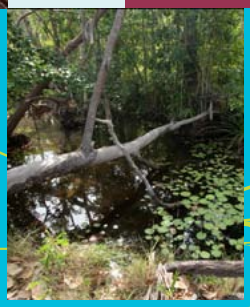
Australian Government



Cobourg Peninsula

Ramsar Site

Ecological Character Description

March 2011

Citation

BMT WBM (2011) Ecological Character Description for Cobourg Peninsula Ramsar Site. Prepared for the Australian Government, Canberra.

Copyright

Introductory Notes

This Ecological Character Description (ECD Publication) has been prepared in accordance with the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* (National Framework) (Department of the Environment, Water, Heritage and the Arts, 2008).

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) prohibits actions that are likely to have a significant impact on the ecological character of a Ramsar wetland unless the Commonwealth Environment Minister has approved the taking of the action, or some other provision in the EPBC Act allows the action to be taken. The information in this ECD Publication does not indicate any commitment to a particular course of action, policy position or decision. Further, it does not provide assessment of any particular action within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), nor replace the role of the Minister or his delegate in making an informed decision to approve an action.

This ECD Publication is provided without prejudice to any final decision by the Administrative Authority for Ramsar in Australia on change in ecological character in accordance with the requirements of Article 3.2 of the Ramsar Convention.

Disclaimers

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for the Environment.

While reasonable efforts have been made to ensure the contents of this ECD are correct, the Commonwealth of Australia as represented by the Department of the Environment does not guarantee and accepts no legal liability whatsoever arising from or connected to the currency, accuracy, completeness, reliability or suitability of the information in this ECD.

Note: There may be differences in the type of information contained in this ECD publication, to those of other Ramsar wetlands.

Acknowledgements

This report was prepared by BMT WBM Pty Ltd with expert input from Melaleuca Enterprises under contract to the Australian Government.

The consultant project team wish to express their thanks to the members of the Inter-Governmental Steering Group and Knowledge Management Committee formed for the project for their assistance and guidance. Input from the traditional owners (the 'Arrarrkbi') greatly enriched aspects of the project.

Photos that appear in the report are supplied by BMT WBM or other organisations where noted. Figures that have been reproduced (without modification) from other sources have been referenced accordingly.

Use of terms and information sources

All definitions and terms used in this report were correct at the time of production in March 2011. Refer to the References (Section 8) for works cited and Glossary (Section 9) for a list of key terms and terminology used.

Cover photos: Rocky marine shores (Simon Drummond); Wolf Claw Spring (Simon Drummond); Mangrove and saltpan interface (Simon Drummond); Smith Point Beacon (Jeanette Muirhead); Crested terns (© Copyright, Brian Furby).

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANZECC/ARMCANZ:	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
CAMBA:	China-Australia Migratory Bird Agreement
CEPA:	Communication, education, participation and awareness
CMS:	Convention on the Conservation of Migratory Species
CSIRO:	Commonwealth Scientific and Industrial Research Organisation
DEWHA:	Department of the Environment, Water, Heritage and the Arts
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
ECD:	Ecological Character Description
EPBC:	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and regulations under that Act
HAT:	Highest Astronomical Tide
IMCRA:	Integrated Marine and Coastal Regionalisation of Australia
IUCN:	International Union for Conservation of Nature
JAMBA:	Japan-Australia Migratory Bird Agreement
KMC:	Knowledge Management Committee
LAC:	Limit(s) of Acceptable Change
MA:	Millennium Ecosystem Assessment
LAT:	Lowest Astronomical Tide
NES:	(matter of) National Environmental Significance
NLC:	Northern Land Council
NRM:	Natural Resource Management
NRETAS:	Northern Territory Department of Natural Resources, Environment, the Arts and Sport (previously NRETA)
NT:	Northern Territory

RIS:	Ramsar Information Sheet
ROKAMBA:	Republic of Korea- Australia Migratory Bird Agreement
sp.:	Species (singular)
spp.:	Species (plural)

EXECUTIVE SUMMARY

The Cobourg Peninsula Ramsar site is listed as a Wetland of International Importance under the "Convention on Wetlands of International Importance especially as Waterfowl Habitat" or, as it is more commonly referred to, the Ramsar Convention (the Convention). Cobourg Peninsula was the first site listed under the Convention in 1974.

This report provides the Ecological Character Description (ECD) for the Cobourg Peninsula Ramsar site, and has been prepared in accordance with the National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands (DEWHA 2008). This is the first ECD prepared for the site. In parallel with the preparation of the ECD, the Ramsar Information Sheet (RIS) for the site has been updated for submission to the Australian Government and Ramsar Secretariat.

The Cobourg Peninsula Ramsar site is located approximately 163 kilometres north-east of Darwin in the Northern Territory. The site occupies the entire peninsula and several nearby islands including the Sir George Hope Islands group, Sandy Island No. 1 and II, Allaru Island, High Black Rock and Burford Island. The Ramsar site covers an area of approximately 220 700 hectares. Cobourg Peninsula contains no towns or settlements. Three outstations occupied by traditional owners are based at Araru Point, Reef Point and Danger Point. The ranger station, staffed by Parks and Wildlife Service, is at Black Point.

The Ramsar site is bounded by the following geographic features:

- Van Diemen Gulf and the Timor Sea to the south
- Bowen Strait and Mountnorris Bay to the east
- Arafura Sea to the north
- Dundas Strait to the west.

Under the *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act 1996,* Cobourg Peninsula and surrounding waters are a declared National Park (Garig Gunak Barlu National Park). Cobourg Peninsula is inalienable freehold land under the Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976*. All land formerly held by the Crown in the former Sanctuary is vested in the Cobourg Peninsula Sanctuary Land Trust. The Land Trust also supervises management of the marine park which includes customary marine estates of the traditional owners. The *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act 1996* acknowledges the right of traditional owners to participate in management of the park.

The Cobourg Peninsula Ramsar site is composed of a diversity of coastal and inland wetland types. Wetland types present include intertidal forested wetlands and saltflats, seasonal freshwater marshes and permanent freshwater pools. Using the Ramsar typology, there are ten coastal types and ten inland types within the site. Garig Gunak Barlu National Park includes the marine waters surrounding the peninsula, but these are not included in the Ramsar site.

The ECD has reviewed the nomination criteria under which the Ramsar site was first listed. Despite the absence of formal listing criteria in 1974, the site is deemed to continue to reflect the values for which it was first nominated. The site has now been assessed in the context of the nine current

nomination criteria of the Convention and is considered to meet five criteria. This recognises the representative wetland habitats of the site at a bioregional level, support of populations of threatened species, support for key life-cycle functions such as marine turtle breeding and waterbird breeding and refugia values, and its importance for supporting fish nursery and spawning habitats.

The critical component of the site is the diversity and connectivity of a wide range of wetland habitat types, and is supported by populations of waterbirds, terrestrial ecosystems and freshwater fish and invertebrates. The catchments for all wetland types are also contained within the site boundaries. Critical ecosystem processes that underpin the wetland values of the site include breeding populations of marine turtles and waterbirds, with supporting processes including climate, fire regime, hydrology, water quality, geology and geomorphology. One critical service provided by the site, contemporary living heritage, enables the traditional owners (the 'Arrarrkbi') to continue the cultural practices handed down over many generations. The other critical service provided is the maintenance of global biodiversity through supporting threatened fauna and a species-rich ecosystem. The wetland components and processes of the site support a broad range of ecosystem services/benefits including fisheries resource values, tourism and recreation values and historical heritage.

A summary of the components, processes and services/benefits provided by the Cobourg Peninsula Ramsar site as nominated by this ECD is given in Table E-1. The critical wetland components, processes and services/benefits have been selected based upon the following considerations from the National Framework document:

- the component, process or service/benefit is an important determinant of the unique character of the site
- the component, process or service/benefit is important for supporting one or more of the Ramsar Nomination Criteria under which the site was listed
- a change in a component, process or service/benefit is reasonably likely to occur over short or medium timescales (less than 100 years)
- a change to the component, process or service/benefit will cause significant negative consequences.

As required by the National Framework document, the study has:

- sought to identify and describe critical components, processes and services/benefits
- sought to define the natural variability and limits of acceptable change (LAC) for the critical components, processes and services/benefits identified (Table E-2)
- examined ecological character changes that have been observed or documented since listing in 1974, including assessment against relevant LAC
- investigated current and future threats to ecological character.

It would appear unlikely that any of the LAC presented in the ECD have been meaningfully exceeded since listing. However, the degree of quantitative information and data required for a definitive assessment of ecological character change is not currently available.

Recent or continuing threats that are notable in the context of the site that may affect future ecological character include:

- introduction and/or proliferation of exotic flora and fauna
- climate change
- tourism and recreational activities (including boating)
- marine debris
- Impacts on living culture
- living resource extraction.

Of these threats, future impacts from climate change in terms of coral bleaching and saltwater intrusion and impacts from large populations of non-indigenous ungulates (that is, pigs, banteng, buffalo and horses) and spread of cane toads are seen as the most likely and potentially severe.

Key information gaps that have been identified in the context of this ECD include:

- Additional research and monitoring to establish an ecological character baseline for some key habitats (such as coral communities and seagrass)
- Better information and data sets about the presence and natural history of critical wetland species and their habitats including for example, surveys of nesting marine turtles and waterbird breeding colonies, and more systematic surveys of important avifauna and fish species and populations
- Better information and understanding about the natural variability of wetland fauna populations and key attributes and controls on those populations
- Additional investigation of the ecological character thresholds of particular habitats and communities to changes in key attributes/controls such as hydrology. Several LAC stated in the ECD should be reviewed and revised as improved information becomes available
- More specific assessment of the vulnerability of the site to the impacts of climate change, and adaptation options that could be explored to reduce the future impacts.

In accordance with the above, monitoring needs and recommendations presented in this ECD relate to the need to assess the suitability of the LAC (versus natural variability) and to assess more definitively if changes to ecological character have occurred or are being approached. Since the monitoring needs are quite extensive, a broad scale ecosystem health-based monitoring program may be most appropriate for the Ramsar site using lessons learned from similar approaches elsewhere. Emphasis should be placed on the collection of data and information about critical and supporting process indicators, such as water quality and biotic indicators of ecosystem health.

A combined set of communication, education, participation and awareness messages relevant to the ECD have been presented and can be used to communicate the importance of the site, why it was listed, possible changes to ecological character, the threats to the site and future actions required. These messages also serve as a summary of the key findings and conclusions of the ECD study.

