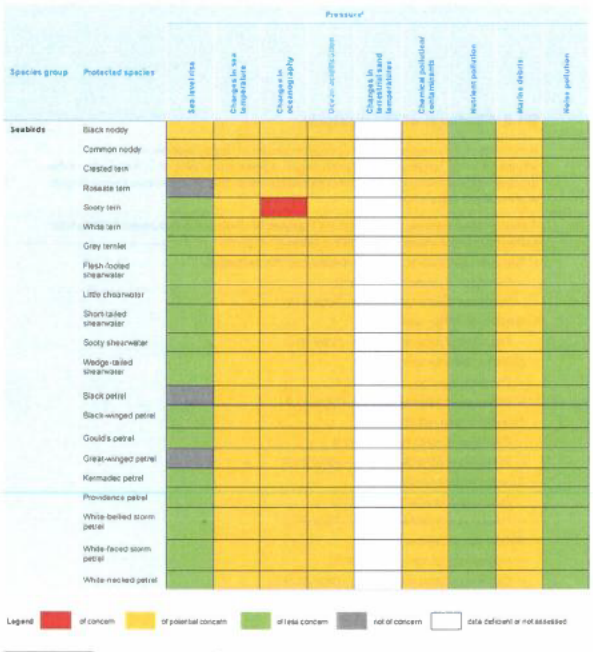

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Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

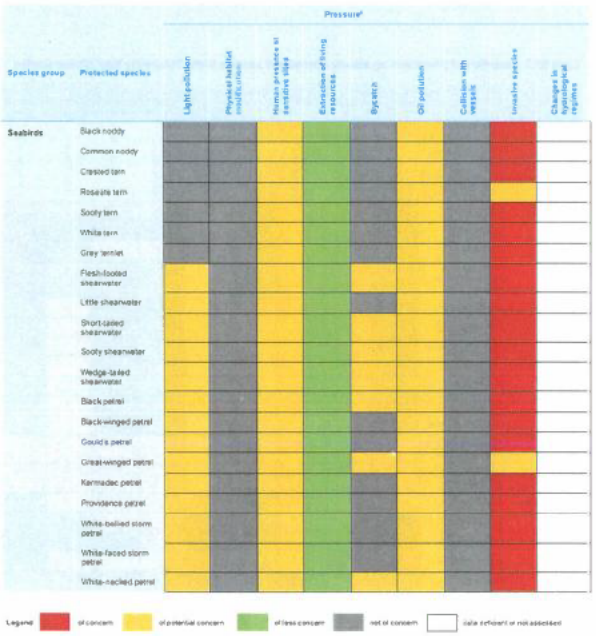

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Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

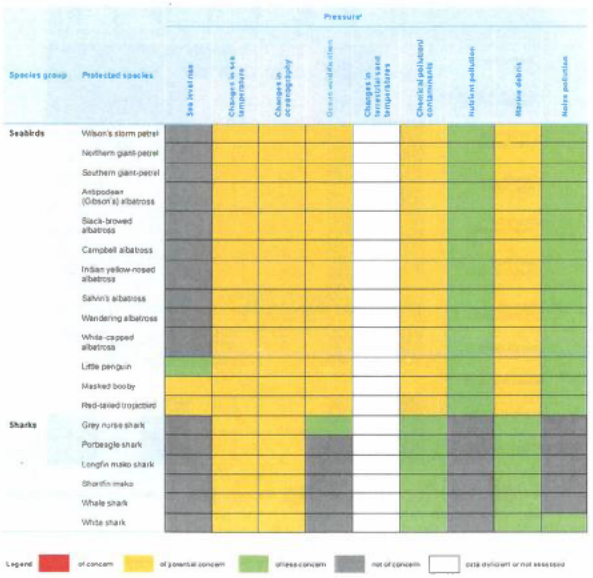

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Table S1.3 continued: Summary of pressures on selected protected species in the Temperate East Marine Region

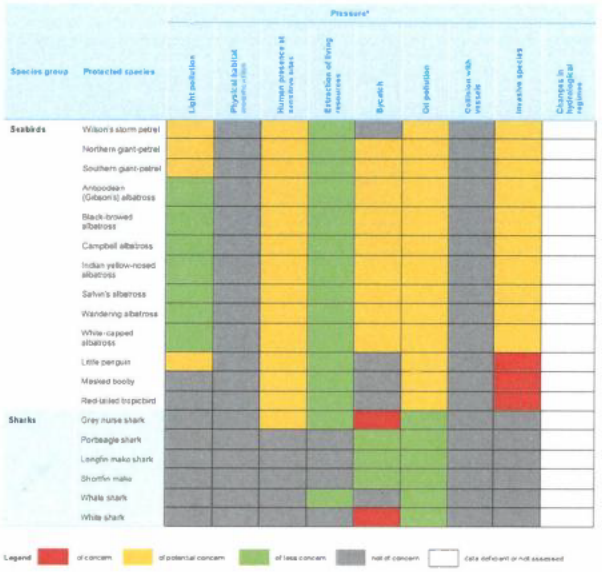

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Table S1.4: Pressures of concern to key ecological features of the Temperate East Marine Region

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Changes in sea temperature (climate change)	Elizabeth and Middleton reefs	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Elizabeth and Middleton reefs are valued for their aggregations of marine life and biodiversity. Ocean warming is expected to alter food web dynamics (Hoegh-Guldberg & Bruno 2010), potentially increase the frequency or severity of coral bleaching events and result in southerly distribution shifts of pelagic fish species (Hobday et al. 2006). The reefs are at risk from these expected impacts, however, the overall implications for ecosystem processes and responses are not known, and will be influenced by species tolerance and adaptive capacity.
Ocean acidification (climate change)	Elizabeth and Middleton reefs	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, ocean acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Climate models predict this trend will continue, with a further 0.3–0.3 unit decline by 2100 (Howard et al. 2009). Elizabeth and Middleton reefs are valued for their aggregations of marine life and biodiversity, and expected impacts of acidification include a reduction in coral growth rates and resilience, which may make the reef systems more vulnerable to erosion and disturbance from storms (Anthony & Marshall 2009) and affect the ability of molluscs, echinoderms and some planktonic organisms to form skeletal material (Doney et al. 2009). Corals provide structural habitat complexity for a range of invertebrates and fish (Althaus et al. 2009); therefore, any impact on coral reef habitat is likely to result in changes to the distribution and abundance of species that depend on the reefs for food and shelter.

Table S1.5: Pressures of *potential concern* to key ecological features of the Temperate East Marine Region

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Sea level rise (climate change)	Elizabeth and Middleton reefs	Global sea levels rose by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030 relative to 1990 levels (Church et al. 2008). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). Elizabeth and Middleton reefs are shallow water reefs valued for their aggregations of marine life and biodiversity. Over time, rising sea levels are expected to decrease the amount of light that reaches the corals, thereby reducing coral growth rates (Anthony & Marshall 2009). Any impact on coral reef habitat is likely to change the distribution and abundance of species that depend on the reefs for food and shelter (Chambers et al. 2009).
Changes in sea temperature (climate change)	Shelf rocky reefs Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Norfolk Ridge	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Ocean warming is of potential concern for all of the region's key ecological features, except the Elizabeth and Middleton reefs, where it is of concern (see Table S1.4). Expected impacts include changes to food web dynamics (Hoegh-Guldberg & Bruno 2010), potentially increasing the frequency or severity of coral bleaching events, and a southerly shift in the distribution of pelagic fish species (Hobday et al. 2006). For features located in the deeper waters of the region (such as the shelf rocky reefs, seamounts and ridges), the impacts of rising sea temperatures are more complex. Rising temperatures drive changes such as thermal expansion (Hoegh-Guldberg & Bruno 2010), resulting in greater stratification in the water column, reducing mixing in some parts of the ocean, and consequently affecting nutrient availability and primary production at depth (Hoegh-Guldberg & Bruno 2010).

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Changes in oceanography (climate change)	Shelf rocky reefs Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Elizabeth and Middleton reefs Norfolk Ridge	Changes in oceanography include consideration of circulation patterns, current intensities, wind strength and direction, the location and strength of eddy and upwelling events, and climatic oscillations such as the El Niño–Southern Oscillation. In the region, changes in oceanography will be primarily influenced by the East Australian Current, which is one of the key drivers of the region's biological productivity, species' distribution and abundance (Dambacher et al. 2011). The East Australian Current has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km) (Ridgeway & Hill 2009). Changes in the strength and extent of the current are likely to impact on productivity, shifting trophic webs, and changing migration patterns and reef and shelf habitats, all of which have implications for marine species (Ohin et al. 2010). Offshore, the current is partly responsible for the unique mix of warm and cold water species associated with Elizabeth and Middleton reefs and the Tasmantid and Lord Howe seamount chains (Dambacher et al. 2011).

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Ocean acidification (climate change)	Shelf rocky reefs Tasmantid seamount chain Lord Howe seamount chain Norfolk Ridge	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, ocean acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.7–0.3 unit decline by 2100 (Howard et al. 1998). The key ecological features listed here are particularly vulnerable to ocean acidification because they support a range of shallow and deepwater coral reef systems. The direct impacts of ocean acidification are expected to be most marked for organisms with calcareous skeletons, such as corals, plankton, molluscs and echinoderms (Doney et al. 2009). Increasing acidity reduces the ability of these organisms to form skeletal structures, which is likely to affect not only their ability to function within the ecosystem, but the functioning of the ecosystem as a whole (Kleypas & Yates 2009). For example, research on coral cores in the Great Barrier Reef identified a 14% decline in coral calcification rates between 1990 and 2005 (De'ath et al. 2009), which the authors attribute to excessive temperature increases, ocean acidification, or a combination of the two. For this region, increased ocean acidification and sea surface temperatures are predicted to have combined impacts, prompting reef ecosystems to shift from 'marginal' (Kleypas et al. 1999) to 'extremely marginal' by the middle of this century (Hoegh-Guldberg et al. 2007). For the subtropical regions of the Tasmantid and Lord Howe seamount chains, it is likely that increased ocean acidity will reduce coral growth rates and resilience, making the reef systems more susceptible to erosion and disturbance from storms (Anthony & Marshall 2009). Predictive climate models indicate that the unique, deep, cold-water reefs and sponge gardens of the Norfolk Ridge, shelf edge and seamount chains are also at risk from a similar range of impacts (Cohen & Holcomb 2009; Howard et al. 2009; Hyder Consulting 2006). Corals provide structural habitat complexity for a range of invertebrates and fish (Allnutt et al. 2008). Consequently, any impact on coral reef habitat is likely to change the distribution and abundance of species that depend on them for food and shelter.

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Chemical pollution	Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Elizabeth and Middleton reefs	Chemical pollutants/contaminants is of potential concern for key ecological features with values that make them particularly vulnerable to the impacts of a chemical spill, such as important aggregations of marine life at or near the sea surface. Vulnerable key ecological features include the Tasman Front and eddy field, the Fraser upwelling, the Tasmantid and Lord Howe seamount chains, canyons on the eastern continental slope, and Elizabeth and Middleton reefs. As is the case with oil spills, chemical spills are unpredictable events and their likelihood is low in the context of the international and domestic regulatory mitigation measures that apply in Australia. The effects of a major chemical spill can be similar to those of oil spills (OSMFPA 2008), particularly in areas and at times of biological significance for important or threatened species. The impacts vary depending on the toxicity of chemicals, how the materials are packaged and transported, the quantity spilled, the site and ecological sensitivity.