Table E-1 Summary of critical and supporting components, processes and services/benefits

	Components	Processes	Services/Benefits
Critical	C1 – Diversity and Connectivity of Wetlands	P1 – Flatback and Green Turtle Nesting P2 – Waterbird Breeding Colonies	S1 - Contemporary Living Culture S2 - Maintenance of Global Biodiversity
Supporting	Populations of Migratory and Resident Waterbirds and Seabirds Monsoon Rainforests Terrestrial Habitats Aquatic Invertebrates Fish Populations	Climate Geology/Geomorphology Hydrology (tidal, surface, groundwater) Water Quality Fire Regime Other Notable Biological Processes	Fisheries Resource Values Recreation and Tourism Scientific Research and Education Historical Indigenous and Non-Indigenous Cultural Heritage Biological Products

LAC explanatory notes

1. Limits of Acceptable Change are a tool by which ecological change can be measured. However, Ecological Character Descriptions are not management plans and Limits of Acceptable Change do not constitute a management regime for the Ramsar site.
2. Exceeding or not meeting Limits of Acceptable Change does not necessarily indicate that there has been a change in ecological character within the meaning of the Ramsar Convention. However, exceeding or not meeting Limits of Acceptable Change may require investigation to determine whether there has been a change in ecological character.
3. While the best available information has been used to prepare this Ecological Character Description and define Limits of Acceptable Change for the site, a comprehensive understanding of site character may not be possible as in many cases only limited information and data is available for these purposes. The Limits of Acceptable Change may not accurately represent the variability of the critical components, processes, benefits or services under the management regime and natural conditions that prevailed at the time the site was listed as a Ramsar wetland.
4. Users should exercise their own skill and care with respect to their use of the information in this Ecological Character Description and carefully evaluate the suitability of the information for their own purposes.
5. Limits of Acceptable Change can be updated as new information becomes available to ensure they more accurately reflect the natural variability (or normal range for artificial sites) of critical components, processes, benefits or services of the Ramsar wetland.

Table E-2 Limits of Acceptable Change

Number	Indicator for critical component / process/service for the LAC	Relative timescale[1]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
C1: Critical Component – Diversity of wetlands						
1	Reduction in extent of any one of the following marine/coastal habitat types: • marine subtidal aquatic beds (seagrass) • intertidal mud, sand and saltflats • intertidal marshes (saltmarsh) • intertidal forested wetlands (mangroves) • sand, shingle or pebble shores • estuarine waters	Long term	Extent of each habitat type will not decline by more than 20 percent of the following baseline values^: • intertidal mud, sand and saltflats = 6212 ha • intertidal marshes (saltmarsh) = 2734 ha • intertidal forested wetlands (mangroves) = 26 207 ha • sand, shingle or pebble shores = 2070 ha • estuarine waters = 7592 ha Marine subtidal aquatic beds (seagrass) have not been mapped and represent an information gap, a baseline value cannot be set at this time. Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	• Minimum three sample events separated by at least two year intervals[#]. • Measured over any 10 year period.	2B (Appendix A) except marine subtidal aquatic beds where no empirical data currently exists therefore has a data rating of 2C.	S1, S2
2	Reduction in extent of any one of the following marine/coastal habitat types: • rocky marine shores (rocky cliffs)	Long term	Extent of each habitat type will not decline by more than 10 percent of the following baseline values^: • rocky marine shores (rocky cliffs) = 36.5 km Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	• Minimum three sample events separated by at least two year intervals[#]. • Shores and estuarine water measurements to be undertaken over a consistent tidal period, such as mean low water springs. • Measured over any 10 year period.	2B (Appendix A)	P1, P2, S1, S2
3	Reduction in the number of any one of the following marine/coastal habitat types: • coastal brackish/saline lagoons (with sea connection)	Short and Long term	A 25 percent loss in the number of mapped waterbodies (see Appendix A) or identified reef sites, based upon the following baseline values^: • coastal brackish/saline lagoons (with	• Loss is defined as feature not being present or in a substantially modified condition for a period of greater than 5 years	2B for the lagoons (Appendix A) 2C (coral reef) with identified sites including: Popham	S1, S2

[1] Short Term – measured in years; Long term – 10+ year intervals.

Number	Indicator for critical component / process/service for the LAC	Relative timescale[1]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
	• coastal freshwater lagoons • coral reef		sea connection) = 28 lagoons • coastal freshwater lagoons = 4 lagoons • coral reef = 12 sites Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.		Creek, Kuper Point, Sandy Island No. 1 and Sandy Island No. 2, Table Head, Turtle Point, Coral Bay, adjacent Vashon Head, Danger Point, Smith Point, Black Point and Caiman Creek	
4	Reduction in the number of any one of the following inland wetland habitat types: • seasonal freshwater lakes • seasonal saline/brackish lakes • permanent saline/brackish lakes • freshwater springs	Short and Long Term	A 25 percent loss in the number of mapped waterbodies (see Appendix A), based upon the following baseline values^: • seasonal freshwater lakes = 14 lakes • seasonal saline/brackish lakes = 7 lakes • permanent saline/brackish lakes = 8 lakes • freshwater springs = 22 springs Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.	• Loss is defined as feature not being present or in a substantially modified condition for a period of greater than 5 years	2B (Appendix A)	S1, S2
5	Reduction in the extent of freshwater, tree-dominated wetlands (*Melaleuca*)	Long term	No decline in the extent of *Melaleuca* forests by more than 10 percent of the following baseline value^: 770 ha Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected	• Minimum three sample events separated by at least two year intervals. • Measured over any 10 year period.	2B (Appendix A)	S1, S2
P1: Critical Process – Marine turtle nesting						
6	Marine turtle nesting	Short term	The average number of nesting attempts at core turtle nesting areas on Black Point, Smith Point, Danger Point and Greenhill Island does not decline by more than 20 percent. Note no baseline data exists at present.	• Recommended baseline monitoring program should follow survey protocols of Schäuble et al. 2006 for Field Island. The programme should include annual sampling over a ten year period, with sampling events timed to meet peak nesting periods (i.e. dry season for flatback turtles, wet season for green turtles). • LAC based over a 10 year period from date of ECD preparation.	2C	S1, S2

Number	Indicator for critical component / process/service for the LAC	Relative timescale[1]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
P2: Critical Process – Waterbird breeding colony						
7	Waterbird breeding (i.e. seabirds, excluding migratory shorebirds)	Short term	Identified sites continue to support breeding colonies of a similar waterbird assemblage. Insufficient current, systematically collected baseline data to enable a quantitative LAC to be described. Long-term LAC to be confirmed on completion of data collection as part of a recommended baseline monitoring program.	• Recommended baseline monitoring program should be based on aerial survey protocols of Morton et al. (1991) and Chatto (2001) The survey should be systematic and involve repeat sampling over corresponding time periods. Based on a ten year cycle, the recommended program should comprise a minimum three sampling events, each separated by at least one year. Each sampling event is comprised of one late dry season and one wet season survey over the course of one year. • LAC based on sampling in at least three years within a 10 year period from date of ECD preparation.	2B with identified sites including Sandy Island No. 1 and Sandy Island No. 2, Edwards Point, Wurrurrlarnbi, sand island in Coral Bay, Warla Island.	S1, S2
S1: Critical Service – Contemporary living culture						
8	Contemporary Arrarrkbi 'living culture' (including the body of Traditional Ecological Knowledge, Arrarrkbi languages, traditional fire and land management practices, traditional resource use) (Service 1)	N/A	Due to the lack of quantitative data regarding 'living culture' attributes, the limits of acceptable change are unable to be defined quantitatively. However a change in the ability of Arrarrkbi to own, occupy, access and use the land and resources of Garig Gunak Barlu National Park could impact on 'living culture'. A change in the ability of Arrarrkbi to use and transmit cultural practices, knowledge and spirituality could also impact on 'living culture'*	N/A	N/A	C1
S2: Critical Service – Maintenance of global biodiversity						
9	Threatened species	N/A	An unacceptable change would have occurred if the site no longer supported at least one of the following species of reptile (flatback turtle, green turtle, leatherback turtle, hawksbill turtle, Olive Ridley turtle, loggerhead turtle), and mammal (dugong)	Based on multiple targeted surveys at appropriate levels of spatial and temporal replication (at least four annual surveys in preferred habitats) over a 10 year period.	2B for reptiles and fish. 2C for mammals and birds.	C1, P1, P2, S1

1 INTRODUCTION

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

1.1 Background

The Cobourg Peninsula Ramsar site is one of 64 wetland areas in Australia that are currently listed as Wetlands of International Importance under the *Convention on Wetlands of International Importance especially as Waterfowl Habitat* or, as it is more commonly referred to, the Ramsar Convention (hereafter referred to as the Convention). Cobourg Peninsula was the first site listed as a Ramsar site under the Convention in 1974.

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

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

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

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

This report provides the ECD for the Cobourg Peninsula Ramsar site. In parallel with the preparation of the ECD, the Ramsar Information Sheet (RIS) for the site is being updated for submission to the Australian Government and Ramsar Secretariat.

This ECD report has been prepared by the consultant study team led by BMT WBM Pty Ltd under contract with the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). This has occurred with input from a Project Steering Committee made up of officials from the Northern Territory Department of Natural Resources, Environment, The Arts and Sport (NRETAS), DSEWPaC and the Board of Management for the Cobourg Peninsula Sanctuary and Marine Park. A range of Government and non-Government individuals with expertise and/or local research experience working within the Ramsar site have also been engaged as part of a Knowledge Management Committee (KMC) for the study.

1.2 Scope and Purpose of this Study

Figure 1-1 shows the key steps of the ECD preparation process from the National Framework document which forms the basis for ECD reporting. Based on the *National framework and guidance for describing the ecological character of Australian Ramsar wetlands* (DEWHA 2008), hereafter

referred to as the National Framework for ECDs, the key purposes of undertaking an ECD are as follows:

1. To assist in implementing Australia's obligations under the Ramsar Convention, as stated in Schedule 6 (Managing wetlands of international importance) of the Environment Protection and Biodiversity Conservation Regulations 2000 (Commonwealth):

a) To describe and maintain the ecological character of declared Ramsar wetlands in Australia

b) To formulate and implement planning that promotes:

i) Conservation of the wetland

ii) Wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem.

2. To assist in fulfilling Australia's obligation under the Ramsar Convention, to arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the Ramsar List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference.

3. To supplement the description of the ecological character contained in the Ramsar Information Sheet submitted under the Ramsar Convention for each listed wetland and, collectively, to form an official record of the ecological character of the site.

4. To assist the administration of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), particularly:

a) to determine whether an action has, will have or is likely to have a significant impact on a declared Ramsar wetland in contravention of sections 16 and 17B of the EPBC Act, or

b) to assess the impacts that actions referred to the Minister under Part 7 of the EPBC Act have had, will have or are likely to have on a declared Ramsar wetland.

5. To assist any person considering taking an action that may impact on a declared Ramsar wetland whether to refer the action to the Minister under Part 7 of the EPBC Act for assessment and approval.

6. To inform members of the public who are interested generally in declared Ramsar wetlands to understand and value the wetlands.

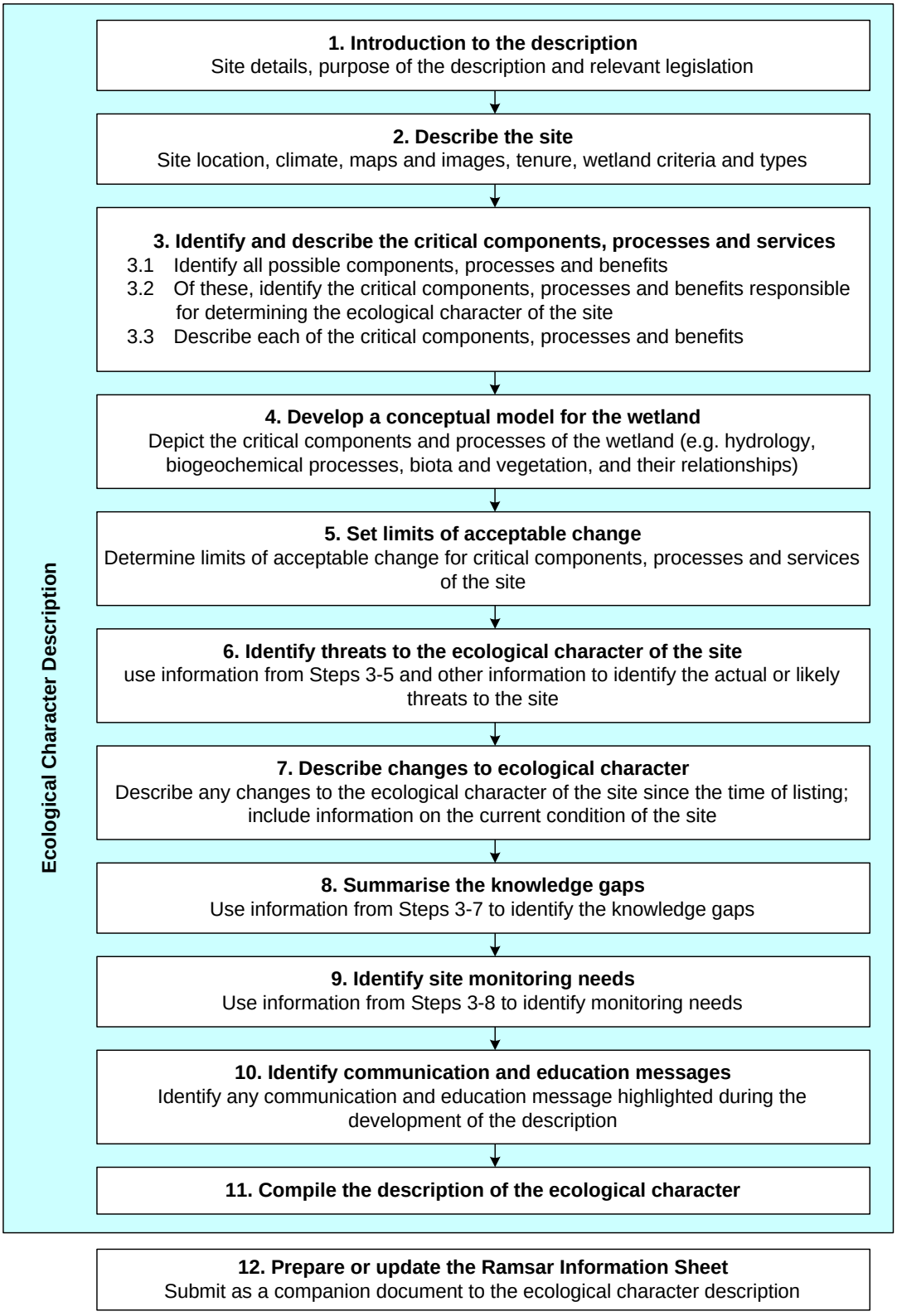


Figure 1-1 Key steps in preparing an Ecological Character Description (source: DEWHA 2008)

1.3 Relevant Treaties, Legislation and Regulations

This section provides an overview of the treaties, legislation, regulations and management plans at various levels of government relevant to the Cobourg Peninsula Ramsar site.

The Convention on Wetlands of International Importance (the Ramsar Convention) (Ramsar, Iran, 1971) is an intergovernmental treaty dedicated to the conservation and sustainable use of wetlands. Australia became a signatory to the Convention in 1971 and the Convention entered into force in Australia in 1974. Currently, sixty-four Australian sites are on the List of Wetlands of International Importance. Australia's obligations to protect and maintain the ecological character of its Ramsar sites is recognised in Commonwealth Legislation through the EPBC Act.

1.3.1 Establishment and Management Arrangements of the Site

1.3.1.1 Ramsar Site Declaration

Cobourg Peninsula has a long history of conservation reserve management (Figure 1-2). Cobourg Peninsula was first declared as a flora and fauna reserve in 1924. In 1940, the western half of this reserve was revoked to become an Aboriginal reserve (Woinarski and Baker 2002; CPSB 1987). In 1962 the Peninsula was declared as a sanctuary under *the Wildlife Conservation and Control Ordinance 1962* (WCC Ordinance), providing legislative protection for the site and placing it under the control of the then Chief Inspector of Wildlife, Department of the Interior (now the Attorney-General's Department) (Wilson 1974).

The protected status of the site was one of the reasons Cobourg Peninsula was declared an internationally important wetland under the Ramsar Convention in 1974 (Ramsar Convention Secretariat 2010). The boundary of the declared site corresponded with the boundary of the Cobourg Peninsula Sanctuary which extends seaward to the low-water mark[2].

1.3.1.2 Protected Area Status of the Site

Following the commencement of the *Territory Parks and Wildlife Conservation Act* (TPWC Act) in 1977, all sanctuaries previously declared under the WCC Ordinance, including the Cobourg Peninsula Sanctuary, were recognised as sanctuaries for the purposes of the TPWC Act (s25A TPWC Act).

The *Cobourg Peninsula Aboriginal Land and Sanctuary Act 1981* then established the WCC Ordinance Sanctuary as a national park (Gurig National Park). The Cobourg Marine Park was declared in 1983, offshore of the former Gurig National Park (s12 TPWC Act). The marine park extends seaward from the low-water mark to the surrounding waters of the Arafura Sea and Van Diemen's Gulf (see Section 1.3.2.2 and Appendix F). Following the declaration of the Cobourg Marine Park, the *Cobourg Peninsula Aboriginal Land and Sanctuary Act 1981* was amended to become the *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act 1996* (Cobourg Peninsula Act) which defines the areas within the Park, and those excluded from the Park that are within the Ramsar site. The Garig Gunak Barlu National Park, incorporating both the former Gurig National Park and

[2] Low-water mark is not defined in the legislation but is assumed to indicate the level of Lowest Astronomical Tide (LAT).

Cobourg Marine Park, was declared as a National Park under the TPWC Act in 2000. An overview of the protected area status and Ramsar site declaration for the Cobourg Peninsula Ramsar site is provided in the following timeline (Figure 1-2).

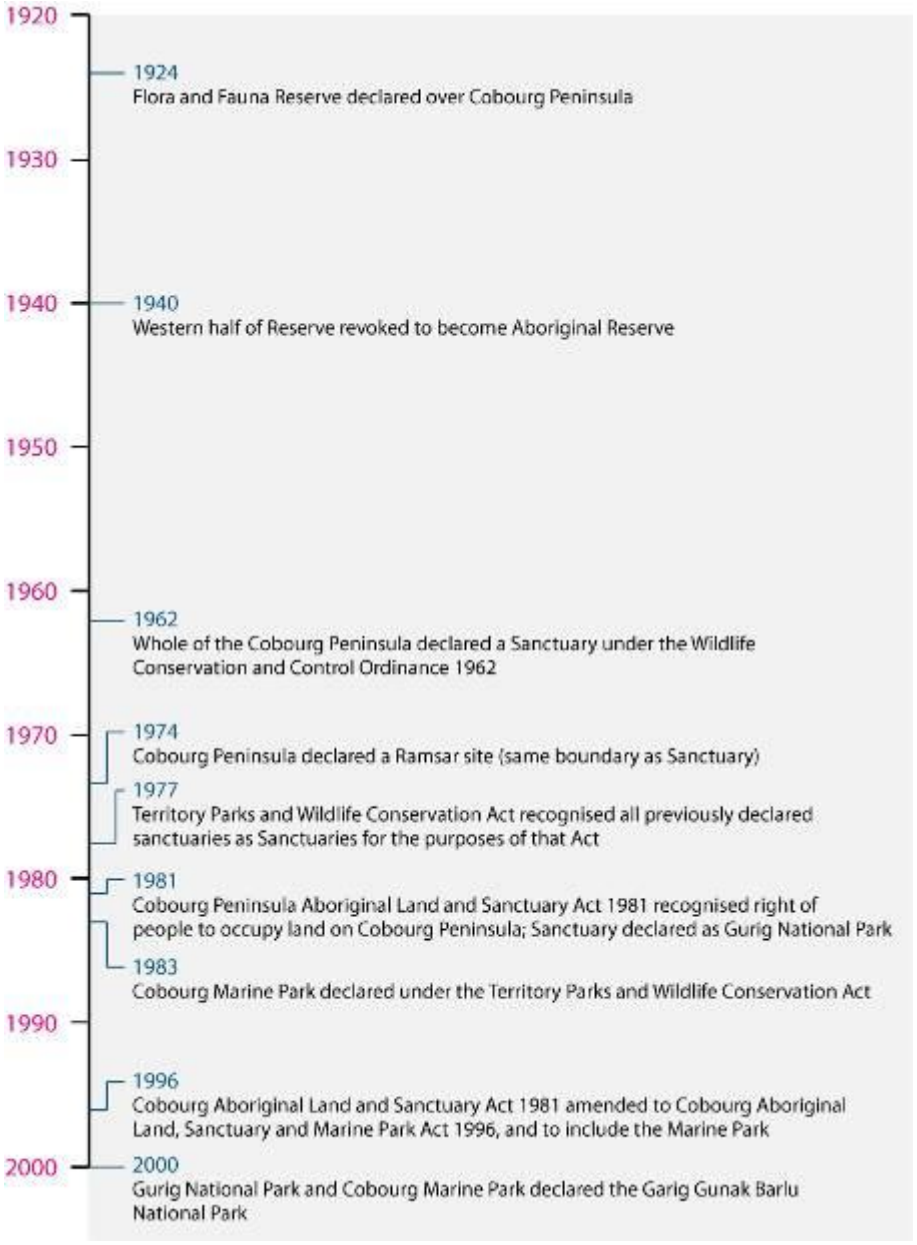


Figure 1-2 Timeline of Protected Areas on Cobourg Peninsula

1.3.1.3 Land Rights

The Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976* (Aboriginal Land Rights Act) makes provision for the granting of inalienable freehold title to traditional Indigenous owners of land in the Northern Territory. The Act also provides for the establishment and management of Land Trusts and Land Councils (Part III). The Land Council for Cobourg Peninsula is the Northern Land Council (NLC) (NLC 2003).