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Marine debris	Shelf rocky reefs Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Elizabeth and Middleton reefs Norfolk Ridge	Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of, or abandoned, in the marine and coastal environment (UNEP 2005). This includes a range of materials from plastics (e.g. bags, bottles, ropes, fibreglass and insulation) to derelict fishing gear and ship-sourced, solid, non-biodegradable floating materials (DEWHA 2009a). Although region-specific marine debris data is limited, key sources for the introduction and spread of debris (such as shipping, commercial fishing and major current systems) are present across the region. This suggests that all key ecological features will experience a high degree of overlap with this pressure (Kattsanevakis 2008). Marine debris has been listed as a key threatening process under the EPBC Act, in recognition of its negative impacts on substantial numbers of Australia's marine wildlife, including protected species of birds, turtles and marine mammals. Therefore, this pressure has implications for key ecological feature values such as biodiversity and aggregations of marine life. The Australian Government has developed a threat abatement plan that provides a coordinated national approach to prevent and mitigate the effects of harmful marine debris on marine life (DEWHA 2009a).
Light pollution	Elizabeth and Middleton reefs	Light pollution is of potential concern to Elizabeth and Middleton reefs as they are known to support important aggregations of marine life that are vulnerable to light (e.g. turtles). Light quality is important for turtles (Salmon 2003), and lighting from shipping and fishing vessels offshore can attract hatchlings to vessel hulls, subjecting them to predation. Shipping traffic, including fishing vessels anchoring in close proximity to Elizabeth and Middleton reefs, have the potential to negatively impact turtles that forage in these areas.

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Physical habitat modification (fishing gear)	Shelf rocky reefs Canyons on the eastern continental slope	Physical habitat modification due to fishing gear can result in loss or significant degradation of key ecological features that are subject to bottom trawl activities or are inherently vulnerable to habitat modification, including the shelf rocky reefs and canyons on the eastern continental slope. Both of these features are characterised by complex communities of benthic species that are highly vulnerable to the impacts of demersal trawl fishing, which removes, modifies or disturbs sessile flora and fauna (Furlani et al. 2007). These communities, particularly the deepwater coral species, are highly fragile, long lived and therefore susceptible to disturbance (Williams et al. 2010). Potential impacts include declines in the richness, diversity and density of benthic species and the range of invertebrates and fish that depend on these habitats for prey opportunities and shelter (Allnutt et al. 2009).
Extraction of living resources (commercial fishing)	Shelf rocky reefs Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Norfolk Ridge	The ecosystem effects of fishing are not well understood. The key ecological features highlighted here are considered valuable for their aggregations of marine life and unique features which support ecological properties of regional significance. The rating of potential concern is primarily driven by the impact of the largest take of commercial fisheries on top-order predators, which are considered to be a key functional species group within these features. The extraction of top predators by fishing activities has implications for ecological communities as it influences the abundance, recruitment, species composition, diversity and behaviour of prey species. Removal of top predators can have a 'cascading' effect on all the components of a food web (Baum & Worm 2009; Ceccarelli & Ayling 2010). Reef sharks, cod and groupers are important for coral reef communities, while tuna and billfish are important for pelagic systems (Ceccarelli & Ayling 2010). In the context of active fisheries management and the steady move towards ecosystem-based management of fisheries by all jurisdictions in Australia, the of potential concern rating is considered a conservative assessment. This rating highlights the limited understanding of both the ecosystem effects of individual fisheries and the cumulative effects of a number of fisheries on protected species, marine communities, habitats and ecosystems.

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Bycatch (commercial fishing—domestic)	Shelf rocky reefs Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Norfolk Ridge	Commercial fishing operations are a key activity in the region and overlap, to varying extents, with these ecological features (e.g. Eastern Tuna and Billfish Fishery, Southern and Eastern Scalefish and Shark Fishery). In the context of active fisheries management and the steady move towards ecosystem-based management of fisheries by all jurisdictions in Australia, the of potential concern rating is considered a conservative assessment. For example, a recent review of all Commonwealth fisheries found that the current numbers of independent observers in a net sufficient to allow a cumulative assessment of the catch of non-target species (Phillips et al. 2010). The review stated that such assessment is important to understand the environmental performance of fisheries more broadly and to underpin a holistic approach to the management of ecosystem impacts (Phillips et al. 2010). Generally, there is also a need to increase our understanding of the effectiveness of bycatch mitigation measures (Bensley et al. 2010).

Key ecological features assessed = 8		
Pressure	**KEFs**	**Rationale**
Oil Pollution	Canyons on the eastern continental slope Tasman Front and eddy field Upwelling off Fraser Island Tasmantid seamount chain Lord Howe seamount chain Elizabeth and Middleton reefs	Oil pollution is of potential concern for key ecological features with values that make them particularly vulnerable to the impacts of an oil spill, such as important aggregations of marine life at or near the sea surface. Vulnerable key ecological features include the Tasman Front and eddy field; upwelling off Fraser Island; Tasmantid and Lord Howe seamount chains; canyons on the eastern continental slope; and Elizabeth and Middleton reefs. These key ecological features are highlighted because of their characteristics that make their ecosystems and communities vulnerable to the effects of an oil spill; for example, features that include regions of high productivity that attract aggregations of marine life. Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas can be severe. The level of impact that actually occurs depends on a number of factors including the concentration of oil chemical and physical properties of the oil (or oil and dispersant mixture). Also influencing the impact of an oil spill event are the timing of breeding cycles and seasonal migrations of species, the amount of contact, the susceptibility of particular species and the health, age and reproductive status of the individuals (AMSA 2011a). Particular ecological values associated with the KEFs that may be impacted by such an event include seasonal feeding aggregations of pelagic invertebrates, fish and mammals associated with the Tasman Front and eddy field and the upwelling off Fraser Island, seabirds and turtles that forage at Elizabeth and Middleton reef and the tropical and temperate demersal and pelagic fish assemblages supported by these reefs; fish that seek refuge on seamounts, and predatory fish and seabirds that forage in waters surrounding seamounts. Both the intensity and distribution of activities that might lead to oil spills (such as transport) are expected to increase in the region.