A grant for inalienable freehold title over Cobourg Peninsula was made under this Act to the traditional owners but in order to resolve pending claims to the land, consent was given to the creation of the Gurig National Park under the then *Cobourg Peninsula Aboriginal Land and Sanctuary Act 1981* (ISP 2007). The Cobourg Peninsula Act, consistent with the Aboriginal Land Rights Act, provided Aboriginal people the right to occupy and use the land on Cobourg Peninsula and vested all land formerly held by the Crown in the Sanctuary in the Cobourg Peninsula Sanctuary Land Trust (the Land Trust) (ss5 and 7). Under the Act, the Land Trust holds inalienable title over Cobourg Peninsula in trust for the traditional owners and supervises management of the marine park which includes customary marine estates of the traditional owners. Cobourg Peninsula is therefore now regarded as Aboriginal freehold land held by the Land Trust with a small area to the south-east of the Peninsula, across the isthmus, held by the Arnhem Land Aboriginal Land Trust.

1.3.1.4 Management Arrangements

The area constituting the Ramsar site (within the Garig Gunak Barlu National Park) is managed under the Cobourg Peninsula Act and is administered by the Cobourg Peninsula Sanctuary and Marine Board (the Board) (s18). The Board's functions include preparation of plans of management, protection and enforcement of the occupation of Cobourg Peninsula, determination of rights of access, protection of sacred sites, and other necessary functions under plans of management. Relevant management plans for Cobourg Peninsula Ramsar site are discussed in Section 1.3.2. Cobourg Peninsula is managed as a Joint Management Park between the Northern Territory Government and the traditional owners of Cobourg Peninsula (the Arrarrkbi).

The boundary of the Ramsar site is consistent with the boundary of the former Gurig National Park under the TPWC Act but also contains parts of a fishery management area under the *Fisheries Act* (NT) (Fisheries Act). Under the Fisheries Act (s22), Cobourg Marine Park and the intertidal area of the former Gurig National Park constitute a declared fishery management area (FMA) known as the Cobourg FMA, which is managed in partnership between the Northern Territory Government, Arrarrkbi and the Cobourg Fisheries Management Area Advisory Committee.

1.3.2 Management Plans Applicable to the Site

In accordance with the Cobourg Peninsula Act, any management plan must be prepared by the Board and approved by the NLC and the Minister.

1.3.2.1 Gurig National Park Plan of Management

The Cobourg Peninsula Act requires that the plan of management details the specific management requirements for the National Park and provides a description of the lands and ecological features. The current Gurig National Park Plan of Management (Gurig Plan) was prepared by the Board and approved in 1987. The Gurig Plan incorporates management programs under the TPWC Act including those for the protection conservation, sustainable use, control and management of wildlife and the control and management of feral animals (s32). There are four areas of management objectives under the Gurig Plan: management for Arrarrkbi interests, management of the resources, management for visitors and park administration. A new plan is currently being prepared and is required for management initiatives to be legally binding.

1.3.2.2 Cobourg Marine Park Plan of Management

The Marine Park Plan was prepared by the Board in partnership with the Cobourg Fisheries Management Area Advisory Committee and in accordance with the Cobourg Peninsula Act in 2007. The Marine Park Plan is also considered a Fishery Management Plan under s23 of the *Fisheries Act* and applies to the areas of the FMA in common with the Marine Park (that is, subtidal areas only; Section 1.3.1.3). The responsibility for review of the Marine Park Plan lies with the Board and the Cobourg Fisheries Management Area Advisory Committee is responsible for reviewing the management programs annually.

Activities that can be undertaken in each Marine Park zone are detailed in the Marine Park Plan (refer to Appendix F). These activities, or uses, include commercial aquaculture, research, fishing and non-extractive tour operations, anchoring and mooring, and require a permit from the Board. Permits are given taking into account the various management values of the Marine Park and a number of other considerations.

1.3.3 General Management Requirements

1.3.3.1 Commonwealth Legislation

Environmental Protection and Biodiversity Conservation Act 1999

Australia's obligation to protect and maintain the ecological character of its Ramsar sites is recognised in Commonwealth legislation through the EPBC Act. The EPBC Act sets out standards for managing Ramsar wetlands through the Australian Ramsar Management Principles and through the referral and assessment of activities that may have an impact on a Ramsar site and other matters of National Environmental Significance (NES) (DEWHA 2009a; DEWHA 2009b). Several matters of NES under the Act are directly relevant to the Cobourg Peninsula including Wetlands of International Importance (Ramsar wetlands), threatened species and migratory species.

The EPBC Act also implements conventions protecting migratory species to which Australia is a signatory, and identifies migratory species protected under these international agreements as matters of NES. The key international conventions on migratory species are as follows:

- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention). It was adopted in 1979 and aims to conserve terrestrial, marine and avian migratory species throughout their range (UNEP/CMS Secretariat 2004)
- Japan-Australia Migratory Birds Agreement (JAMBA), China-Australia Migratory Birds Agreement (CAMBA) and Republic of Korea-Australia Migratory Birds Agreement (ROKAMBA). These are bilateral agreements between Australia and the respective countries to the agreements that protect migratory bird species listed under these agreements (DEWHA, 2009a).

In addition, a multilateral approach to the conservation of migratory birds listed under the EPBC Act has been implemented through the Partnership for the East Asian-Australasian Flyway.

Historic Shipwrecks Act 1976

Historic shipwrecks and similar heritage sites are protected under the *Historic Shipwrecks Act 1976* (Shipwrecks Act) as part of a national heritage conservation scheme. There are 13 historic shipwrecks located along the coast of Cobourg Peninsula and recognised under the *Shipwrecks Act* on the Australian National Shipwreck Database (DSEWPaC 2010) (refer to Section 3.8.5 for the list of recognised shipwrecks). The exact location of most of these wrecks is unknown or not identified in the Database. Persons are prohibited from any conduct or omission that causes damage or destruction, interference, or removal of any historic shipwreck or relic. Protection of the Northern Territory's historic shipwrecks is also provided by the *Heritage Conservation Act 1991*.

Australian Register of the National Estate

Places of national and international heritage importance are listed on the Australian Register of the National Estate. This Register is administered by the Australian Heritage Council under the *Australian Heritage Council Act 2003*. Following amendments to this Act the Register was frozen on 19 February 2007 and will be removed in February 2012. Areas at Cobourg Peninsula that are listed on the Register include the Cobourg Peninsula Historic Sites Precinct and Cape Don Lighthouse Complex. These are managed under the Northern Territory Heritage Conservation Act (see Section 1.3.3.2).

1.3.3.2 Northern Territory Legislation

Legislation applicable to the ecological character of Cobourg Peninsula Ramsar site includes Acts relating to conservation and management, and relating to development and infrastructure. This distinction predominantly relates to the purpose of the Acts.

Legislation concerned with conservation and management includes:

- *Territory Parks and Wildlife Conservation Act*
- *Fisheries Act*
- *Weed Management Act 2001*
- *Soil Conservation and Land Utilisation Act*
- *Heritage Conservation Act 1991.*

Legislation relating to future development and infrastructure which may impact on the ecological character of the site includes:

- *Planning Act*
- *Local Government Act 2008*
- *Water Act*
- *Waste Management and Pollution Control Act*.

2 DESCRIPTION OF THE SITE

This Section of the ECD provides an overview of the site, including a brief description of the site, tenure and adjoining land use, an overview of the wetland types and a review of the site's Ramsar Nomination Criteria.

2.1 Details of the Site – Summary

Summary details of the site for the purposes of the ECD are provided in Table 2-1.

2.2 Location and Brief Description

The Cobourg Peninsula Ramsar site is located approximately 163 kilometres north-east of Darwin in the Northern Territory. The site occupies the entire peninsula, connected to the mainland via a narrow isthmus (11 kilometres wide) near the Murganella area of West Arnhem Land at approximately 11°32'S, 132°36'E, as well as several nearby islands including the Sir George Hope Islands group, Sandy Islands I and II, Allaru Island, High Black Rock and Burford Island. The Ramsar site covers an area of approximately 220 700 hectares. A map showing the boundaries of the Ramsar site is presented in Figure 2-1. The site contains extensive intertidal areas, estuarine reaches, freshwater wetlands and streams and terrestrial areas. It is important to note that the Ramsar boundary is defined as the low-water mark (see Section 1.3.1.1), though no accurate dataset describing this level currently exists. The actual site boundary may vary, particularly with respect to areas along the southern coastline where intertidal mudflats (above the low-water mark) are poorly defined. Please refer to the on-line RIS for the most accurate boundary information[3].

Cobourg Peninsula contains no towns or settlements. Three outstations occupied by traditional owners are based at Araru Point, Reef Point and Danger Point. The ranger station, staffed by the Parks and Wildlife Service, is at Black Point. Several pearling leases operate within the northern embayments of the site, with associated land operations excluded from the National Park boundaries. These areas are all considered part of the Ramsar site (see Section 2.3.1.1 for a discussion on excised areas).

Access to the site is via an unsealed road through West Arnhem Land, airstrips at Smith Point and Cape Don or via boat. Access through West Arnhem Land requires a permit, issued by the NLC. Tourist use is generally restricted to the areas around Smith Point, Berkeley Bay and Barrow Bay, with boat excursions to the Victoria Settlement ruins.

The climatic zone within which the site is located is defined as the *hot humid summer* climatic zone (Stern et al. 2003). Whilst large expanses of the Ramsar site are Eucalypt-dominated woodlands and forests, this ECD focuses specifically on the wetland habitats. The range of the environmental gradients and contiguous, diverse landscapes, have contributed to a variety of wetland habitat types that support high levels of biodiversity.

The Ramsar site is bounded by the following geographic features:

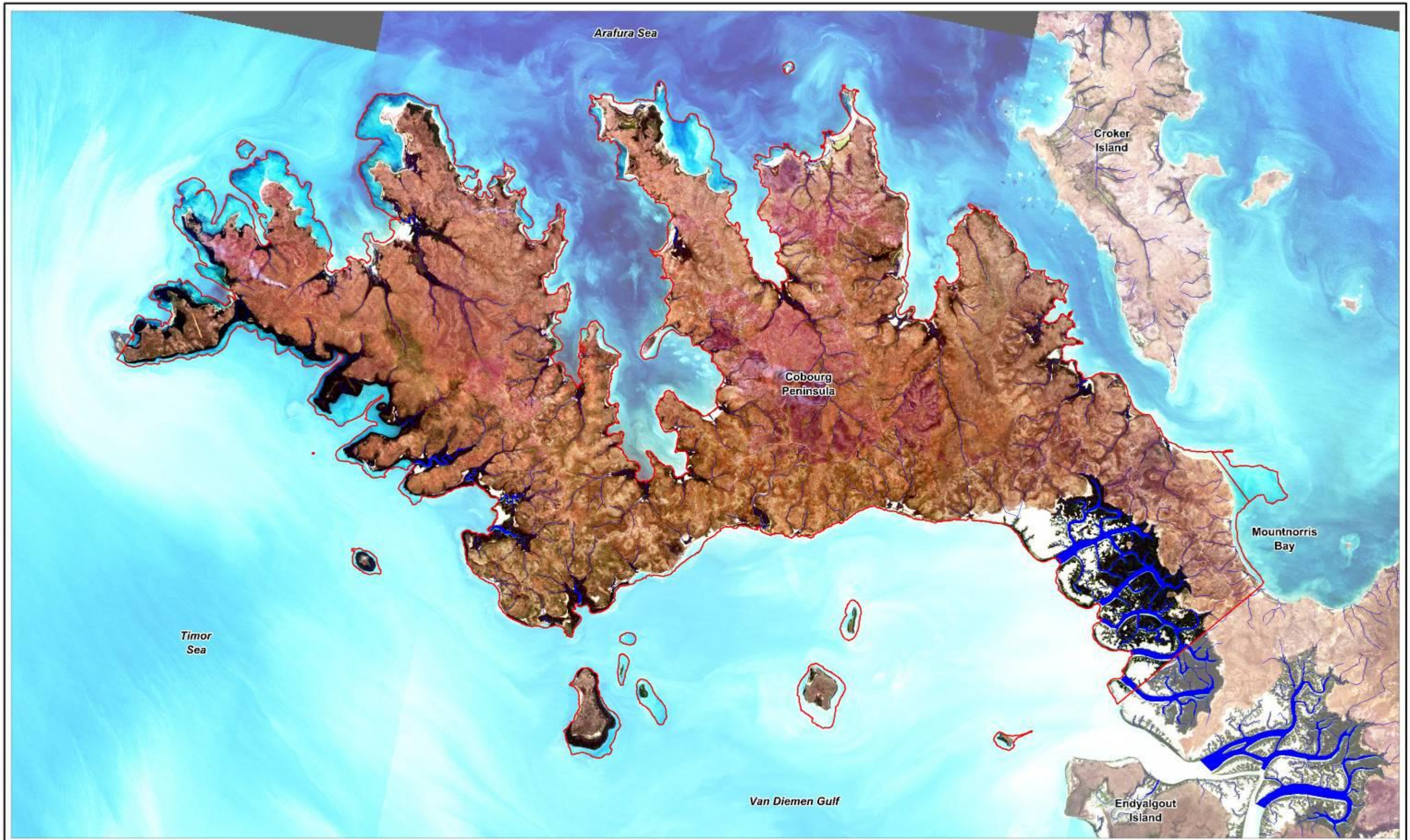
- Van Diemen Gulf and the Timor Sea to the south

[3] http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=1

- Bowen Strait, Mountnorris Bay and a narrow isthmus that connects to West Arnhem Land to the east
- Arafura Sea to the north
- Dundas Strait to the west.

Table 2-1 Site details and location description for the Cobourg Peninsula Ramsar site

Attribute	Cobourg Peninsula Ramsar site
Ramsar Site Number	Site no. 1
Location in coordinates	Indicative extents: 11°07' to 11°38' S; 131°45' to 132°39' E
General Location	The site is located approximately 163 kilometres north-east of Darwin in the Northern Territory. It occupies all of the terrestrial areas of the peninsula, down to the low-water mark, and includes the nearby Sir George Hope Islands group.
Applicable Bioregions	• Division VIII – Timor Sea Drainage Division (East Alligator basin) • Northern IMCRA province
Area	Total site area: 220 700 hectares
Date of Listing	8 May 1974
Dates Used for Ecological Character Description	• 1974 (original listing under the Ramsar Convention) • 2011 (time of ECD and updated RIS preparation)
Justification for Date of Description	See above justification in parenthesis for various dates.
Original Description Date	This is the first ECD undertaken for the site. As part of this project, the Ramsar Information Sheet (last updated in 1998) has been revised.
Compiler's Name	BMT WBM Pty Ltd, with expert input from Melaleuca Enterprises, under contract to DSEWPaC.
Ramsar Information Sheet	See the Australian Wetlands Database website: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=1#
Management Plan	The principal Management Plan for the site is the Gurig National Park Management Plan 1987 (Cobourg Peninsula Sanctuary Board).
Management Authority	The Ramsar site is located entirely within the boundaries of Garig Gunak Barlu National Park. The Park is managed under a joint management arrangement between the traditional owners and the Northern Territory Government, through the Cobourg Peninsula Sanctuary and Marine Park Board.



LEGEND

Cobourg Peninsula Ramsar Site

Watercourses

Title:

Location of the Cobourg Peninsula Ramsar Site

Figure: 2-1

Rev: A

N

0 5 10km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath :

The site is separated from Croker Island by Bowen Strait and from Melville Island by the Dundas Strait. Neither Croker nor Melville Islands are included in the Ramsar boundary. Together, Cobourg Peninsula, Melville Island, Bathurst Island and Croker Island form the Tiwi-Cobourg Bioregion under the Interim Biogeographic Regionalisation for Australia, a system based largely upon vegetation communities and land systems.

The site is officially incorporated within the biogeographic regions defined as: Division VIII - Timor Sea Drainage Division (East Alligator basin: Figure 2-2) [4], however is not actually connected to the East Alligator River; and the Northern IMCRA (Integrated Marine and Coastal Regionalisation of Australia) province. Drainage within the Ramsar site is localised, with short water courses and few permanent waterways. Cobourg Peninsula has very low relief, trending north-west. The majority of the land area consists of undulating plains of between 30 and 40 metres above sea level. Two minor peaks, Mount Roe and Mount Bedwell are found in the south-east (147 metres and 160 metres, respectively).

The deeply incised coast, evidence of recent higher sea levels drowning former river valleys (Woinarski and Baker 2002), provides a coastline of more than 700 kilometres. The predominantly flat interior contains springs, permanent creeks, ephemeral creeks, tidal embayments and wetlands characterised by steep salinity gradients.

Generally the northern coastline of the Peninsula is characterised by isolated bays, rocky headlands and beaches. Intertidal and coastal habitats consist of extensive dunes, fringing coral, rocky reefs, sand, mudflats, with few areas of mangroves and seagrass communities. In contrast, the southern coastline and islands comprise mainly mangrove communities associated with large mudflats. These mangrove communities are interspersed with rocky headlands. Sandy beaches do occur in the southern area of the Peninsula, but are mainly restricted to the associated islands. Besides the larger Sir George Hope Islands to the south, the Ramsar site also includes more than half a dozen smaller sand, coral rubble and vegetated islands offshore of the western and northern coast. Major seagrass communities are found off Kuper Point, Mangrove Point and around Cape Don (see Section 2.4.1).

The majority of the area within the site boundary is terrestrial, and does not contain any wetland habitat. These dryland areas are dominated by forests of tropical eucalypt open-forests and woodlands. Dry coastal monsoon vine-forests are common near the coast and in seepage zones below rocky slopes. The headwaters of some creeks, natural springs and more permanent streams may support evergreen monsoon forests (Brocklehurst 2010). These terrestrial habitats support a number of threatened species that are not wetland dependant, but nevertheless contribute to the value of the site (for example the Gouldian finch *Erythrura gouldiae*, red goshawk *Erythrotriorchis radiatus* and arenga palm *Arenga australasica* see Appendix D).

The Cobourg Peninsula Ramsar site displays significant cultural characteristics, having been continuously inhabited for at least 50 000 years (Roberts et al. 1993). An ongoing 'living culture' is maintained by the Arrarrkbi peoples today, with an evident fundamental connection between Iwaidja and the coast and wetlands within the landscape of the Ramsar site.

[4] Guidelines under the Ramsar Convention favour the use of international or national biogeographic regions in the context of interpretation of Ramsar Nomination Criteria and other aspects of the Convention.