Table S1.6: Pressures *of potential concern* to bony fishes of the Temperate East Marine Region

Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group)		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Eastern garfish Orange roughy Black cod Seahorses, pipehorses and sea dragons	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Research from Europe suggests that the warming of deep waters may have negative consequences for ecosystem function and community distribution (Weaver et al. 2009). All species assessed are likely to experience shifts in distribution and abundance due to sea temperature rises, with impacts on their life cycle stages, prey availability and habitat. Adult black cod and syngnathids are particularly vulnerable given the species' tendency to have specific habitat preferences within a small home range, thus reducing their ability to find and adapt to new habitats (Malcolm 2011; McClatchie et al. 2006).
Changes in oceanography (climate change)	Eastern garfish Orange roughy Black cod Seahorses, pipehorses and sea dragons	Changes in oceanography include consideration of circulation patterns, current intensities, wind strength and direction, the location and strength of eddy and upwelling events and climatic oscillations such as the El Niño–Southern Oscillation. Although species-specific responses to oceanographic changes are limited, consequences are expected for the structure, function and dynamics of deep sea habitats. For example, there is likely to be an impact on the transport of matter and energy to depths (Enteyer 2010; Weaver et al. 2009), thereby impacting on food supplies reaching these systems. Evidence from Europe suggests that this change alone will alter the population dynamics of commercial deep sea species such as orange roughy (Weaver et al. 2009). In New South Wales ocean current changes resulting from climate change are predicted to cause a reduction in the flow of freshwater to estuaries, and an increase in nutrient-laden waters in near coastal areas. These changes will alter species distribution and abundance and potentially decrease sources of prey for juvenile black cod which use these habitats (DTIRIS 2012). Eastern garfish are considered vulnerable to changes in productivity associated with changes in wind strength (Hobday et al. 2008), and the annual pre-spawning migration may also be impacted by changes in oceanography; however, it is unclear whether the impacts on migration will be positive or negative on the species (Prince & Griffin 2001; Rowling 2001). Black cod, seahorses, pipehorses and sea dragons have specific habitat preferences with small home ranges, and this may reduce their ability to find and adapt to new habitats (Malcolm 2011; McClatchie et al. 2006).

Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group)		
Pressure	**Species**	**Rationale**
Chemical pollution/ contaminants **Nutrient pollution (agricultural activities, urban development)**	Black cod	Black cod's use of estuaries as juvenile development grounds makes them vulnerable to the effects of water pollution in the form of pollutants contained within run-off from urban development and agricultural activities. These pollutants can degrade the quality of habitats, alter the water chemistry, encourage the growth of algae and other benthic flora and fauna species. In particular, heavy metals and organochlorine pesticides pose high risks to estuarine biota, as they persist in the environment, magnify along food chains and reduce the relative abundance of top-order predators (ANZECC 2000; DECC 2008). Over time, changes in the water chemistry, food chain and turbidity caused by urban and agricultural run-off may significantly impact the long term viability of black cod within estuaries (DTIRIS 2012).
Physical habitat modification (dredging)	Seahorses, pipehorses and sea dragons	Physical habitat modification due to dredging activities is expected to increase adjacent to the Temperate East Marine Region due to the growth in recreational boating activity (Bay Journal 2004; MSQ 2011). Seahorses, pipehorses and sea dragons have a sedentary lifestyle and close affinity to sponge and reef habitats, which makes them vulnerable to impacts arising from this pressure. Impacts on habitat include a reduction in structural diversity and fewer opportunities for the settlement of new coral colonies, due to the removal of biogenic substratum (Althaus et al. 2009; Lack et al. 2003; Pogonoski et al. 2002).
Physical habitat modification (fishing gear)	Orange roughy Seahorses, pipehorses and sea dragons	Physical habitat modification from fishing gear (e.g. trawling) has the potential to impact on seahorses, pipehorses and sea dragons due to their specific habitat requirements and limited geographic range (Foster & Vincent 2004; Kuiter 2009). These species are distributed across the fishing grounds of the Queensland East Coast Otter Trawl Fishery. As is the case with dredging, mobile fishing gear crushes, buries and exposes marine animals and their habitat (e.g. sponge gardens and rocky reefs), and reduces the structural diversity of preferred habitat (Althaus et al. 2009; Lack et al. 2003; Pitcher et al. 2008; Pogonoski et al. 2002). Commercial bottom trawling on seamounts can cause physical damage to benthic environments affecting benthic fauna. Damage to seamounts could affect orange roughy recruitment due to the link between their spawning aggregations and this habitat feature.
Physical habitat modification (anthropogenic development)	Black cod	Estuaries provide a nursery refuge and feeding opportunities for black cod in its juvenile development stages. Physical habitat modification of estuaries as a result of urban and coastal development can impact black cod prior to their migration to coastal rocky reefs. In particular, the ongoing building and repair of seawalls designed to protect low-lying foreshore infrastructure from sea level rise associated with climate change (DTIRIS 2012) can have a detrimental effect on flows, vegetation and habitat, impacting juvenile black cod.

Species assessed = 10 (seahorses, pipehorses and sea dragons assessed as a group)		
Pressure	**Species**	**Rationale**
Extraction of living resources (illegal, unregulated and unreported fishing)	Black cod	Isolated incidences of the illegal take of black cod by recreational anglers in New South Wales coast are occasionally reported (DPIRIS 2012), and illegal fishing is of potential concern for black cod. The New South Wales Fisheries 2003 draft recovery plan for black cod reported anecdotal evidence of large catches of blacks cod in the early 1980s from Elizabeth and Middleton Reefs, and in 1993 a commercial fishing boat crew was found to have taken 24 black cod from the same area (TSSC 2012).
Bycatch (commercial fishing)	Black cod Seahorses, pipehorses and sea dragons	There is evidence that black cod, seahorses, pipehorses and sea dragons are caught in commercial fisheries in the region. Commercial take of black cod is prohibited, however, the species is still caught as bycatch in Commonwealth fisheries, with fish suffering mortality due to hooks from fishers and barotrauma (Batsur 2005). Indiscriminate fishing methods such as bottom-set (seine) lines (e.g. setlining, trotlining, handlining) are the most widely used methods with the potential to have a significant negative impact on black cod numbers and distribution (DPIRIS 2012). Commercial fisheries targeting estuarine species may also impact juvenile black cod numbers, in particular those fisheries operating in the lower reaches of estuaries on the north coast of New South Wales (DPIPWO 2012). Seahorses, pipehorses and sea dragons are considered vulnerable to Danish-seine operations as these activities occur in relatively shallow waters and use nets with a small mesh size. They are also caught as bycatch in the Queensland East Coast Otter Trawl Fishery, particularly Duncker's and Hardwick's pipehorses, although numbers are low and considered to be declining (Coles et al. 2008). In New South Wales, bycatch of these species, particularly *Solegnathus* spp. (pipehorses) is a concern (Bowles & Martin-Smith 2003).
Bycatch (recreational fishing)	Black cod	As for commercial fishing, recreational fishing of black cod is prohibited; however recreational rates are set known to occasionally catch black cod. Limited knowledge of the species has meant that it is not always released, or even when released does not survive due to barotrauma. New fishing technologies have improved recreational fishing effectiveness, particularly in deeper waters where adult black cod are found, which may increase the risk of recreational bycatch of the species (TSSC 2012).

Table S1.7: Pressures *of concern* to selected cetaceans of the Temperate East Marine Region

Species assessed = 9		
Pressure	**Species**	**Rationale**
Physical habitat modification (urban/coastal development)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Increased physical habitat modification associated with urban and coastal development is expected adjacent to the region, along the south-east Queensland and New South Wales coastline. Studies on coastal and riverine cetaceans worldwide indicate that habitat degradation is a serious threat that fragments populations and, in some cases, eliminates habitat (Weilers & Smith 1999). In the Temperate East, the overlap between coastal development and habitats used by inshore dolphins makes them vulnerable to this pressure. Indo-Pacific humpback dolphin populations are particularly susceptible because they are highly localised, occur in small subpopulations and are extremely sensitive to disturbance in their preferred habitats (Corkeron et al. 1997, Parra et al. 2006).
Bycatch (commercial fishing)	Killer whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Bycatch of cetacean species predominantly results in drowning and may cause changes to species distribution and population health. Diet studies of inshore dolphins by Heinsohn (1979), Marsh et al. (1980) and Parra & Jedensjö (2008) indicate that coastal estuarine waters are important foraging habitats for these species and, as a result, they are at greater risk of directly or indirectly interacting with fisheries operating in coastal waters (Parra & Jedensjö 2008). For inshore dolphins, bycatch in gillnets has emerged as a key threat to their survival (DAgrose et al. 2000, Northridge 1991, Rojas-Bracho & Taylor 1999). Australian net fisheries' catch is taken close to the coast, at depths less than 50 m (Kasuya et al. 1996) and there is evidence that coastal dolphin bycatch occurs in these fisheries (Corkeron et al. 1997). For example, the outcome of the ecological risk assessment process by AFMA for the Small Pelagic Fishery (purse seine) estimated both the coastal bottlenose and Indo-Pacific humpback dolphin as at high risk of capture. The Small Pelagic Fishery Bycatch Action Plan is intended to reduce bycatch in this fishery. This rating assigned for the killer whale has been lost by the outcome of the AFMA ecological risk assessment process, which established the species as at high risk of capture in the Eastern Skipjack Tuna Fishery. *Australia's tuna purse seine fisheries bycatch action plan* (AFMA 2005) is intended to reduce bycatch and associated impacts in the Commonwealth tuna purse seine fisheries.

Species assessed = 9		
Pressure	**Species**	**Rationale**
Bycatch (bather protection programs)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Bather protection (shark meshing) programs have been in operation for over 70 years, deploying nets and drumlines to protect swimmers from the risk of shark attacks in coastal waters adjacent to the Temperate East Marine Region (Queensland and New South Wales). However, these programs lead to the bycatch of other marine species, including inshore dolphins. Between 1995 and 2009, 257 dolphins were caught in nets and drumlines associated with the bather protection programs (228 were caught in nets and 29 on drumlines); of these, 47 were bottlenose dolphins and 25 were Indo-Pacific humpback dolphins (Hale 2011).