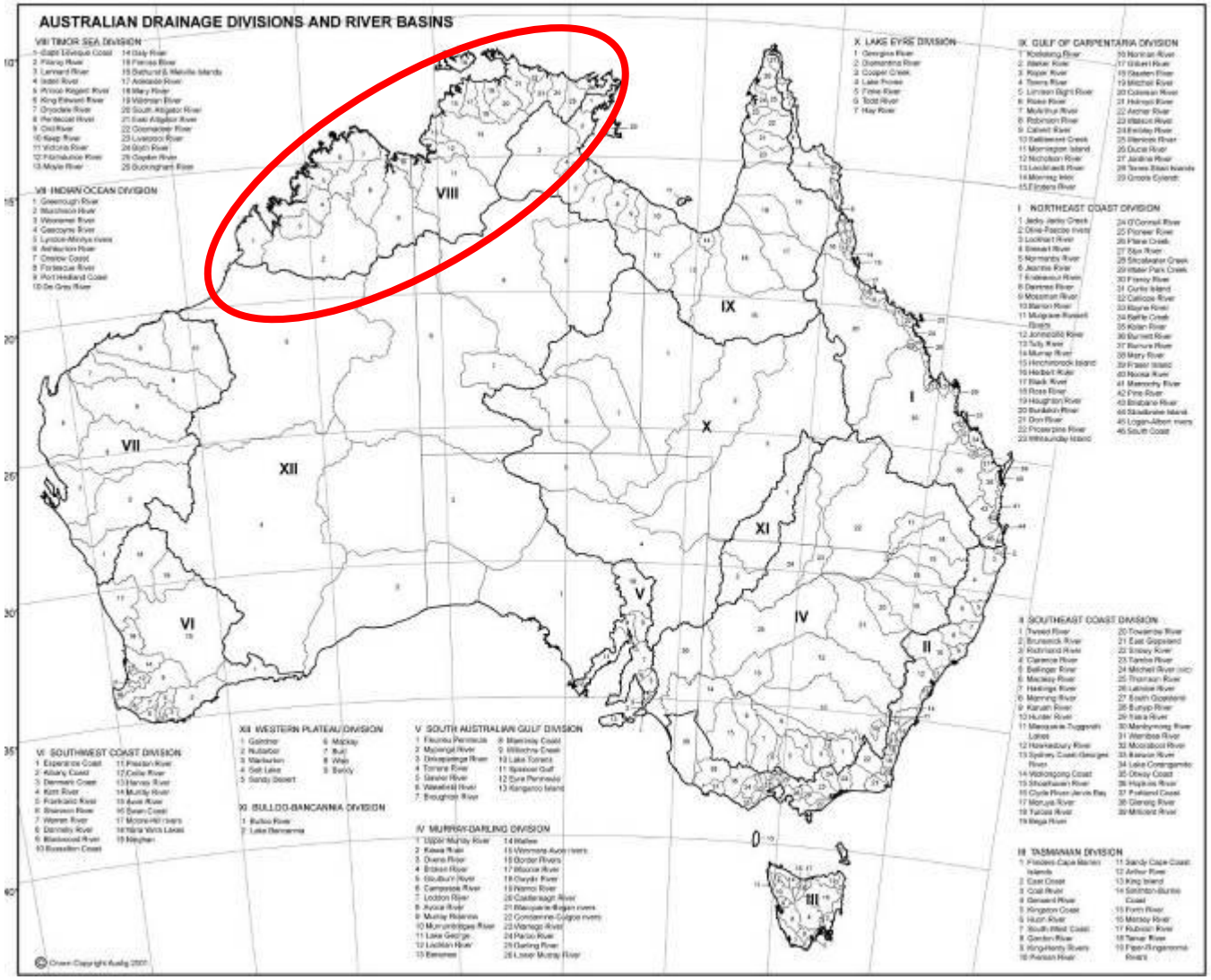


Figure 2-2 Australian drainage divisions, indicating the Timor Sea Drainage Division (number VIII) (source: Bureau of Meteorology undated)

2.3 Land Use and Tenure

2.3.1 Tenure and Land Use within the Site

2.3.1.1 Tenure

Cobourg Peninsula Ramsar site is Aboriginal freehold held in trust for the traditional owners by the Cobourg Peninsula Sanctuary Land Trust. The adjacent area of the Cobourg Marine Park is not held in trust by the Land Trust. The land held by the land trust consists of '*All that piece or parcel of land known as Cobourg Peninsula containing an area of about 1916 square kilometres above low-water mark and lying to the west of a line on a true bearing of 231 degrees from a point on the sea coast at low-water mark distance about 10 miles on a true bearing of 245 degrees from Coombe Point, Mount Norris Bay*' (Schedule of the Cobourg Peninsula Act). This also includes the Sandy islands, Allaru Island, Burford Island, Greenhill Island, Wangoindjung Island, Warldagawaji Island, Warla Island, Wunmiyi Island, Morse Island, Mogogout Island, and Black Rock. At the time of establishment, however, two parcels of land were excluded (and remain excluded from the Ramsar site). These were:

- the land surrounding Cape Don Lighthouse
- a special purposes lease on the eastern shore of Knocker Bay, Port Essington, as a land base for pearl farming operations for Paspaley Pearling Company Pty Ltd.

Cape Don Lighthouse was de-manned in 1983 following automation of the site. The cottages on the excised land were handed over to the Northern Territory Conservation Commission and the site was later gazetted on the Northern Territory Heritage Register on 6 November 1996 (see Section 1.3.3.2) (Heritage Advisory Council 2007). The pearling lease on the Peninsula held by Paspaley Pearling continues but merely represents a special lease of the National Park and is subject to the Land Trust.

The resort operating in Coral Bay was established in 1988 under a lease agreement with the Board (Foster 1997). The current tenure of Cobourg Peninsula including both of these areas is shown in Figure 2-3.

2.3.1.2 Land Use

Approximately 80 percent of the Cobourg Peninsula Ramsar site is managed as conservation reserve. Other principal land uses of the site are:

- tourism and education in conjunction with the Garig Gunak Barlu National Park
- commercial fishing, focused around the lodges at Cape Don and Coral Bay (Seven Spirit Bay)
- trophy safari hunting which is practiced within the Park, targeting exotic ungulates (banteng, buffalo, sambar deer, pigs) (see Section 3.9.2).

Under the Cobourg Peninsula Act full beneficial land use is awarded to the traditional owners of Cobourg Peninsula as governed by the Cobourg Peninsula Sanctuary and Marine Park Board. There are low-levels of hunting and gathering by traditional owners living within and around the Park.

Sandy Island No 2
Sandy Island No 1
Allaru Island
Trepang Bay
PORT BREMER
Croker Island
PORT ESSINGTON
RAFFLES BAY
Cape Don
Barrow Bay
Cobourg Peninsula
High Black Rock
Aiton Bay
Wangarlu Bay
Wurgurlu Bay
Burford Island
Two Hills Bay
Wunmiyi Island
Waria Island
Wangoindjung Island
Warldagawaji Island
Morse Island
Greenhill Island
Mogogout Island

LEGEND

- Aboriginal Freehold
- Garig Gunak Barlu National Park
- Cobourg Peninsula Ramsar Site

Title:

Aboriginal Freehold Land on Cobourg Peninsula

Figure: 2-3

Rev: A

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

2.3.2 Tenure and Land Use Adjacent to the Site

2.3.2.1 Tenure

Northern Territory waters adjacent to the site are the Van Diemen Gulf and Timor Sea to the south and the Arafura Sea to the north, and these areas are considered Crown Land. Croker Island, situated to the north-east and separated from the site by the Bowen Strait is Aboriginal freehold land held by the Arnhem Land Aboriginal Land Trust. The Ramsar site is connected to the mainland via a narrow isthmus along the eastern extent, where it abuts mainland holdings of the Arnhem Land Aboriginal Land Trust.

2.3.2.2 Land Use

Several commercial fisheries operate within the boundaries of the Marine Park, adjacent to Cobourg Peninsula Ramsar site. These include:

- cultured pearl farming in the northern embayments (Port Essington, Port Bremer, Raffles Bay)
- commercial *trepang* harvesting
- aquarium fish harvesting
- net fishing for sharks and barramundi
- long line fishing for sharks
- drop lining and trapping of finfish
- mud crabs
- mackerel trolling
- prawn trawling.

Within Arnhem Land, bordering the south of the site, there are a number of trophy hunting activities for wild banteng, buffalo, and pig. Hunting safaris also hunt ducks and sambar deer. Parts of Arnhem Land are also subject to mining exploration leases though these are not immediately adjacent to the site.

2.4 Description of Wetland Types

The Cobourg Peninsula Ramsar site is composed of a diversity of coastal and inland wetland types. Wetland types present range from intertidal forested wetlands and mudflats, to seasonal freshwater marshes and permanent freshwater pools. The site is considered unique in the Northern Territory in its juxtaposition of so many different wetland types. The catchment is also wholly contained within the site boundary.

For this report, the Ramsar Classification System for Wetland Types (approved by Recommendation 4.7 and amended by Resolutions VI.5 and VII.11 of the Conference of the Contracting Parties) has been adopted. Ramsar wetland types have been mapped for the site (Appendix A) using a combination of remotely sensed image interpretation and ground-truthing (AECOM 2011). Other relevant mapping data at a whole-of-site scale includes:

- broad-scale (1:1 000 000) vegetation mapping (Wilson et al. 1990)
- more detailed (1:100 000) vegetation community mapping (Brocklehurst 2010)
- broad mapping (1:100 000) of Melaleuca forests (Brocklehurst and Lynch 2009)
- mapping (1:100 000) of mangrove communities, saline grassland, saltpan and foreshore flats (Hay et al. 2005)
- mapping of monsoon forests and spring forests (Russell-Smith 1991).

Other data sources that describe habitats and communities across the site (e.g. Frith and Calaby 1974, CPSB 1987, Billyard 1995, Woinarski and Baker 2002, Gomelyuk 2003) have been considered for this report. Further details and descriptions of these wetland types are provided below and summarised in Table 2-2. Ramsar wetland maps prepared by AECOM (2011) are reproduced in Appendix A.

Note that there are discrepancies between the wetland types identified as present in the 1998 RIS (PWCNT 1998) and those identified in the present study, and these are discussed below.

Table 2-2 Wetland types and representative examples within Cobourg Peninsula Ramsar site (adapted from AECOM 2011)

Ramsar wetland type	Representative examples	Number of areas	Total area
Marine/coastal wetlands			
A - Permanent shallow marine waters in most cases less than 6 m deep at low tide; includes sea bays and straits. (i.e. not intertidal)	Absent – site boundaries do not include subtidal areas. Subtidal waters within rivers are classified as estuarine waters (Type F)	-	-
B - Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, and tropical marine meadows.	Present –seagrass communities exist along the northern coastline, including Blue Mud Bay, Araru Point, upper Port Essington, Kuper Point, Irgul Point and south of Cape Don.	Several	Not calculated
C - Coral reefs	Present – adjacent Sandy Island No. 1 and Sandy Island No. 2, Black Point and Popham Creek	greater than 4 (not confirmed)	Not calculated
D - Rocky marine shores; includes rocky offshore islands, sea cliffs.	Present – predominantly found within Port Essington, rocky cliffs also exist along the south western coastline	26	greater than 36.5 km shoreline length
E - Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.	Present – occurs in extensive areas mostly along the northern coastline and islands	49	2070 ha
F - Estuarine waters; permanent water of estuaries and estuarine systems of deltas.	Present – tidal sections of numerous large creeks	20	7592 ha
G - Intertidal mud, sand or salt flats.	Present – occurs along the entire coastline with extensive areas around the Ilmaryi River system in the south east	171	6212 ha
H - Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.	Present – occurs predominantly with intertidal forested wetlands such as Shamrock Bay and Caiman Creek	77	2734 ha
I - Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests. (i.e. Mangroves and Melaleuca)	Present – extensive areas along the western coastline and south east in the Ilmaryi River system	112	26 207 ha