Table S1.8: Pressures *of potential* concern to selected cetaceans of the Temperate East Marine Region

Species assessed = 9		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Global sea levels rose by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2008). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). Inshore dolphins are vulnerable to rising sea levels because of the predicted impacts on their preferred foraging habitat (seagrass). In general, seagrass abundance and extent is predicted to decline as sea level rise decreases the light available for photosynthesis (Connolly 2009). A decrease in the extent of seagrass is expected to impact negatively on inshore dolphins.
Changes in sea temperature (climate change)	Blue whale Dwarf minke whale Humpback whale Killer whale Fin whale Sei whale Southern right whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Sea temperatures have warmed by 0.7 °C between 1910–1959 and 1959–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Inshore dolphins are vulnerable to rising sea temperatures because of the expected impacts on their preferred foraging habitat (seagrass) (Connolly 2009, Parra & Corkeron 2001, Parra et al. 2002, Parra 2006). Temperature is a key factor determining the distribution of seagrasses (Poloczanska et al. 2007) and shallow subtidal species are considered at risk from warming ocean and air temperatures (Seddon et al. 2000). Climate variability may also affect other cetaceans, for example, research on climate variability and reproduction in southern right whales suggests a detrimental impact on reproductive success with warming events (Pryd et al. 2008). Environmental fluctuations may impact on reproduction by affecting body condition and health through changes in foraging conditions, with krill availability in the summer feeding grounds influencing reproductive success the following winter (Trathan & Murphy 2002, Trathan et al. 2003).

Species assessed = 9

Pressure	Species	Rationale
Changes in oceanography (climate change)	Blue whale Dwarf minke whale Humpback whale Killer whale Fin whale Sei whale Southern right whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Changes in oceanography include consideration of circulation patterns, current intensities, wind strength and direction, the location and strength of eddy and upwelling events and climatic oscillations such as the El Niño–Southern Oscillation. Oceanographic changes in the region will be primarily driven by the East Australian Current. Studies indicate this major boundary current has been strengthening, pushing warmer, saltier water further southward along the east coast (for up to 350 km). Predictive climate models have medium confidence that this trend will increase (Ridgway & Hill 2009). There will also be associated circulation effects arising from expected changes to the El Niño–Southern Oscillation. Potential consequences of changes in ocean circulation patterns and the bifurcation point of the East Australian Current include shifts in upwelling events, increased thermal stratification, increased eddy activity and a shift in the thermocline depth (Chiri et al. 2010). For cetaceans, these changes may influence the availability of prey, migration patterns and selection of calving sites (Chiri et al. 2010).
Ocean acidification (climate change)	Blue whale Dwarf minke whale Humpback whale Killer whale Fin whale Sei whale Southern right whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already under way and detectable. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). Recent research indicates significant impacts of ocean acidification on Antarctic krill (Kawaguchi et al. 2011), which are a key food source for many whale species that visit Australian waters. While there are no observed impacts of climate change on zooplankton in Australian waters, based on knowledge of impacts elsewhere, Australia is likely to start losing calorifying zooplankton from its southern waters (Richardson et al. 2009).

Species assessed = 9

Pressure	Species	Rationale
Chemical pollution/ contaminants (urban development, agricultural activities)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Cetaceans that frequent nearshore areas, such as the Indo-Pacific bottlenose dolphin and the Indo-Pacific humpback dolphin, may be exposed to higher levels of chemical pollutants than wholly offshore species (Jacob 2009). Shipping is a key activity in the region, with shipping routes servicing a number of ports that are adjacent to the region and inshore dolphin habitat. Higher levels of polychlorinated biphenyls (PCBs) have been found in dolphins from the Gold Coast compared to anywhere else in Australia; high levels of PCBs have been linked to impaired reproductive capacity in dolphins (Gaus et al. 2001). There is limited data on the likelihood of chemical spills in the region, however, like oil spills, they are unpredictable events that may have severe consequences for marine species. Inshore dolphins are particularly vulnerable because of their highly localised populations along the east coast.
Nutrient pollution (urban development, agricultural activities)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Nutrient pollution, also known as eutrophication, refers to an increase in the rate of supply of organic matter into an ecosystem, particularly nitrogen, phosphorus and silica. Eutrophication is considered a threat to coastal marine environments, leading to an increased frequency of harmful algal blooms, loss of ecosystem integrity and changes in biodiversity, high rainfall and catchment run-off, particularly in south-east Queensland, increases the exposure of dolphins to bioaccumulated toxins (Lawler et al. 2007). For example, inshore dolphins can be directly exposed to toxins through algae outbreaks associated with increased nutrient loads, absorbing toxins from water or ingesting algal cells, or indirectly through eating prey that contain toxins (Carmago & Alonso 2006).

Species assessed = 9

Pressure	Species	Rationale
Marine debris	Blue whale Dwarf minke whale Humpback whale Killer whale Fin whale Sei whale Southern right whale Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2009 as a key threatening process under the EPBC Act (DEWHA 2009a). Marine debris is defined as any persistent, manufactured or processed solid material that has been disposed of or abandoned in the marine and coastal environment (UNEP 2005). Cetaceans are considered vulnerable to entanglement in marine debris, and the threat abatement plan lists a number of cetaceans that are known to be adversely affected by marine debris, including the southern right whale, blue whale and humpback whale (DEWHA 2009a). The potential for marine debris to affect inshore dolphin habitat is high because of the high number of people living adjacent to the coast (ABS 2001), the popularity of recreational fishing, and the number of commercial fisheries operating in and adjacent to the region (DEWHA 2008b). The Australian Government has developed a threat abatement plan that provides a coordinated national approach to prevent and mitigate the effects of harmful marine debris on marine life (DEWHA 2009a).
Noise pollution (shipping, urban development)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	There is growing concern over the impacts of human-made noise on marine life, particularly cetaceans, may result in physical or behavioural effects on these species (DEWHA 2008a). With pressures such as coastal development, a number of important ports and associated shipping activity, there is concern that noise may interfere with the ability of inshore dolphins to communicate, resulting in displacement from preferred habitat, or physical trauma and damage to sensory systems (Bejder & Samuels 2003; Mattson et al. 2005; Nowacek et al. 2007; Richardson et al. 1995). Evidence of changes in behaviour can be found in Moreton Bay, where the rate of whistling by humpback dolphins has increased in the presence of travelling boats, particularly in mother–calf pairs (van Parijs & Corkeron 2001).
Physical habitat modification (dredging/ dredge spoil)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Physical habitat modification from dredging activities is expected adjacent to the Temperate East Marine Region due to the growth in recreational boating activity (Bay Journal 2008; MSO 2011). Dredging can also occur in association with development projects for extractive purposes and for the installation of pipelines and cables. Dredging modifies nearshore habitats by removing or smothering benthic flora and fauna, and changing water flows (GBRMPA 2008). Studies on coastal and inverine cetaceans worldwide indicate that habitat degradation is a serious threat their fragments populations and, in some cases, eliminates habitat (Reeves & Smith 1999). In the region, the overlap between coastal development and habitats used by inshore dolphins makes them vulnerable to this pressure. The Indo-Pacific humpback dolphin populations are particularly susceptible because they are highly localised, occur in small subpopulations and are extremely sensitive to disturbance in their preferred habitats (Corkeron et al. 1997; Parra et al. 2006).