Ramsar wetland type	Representative examples	Number of areas	Total area
J - Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.	Present – scattered along the north coastline in areas such as Trepang Bay and Raffles Bay	28	1314 ha
K - Coastal freshwater lagoons; includes freshwater delta lagoons.	Present – Mariah Lagoon and Spear Point	4	254 ha
Zk(a) – Karst and other subterranean systems	None mapped or known	-	-
Total marine/coastal wetland types	**10**	**461**	**46 383 ha^**
Inland wetlands			
L - Permanent inland deltas.	None mapped or known	-	-
M - Permanent rivers/streams/creeks; includes waterfalls.	None mapped or known	-	-
N - Seasonal/Intermittent/ irregular rivers/ streams/ creeks.	Present – widespread in upper reaches of all catchments	111	7776 ha
O - Permanent freshwater lakes (greater than 8 ha); includes large oxbow lakes.	None mapped or known	-	-
P - Seasonal/intermittent freshwater lakes (less than 8 ha); includes floodplain lakes.	Present – several sites exist mainly within the Smith Point and Wanaraij Point areas	14	359 ha
Q - Permanent saline/brackish/alkaline lakes.	Present – only confirmed location inland from Smith Point	8	578 ha
R - Seasonal/intermittent saline/brackish/ alkaline lakes and flats.	Present – uncommon on the site, represented inland from Knocker Bay and Raffles Bay	7	169 ha
Sp - Permanent saline/brackish/alkaline marshes/pools.	Present – uncommon on the site, represented inland from Trepang Bay, Minto Head and the far east	5	44 ha
Ss - Seasonal/intermittent saline/brackish/alkaline marshes/pools.	Present – uncommon on the site, represented inland from Kennedy Bay and Popham Bay	5	25 ha
Tp -- Permanent freshwater marshes/pools; ponds (less than 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.	Present – uncommon on the site, represented inland from Trepang Bay, Coral Bay and Raffles Bay	11	79 ha
Ts - Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.	Present	17	110 ha
U - Non-forested peatlands; includes shrub or open bogs, swamps, fens.	None mapped or known	-	-
Va - Alpine wetlands; includes alpine meadows, temporary waters from snowmelt.	None mapped or known	-	-
Vt - Tundra wetlands; includes tundra pools, temporary waters from snowmelt.	None mapped or known	-	-
W -- Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.	None mapped or known	-	-
Xf - Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.	Present – relatively extensive areas exist including inland from Trepang Bay, Reef Point and the far east coastline	16	770 ha
Xp - Forested peatlands; peatswamp forests.	None mapped or known	-	-

Ramsar wetland type	Representative examples	Number of areas	Total area
Y - Freshwater springs; oases.	Present – occurs at the upper reaches of several catchments including Ferny Springs and Wolf Claw Springs	22	302 ha
Zg - Geothermal wetlands	None mapped or known	-	-
Zk(b) – Karst and other subterranean hydrological systems, inland	None mapped or known	-	-
Total Inland Wetland Types	**10**	**216**	**10 212 ha^**

Note: ^ the total area is an underestimate as the area of some wetland types that exist in the Ramsar site could not be calculated (AECOM 2011)

2.4.1 Marine/Coastal Wetland Types Present

Type B: Marine subtidal aquatic beds

This wetland type is represented by intertidal seagrass communities. No mapping of this wetland type has been conducted to date, however the presence of seagrass within the Ramsar site has been confirmed through consultation with traditional owners, researchers and NRETAS. The likely species of seagrass can be inferred from surveys conducted along the southern shores of Van Diemen Gulf (that is, adjacent Kakadu) which reported *Halophila ovalis* and *Halodule uninervis* (Figure 2-4) as the dominant species (Roelofs et al. 2005). Within the region, these species together with *Enhalus acoroides, Thalassia hemprichii* and *Halophila decipiens* are most common. Significant macroalgal beds (*Sargassum* species) occur off Gul Gul (Danger Point) (NRETAS 2007).

Across Australia's northern coastline, intertidal seagrass beds are typically disjointed and are formed of aggregated seagrass patches, rather than large meadows. Seagrass is typically found in and around inshore islands, small bays and inlets. Large, open bays often contain no seagrass. The coastline of Cobourg Peninsula contains numerous examples of areas conducive to intertidal seagrass growth. Traditional owner knowledge of areas considered good for hunting turtle and dugong (both are seagrass consumers), suggests that the Ramsar site supports significant areas of this habitat type. Note that only a proportion of the seagrass will occur within the site, as the Ramsar boundary extends only to the low water mark (LAT).

Halophila ovalis

Halodule uninervis

Figure 2-4 Seagrass species occurring within the Ramsar site (source: BMT WBM)
© Copyright, Simon Drummond

Type C: Coral reefs

Four coral reefs have been mapped within the Ramsar site, including: Popham Creek, Kuper Point, Sandy Island No. 1 and Sandy Island No. 2 (AECOM 2011). It is likely other coral reefs occur within the site, since coral reefs have been recorded within Port Essington adjacent to Table Head and Turtle Point (Gomelyuk 2009), inside Coral Bay (Gomelyuk 2007), adjacent to Vashon Head, Danger Point, Smith Point, Black Point (Gemolyuk 2003) and Caiman Creek (NRETAS 2007). The habitat characteristics of the coral reefs vary: rocky headlands (each 'Point' is a rocky headland) have corals established in inshore waters, inshore islands such as Sandy Island No. 1 forms part of an exposed coastline, Sandy Island No. 2 is a coral fringed sand island, Popham Creek is a tidal channel where coral communities occur beneath a canopy of mangroves.

Coral community diversity has been described for several locations within the site. Coral Bay contains a very shallow reef, fully exposed during neap tides (Gomelyuk 2007). Coral diversity is considered low, containing sub-massive *Fungia, Montastrea, Porites, Favia, Favites* and encrusting *Merulina* corals growing in part on areas of dead plate-like colonies of *Acropora*. In 2007, no live plate- or branching *Acropora* were recorded. Coral reefs at Black Point, Smith Point and Sandy Island No. 1 were described as supporting a community of high coral diversity with a variety of growth forms (Gomelyuk 2007). The coral reef system within Popham Creek has been described as a "microcosm of that occurring elsewhere on Cobourg Peninsula" (Billyard 1995, p.15). Sixty four coral species have been recorded in the system (see Appendix D for the species list), divided into four discrete communities based upon their position in the system (that is, reef flat, central, open mangrove, shaded mangrove: Billyard 1995).

Corals across much of the Northern Territory coastline are generally restricted to very shallow waters, occasionally exposed at low tide (NRETA 2007). Deeper coral communities are present, though rare, and in the waters surrounding Cobourg Peninsula are represented by solitary colonies of *Fungia, Montastrea* and massive forms of *Porites, Favia, Favites* and *Platygra* ('bommies') (Gomelyuk 2007). Note that, similar to wetland type B, not all coral communities will occur within the Ramsar site as the boundary extends to the low water mark only.

Figure 2-5 Coral communities at Ungalwik, between Black Point and Smith Point. (© Copyright, Victor Gomelyuk)

Type D: Rocky marine shores

Rocky marine shores are common along much of the site's coastline (Figure 2-6). This wetland type is represented by extensive rocky cliffs up to 20 m high, weathered rocky foreshores and rocky offshore islands. Much of these rocky shores are composed of distinctive, red laterised sediments (Geoscience Australia 2008). They form headlands, isolated bays, islands and rocky foreshores that

support encrusting fauna and coral communities. Some rocky shores drop straight into water, others into boulder and rubble fields or extensive beaches.

AECOM (2011) mapped 36.5 kilometres of rocky shores, though the actual length of this habitat type is likely to be much greater.

Figure 2-6 Rocky marine shores (source: BMT WBM and AECOM)
© Copyright, Simon Drummond

Type E: Sand, shingle or pebble shores

Sandy shores are represented by sand bars, sandy islets, dune systems and humid dune slacks. At Cobourg Peninsula, the open coastline dune system is the most common representative of this wetland type (AECOM 2011). Numerous sandy islands and islets (e.g. Sandy Island No. 1 and Sandy Island No. 2) are found around the site, more commonly along the northern coastline. Floral species common to this wetland type include *Casuarina equistefolia* (beach she-oak) and *Ipomoea pes-caprae* (goat's foot) (AECOM 2011). Sand shores are more common along the northern coastline and offshore islands (including the Sir George Hope islands in the south).

Sandy shores provide important habitat for nesting marine turtles and breeding colonies of several seabirds (see Sections 3.6.1 and 3.6.2 for further discussion on these fauna).

Figure 2-7 Sand shores between Black Point and Smith Point (source: BMT WBM) © Copyright, Lyn Leger

Type F: Estuarine waters

This wetland type includes permanent waters of estuaries and estuarine systems of deltas. There are several extensive areas of this wetland type within the Ramsar site, notably the Ilamaryi Creek system in the south-east and Aiton Bay in the south-west (AECOM 2011). Red mangrove *Rhizophora stylosa* is common along the interface of this wetland type and the coastline (AECOM 2011).

Freshwater input to these systems is very seasonal, and in the dry season they are predominantly tidal systems.

Figure 2-8 Estuarine waters wetland type at East Bay (© Copyright, AECOM)

Type G: Intertidal mudflats

Extensive areas of intertidal mud, sand or salt flats occur within the Ramsar site, often interspersed with mangroves and marshes (Figure 2-9). The flats are generally devoid of erect flora (AECOM 2011), though benthic micro-algal communities are commonly found in the upper layers of sediment, supporting a broad range of benthic feeders such as prawns and other crustacea, benthic worms and other macroinvertebrates. This habitat also supports microbial and infaunal decomposition of plant and organic matter, such as the leaf litter from surrounding mangroves. Intertidal flats are represented around much of the site's coastline, with notable examples among the Ilmaryi Creek system and Barrow Bay. Much of the former are salt flats (Hay et al. 2005).

When exposed at low tide, intertidal flats can provide an important food source for shorebirds. This type of wetland habitat can represent a transitional zone between juvenile and adult habitats for many fish species. Common seabirds and shorebirds observed in this habitat type include the great egret *Ardea alba*, eastern reef egret *Egreta sacra* and little egret *E. garzetta*, great-billed heron *Ardea sumatrana*, common tern *Sterna hirundo*, little tern *S. albifrons*, black-necked stork *Ephippiorhynchus asiaticus*, and the raptors including whistling kites *Haliastur sphenurus*, brahminy kites *H. Indus* and ospreys *Pandion haliaetus* (AECOM 2011).