Species assessed = 9

Pressure	Species	Rationale
Bycatch (further protection programs)	Humpback whale	Bather protection (shark meshing) programs have been in operation for over 70 years, deploying nets and drumlines to protect swimmers from the risk of shark attacks along the New South Wales and Queensland coasts. However, these programs lead to the bycatch of other marine species. The number of humpback whales caught in nets along the Queensland coast during migration has remained relatively constant over recent years (DERM 2008); however, as the population recovers, the interaction between humpback whales and shark meshing may increase.
Oil pollution (shipping, vessels)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Oil spills are unpredictable events and their likelihood is low, particularly in the context of the international and domestic regulatory mitigation measures that apply in Australia. However, their consequences can be severe, particularly in biologically significant areas or times. Shipping is a key activity in the region, with shipping routes servicing a number of ports that are adjacent to the region and inshore dolphin habitat. In the event of an oil spill, dolphins have been known to detect oil and avoid it, however, at other times they have been exposed to floating oil (AMSA 2010). Inshore dolphin species are particularly vulnerable to oil spills because of their highly localised populations along the east coast.
Collisions with vessels (shipping, tourism, fishing)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Collisions between dolphins and vessels have been recorded in Australian waters, with records of dolphin mortality attributed to boat strike in Victoria (DSE 2011) and South Australia (News Limited 2010). The growth in recreational boating activity in the region (Bay Journal 2008; MSO 2011), combined with a preference for nearshore habitats, makes inshore dolphins vulnerable to collisions with vessels.
Changes in hydrological regimes (climate change)	Indo-Pacific (coastal) bottlenose dolphin Indo-Pacific humpback dolphin	Changes in hydrological regimes through, for example, an increase in the frequency and intensity of storm and flooding events could impact on nearshore environments used by inshore dolphins. The predicted increase in intensity of storm events, combined with rising sea levels, is expected to cause shoreline erosion, thereby increasing turbidity of shallow coastal waters (Cahoon et al. 2008; Hennessy et al. 2007; Walcott et al. 2007) and reducing the amount of light available for photosynthesis in seagrasses (Connolly 2009), the preferred habitat of inshore dolphins. Increases in turbidity within mangrove environments may also reduce the efficiency of predators (Abrahams & Kattenfeld 1997), including both species of inshore dolphin.

Table S1.9: Pressures *of concern* to selected marine reptiles of the Temperate East Marine Region

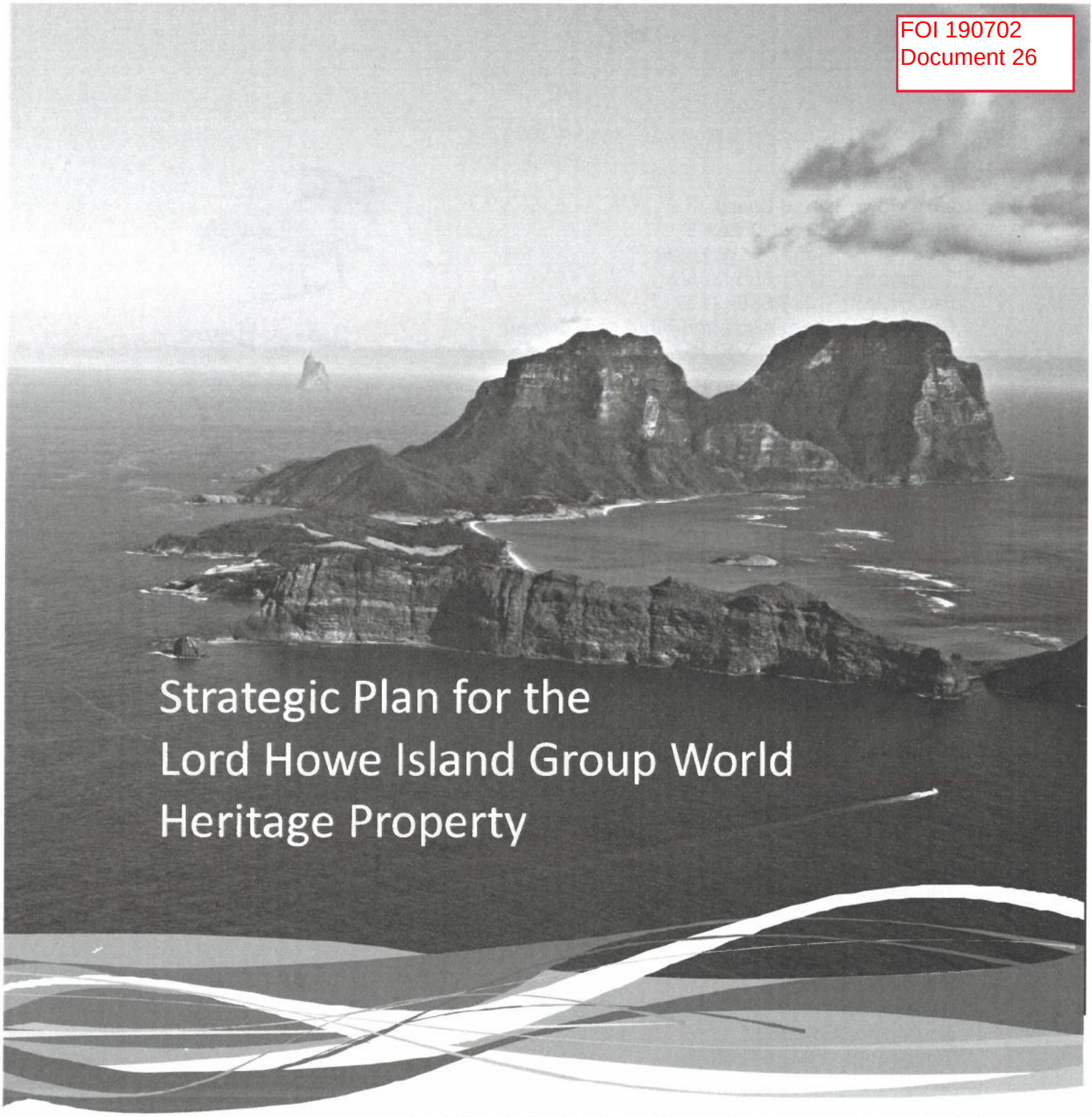
Species assessed = 24 (sea snakes assessed as a group)

Pressure	Species	Rationale
Bycatch (commercial fishing)	Green turtle Leatherback turtle Loggerhead turtle	Bycatch associated with commercial fisheries operating in the region is of concern to marine turtles that are listed as threatened, including the green, leatherback and loggerhead turtle. Turtles are vulnerable to trawl, gillnet and longline fisheries gear, and bycatch interactions typically result in the death of individuals by drowning. All three gear types are used across the region and records indicate that all three species of turtle are caught (Limpus 2009a, 2009b, 2009). The population effects of bycatch mortality are unknown for some species, however, for others such as the loggerhead and green turtle, it has led to population declines. For example, mortality associated with other trawl operations across eastern and northern Australia were identified as the cause of the 55% decline in loggerhead annual nesting numbers in eastern Australia from the mid-1970s to 2000. In the past decade, the introduction of turtle excluder devices (TEDs) in several key trawl fisheries such as the Queensland East Coast Otter Trawl Fishery has resulted in a significant reduction of bycatch. Despite their success, TEDs are not universally used. For example, New South Wales trawl fisheries (e.g. New South Wales Otter Trawl Fishery) do not use these devices and it is expected this will slow the recovery of threatened species across the Temperate East Marine Region and in the south-west Pacific. For other fisheries, such as longline operations where TEDs cannot be used, bycatch levels continue to be considered a high risk. For example, in the Eastern Tuna and Billfish Fishery green and leatherback turtles are the most frequently caught turtle species.
Collision with vessels	Green turtle Hawksbill turtle Loggerhead turtle	Boat strikes are a common cause of death and injury in marine turtles, with turtles' poor hearing and vision hampering their ability to avoid boats. Turtles are most vulnerable to boat strike when they are in shallow waters, or basking or breathing at the surface. Growing coastal development and the associated rise in recreational boating activities in the region are expected to exacerbate this issue (Limpus 2008a, b, 2009a). Adult turtles are particularly vulnerable and this compounds the impact of this pressure on turtle populations by disproportionately reducing the numbers of breeding-age individuals (Limpus 2008b). Some very effective mitigation measures are in place such as the 'Go slow' zones in the Moreton Bay Conservation Park, however, experts remain concerned about the impact of boat strikes on turtle populations within the region.

Table S1.10: Pressures *of potential concern* to selected marine reptiles of the Temperate East Marine Region

Species assessed = 24 (sea snakes assessed as a group)

Pressure	Species	Rationale
Sea level rise (climate change)	Green turtle	Global sea levels have risen by 20 cm between 1870 and 2004, and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5–1 m by 2100, relative to 2000 levels (Climate Commission 2011). The implications of sea level rise for marine turtles include an increased risk of tidal inundation or destruction of nests, the selection of suboptimal nesting areas, and risk of nest destruction by other turtles associated with higher nesting densities (Hamann et al. 2007; Poloczanska et al. 2010). Collectively, these impacts may reduce breeding success. It is expected that the effects of sea level rise will be particularly marked in regions of extensive coastal development, such as eastern Australia, where development acts as a barrier to the landward movement of beaches or hinders natural accretion of beach material and the evolution of beach morphology (Poloczanska et al. 2010).
Changes in sea temperature (climate change)	Green turtle Hawksbill turtle Leatherback turtle Sea snakes	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be a further 1 °C warmer by 2030 (Lough 2009). Increasing sea temperatures have the potential to impact on marine turtles in a number of ways, including a shift in distribution that may either increase or decrease the species range (Hawkes et al. 2009; Milton & Lutz 2003), alterations to life history characteristics (e.g. growth rates, age at maturity and reproductive periodicity) (Baltais & Chaloupka 2004; Chaloupka & Limpus 2001; Fuentes et al. 2009; Hamann et al. 2007) and reduced prey availability (Chaloupka et al. 2008). Sea snakes depend on water temperatures for their body heat while foraging (Guinea 1995; Heatwole 1981). Little is known about the thermal requirements and tolerances of sea snakes and how they will respond to increasing water temperatures (Hamann et al. 2007). Potential impacts from changes in sea temperatures include changes to the availability of prey species and seasonal movements for breeding or feeding (Fuentes et al. 2009; Hamann et al. 2007).



Strategic Plan for the Lord Howe Island Group World Heritage Property

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