Figure 2-9 Intertidal salt flats, marshes, mangroves and estuarine waters of the Ilmaryi Creek system (source: BMT WBM) © Copyright, Lyn Leger

Type H: Intertidal marshes

Intertidal marshes are often found landward of mangroves, and interspersed with unvegetated mud or salt flats. They typically fringe the lower and mid estuarine sections of channels, and are more common along the south-western coast and upper Port Essington (AECOM 2011). Typical floral species include the shrubby samphire *Tecticornia indica*, grey samphire *T. australasica* and shoreline purslane *Sesuvium portulacastrum* (AECOM 2011).

Saltmarsh communities are generally floristically poor. Other species commonly found in marsh communities throughout Australia include suaeda *Suaeda arbusculoides* and grasses such as marine couch *Sporobolous virginicus* and *Cynodon dactylon* (Russell-Smith 1991).

Type I: Intertidal forested wetland

Intertidal forested wetlands are represented by mangrove forests (Figure 2-10), with over 26 000 hectares of mangrove mapped across the Ramsar site (AECOM 2011). Mangroves are found in the sheltered areas of much of the southern coastline and within tidal reaches of all estuarine systems. Many of the smaller bays along the northern coastline also support isolated pockets of mangrove (e.g. Knocker Bay: AECOM 2011). The most extensive concentration of mangroves forest is found in the Ilmaryi Creek system.

There are forty-eight species of mangrove that regularly occur in the Northern Territory (Wightman 1989), many of which are widespread throughout coastal Australia and Indo-Malaysia (Duke 1992). Common species found within the Ramsar site include white mangrove *Sonneratia alba*, red mangrove *Rhizophora stylosa*, grey mangrove *Avicennia marina*, orange mangrove *Bruguiera exaristata* and club mangrove *Aegialitis annulata* (AECOM 2011).

Mangrove communities are highly productive and provide important habitat for fauna species. These include birds, fisheries resources including invertebrates and fish (for example, barramundi) and traditional foods. More than one hundred bird species have been recorded using mangrove forests around Darwin Harbour (Dames and Moore 1988 in AECOM 2011). Mangrove communities are also notable as they have an important function in coastal stabilisation through protection against coastal erosion, they create a buffer against extreme weather events, and they have a role in sediment trapping and consequently contribute to the quality of coastal waters.

Figure 2-10 Intertidal forested wetland represented by a mangrove forest (© Copyright, AECOM)

Type J: Coastal brackish/saline lagoon

Coastal brackish/saline lagoons are linked to the sea through at least one narrow connection, and often separated by a barrier sand dune (Figure 2-11). AECOM (2011) mapped twenty-eight such lagoons within the Ramsar site, all along the northern coastline (see Appendix A). The entrances to

these lagoons may intermittently close over as tidal and storm processes distribute sand along the foreshore.

Common flora associated with this wetland type at Cobourg Peninsula include the portia tree *Thespesia populnea*, mangrove fern *Acrostichium speciosum*, black mangrove *Lumnitzera littorea*, sedges *Fimbristylis ferruginea* and *Schoenoplectus litoralis* and sun bladderwort *Utricularia chrysantha*. The habitat is frequented by several raptors including the whistling kite *Haliastur sphenurus*, osprey *Pandion haliaetus*, and white-bellied sea eagle *Haliaeetus leucogaster*. Other common seabirds and shorebird include brolgas *Grus rubicundus*, red-capped plovers *Charadius ruficapillus* and lesser sand plovers *Charadrius mongolus* (AECOM 2011).

Figure 2-11 A coastal saline lagoon at Araru Point (© Copyright, AECOM)

Type K: Coastal freshwater lagoon

This is an uncommon habitat type within the Ramsar site. The most notable representative is Mariah Swamp, which is located in close proximity to the coast but is fed by at least three freshwater springs from the west. Some tidal influence is evident by the presence of mangroves in the east of the swamp (AECOM 2011). The lagoon is dominated by bulkuru sedge *Eleocharis dulcis*, and fringed by *Melaleuca* species in the north and west.

This habitat type supports a wide range of waterbirds and reptiles, common examples include egrets, ducks, magpie geese *Anseranus semipalmata*, cormorants, comb-crested jacanas *Irediparra*

gallinacea, rainbow bee-eaters *Merops ornatus*, forest kingfishers *Todiramphus macleayii* and lemon-bellied flycatchers *Microeca flavigaster* (AECOM 2011).

2.4.2 Inland Wetland Types Present

Type N: Seasonal creeks

This wetland type includes seasonal, that is ephemeral, rivers, streams and creeks. These represent seasonal drainings that commence flowing with monsoonal rains at the start of the wet season. They are the most common inland wetland type encountered within the Ramsar site (see Appendix A). Seasonal creeks are widespread in the upper reaches of all catchments (AECOM 2011).

Riparian vegetation communities typically line the creeks, though the extent and structure differs according to the nature of each system and the relative influence of seasonality (AECOM 2011). Common riparian flora observed include the weeping tea tree *Leptospermum longifolium*, broad-leaf paperbark *Melaleuca leucandendra*, grey bloodwood *Corymbia porrecta* and spiral pandanus *Pandanus spiralis* (AECOM 2011).

Figure 2-12 Seasonal creek at Irgul Road (© Copyright, AECOM)

Type Q: Permanent brackish/saline lake

Permanent saline lakes are uncommon within the Ramsar site. The largest example, Campsite No. 2 Billabong, is part of a larger dune-swale system that contains a series of large swamps connected by small channels during the wet season. The system occasionally connects with the marine environment, probably during the end of the wet season. The cause of the saline conditions has not been directly observed, but it is thought that seawater inundation during cyclonic activity (see Section 3.7.1.3 for further discussion) may be responsible (AECOM 2011).

Aquatic emergent vegetation is dominated by *Eleocharis* sedges. The riparian zone is dominated by broad-leaf paperbark *M. leucadendra* and red-flowering black mangrove *L. littorea* (AECOM 2011). A similar fauna structure as that observed in coastal freshwater lagoons (type K) is common to this wetland type.

Figure 2-13 Permanent saline lake (© Copyright, AECOM)

Type R: Seasonal brackish/saline lake

This wetland type has been mapped by AECOM (2011) at several locations around the Peninsula. The largest representative is Wuwurdi Swamp at Black Point. The lake receives freshwater runoff during the wet season, and is not obviously connected to the sea (AECOM 2011). The cause of the elevated salinity remains a knowledge gap, but may be related to seawater ingress during heavy storms or cyclonic activity. These wetlands are seasonal as they typically receive no or little recharge

from springs or groundwater. A similar fauna structure as that observed in coastal freshwater lagoons (type K) is common to this wetland type.

Figure 2-14 Wuwurdi swamp, an example of a seasonal brackish/saline lake (source: BMT WBM) © Copyright, Simon Drummond

Type Ss: Seasonal brackish/saline pools

Seasonal saline pools within the Ramsar site were all located in close proximity to the coast (AECOM 2011). Given their ephemeral nature, they typically contain very little emergent aquatic vegetation. A representative saline pool at Araru Point was described by AECOM (2011) as occurring in a depression on the boundary between the tertiary weathered surface and coastal sediments. The cause of the salinity remains a knowledge gap as there is no obvious connection between the sea and the pool. Surrounding sediments are presumably not hypersaline as the pool is surrounded by a grassy bank and occasional trees, including *Pandanus* species.

Common fauna observed at this wetland type include white-breasted woodswallows *Artamus leucorynchus* and whistling kite *Haliastur sphenurus.*

Figure 2-15 Seasonal saline pool at Araru Point (© Copyright, AECOM)

Type Tp: Permanent freshwater pools

This wetland type includes ponds less than eight hectares in area, as well as marshes and swamps on inorganic soils with emergent vegetation that is waterlogged for at least most of the growing season. Within the Ramsar site, it is relatively uncommon and represented by eleven sites with a combined area of approximately 79 hectares.

This wetland type is sometimes found in association with other freshwater systems. For example, south of Danger Point there is a permanent freshwater pool surrounded by freshwater tree-dominated wetland (type Xf) and seasonal freshwater marshes/pools (type Ts). A similar habitat progression is observed elsewhere on the peninsula (AECOM 2011).

Permanent freshwater pools provide important dry season refuge for many species of wetland dependant flora and fauna and are often fringed by *Melaleuca*, *Barringtonia, Livistonia* and *Pandanus* tree species (AECOM 2011).

Figure 2-16 Permanent freshwater pool inland from Coral Bay (© Copyright, AECOM)

Type Ts: Seasonal freshwater marshes/pools

This wetland type is composed of seasonal/intermittent freshwater marshes and pools on inorganic soils and includes seasonally flooded meadows and sedge marshes. These occur in small, scattered locations generally inland of the northern coastline (AECOM 2011). Seasonal freshwater marshes/pools are typically dominated by herbaceous vegetation that has adapted to cope with seasonal drying of the pools including grasses such as *Dichanthium sericeum*, *Elytrophorus spicatus* and *Ophiuros exaltatus* (Cowie et al. 2000 cited in AECOM 2011) and the sedge *Leptocarpus spathaceus*. A common tree associated with this wetland type is the silky grevillea *Grevillea pteridifolia* (AECOM 2011).

Common fauna observed within riparian vegetation fringing this wetland type include rufous-throated honeyeaters *Conopophila rufogularis*, lemon-bellied flycatchers and whistling kites (AECOM 2011).

Type Xf: Freshwater, tree-dominated wetlands

This wetland type includes freshwater swamp forests, seasonally flooded forests and wooded swamps on inorganic soils. On Cobourg Peninsula, this is represented by extensive areas of *Melaleuca* swamp forest inland from Trepang Bay, Reef Point and Irgul Point (AECOM 2011). These wetlands are seasonal, receiving freshwater in the wet season.

This wetland type is dominated by white paperbark *Melaleuca leucadendra* and broad-leafed paperbark *M. viridiflora,* and the herbs *Eriocaelon cinereum*, *Dentella dioeca* and *Ammannia*

multiflora, and grasses *Cyperus aquatilis* and *Pseudoraphis spinescens* (AECOM 2011). *Melaleuca* forests offer roosting and nesting sites for birds, including the varied sittella *Daphoenositta chrysoptera*, varied triller *Lalage leucomela*, northern fantail *Rhipidura rufiventris,* forest kingfisher *Todiramphus macleayii* and lemon-bellied flycatcher (AECOM 2011). *Melaleuca* forests also provide seasonal food resources such as nectar for birds during the wet season; they generally contribute a large amount of material to the detrital/debris turnover cycle in the wetland (Finlayson et al. 1993).

Figure 2-17 Freshwater, tree-dominated wetland at Danger Point (© Copyright, AECOM)

Type Y: Freshwater springs

More than twenty-two freshwater springs have been mapped within the Ramsar site (AECOM 2011). Some of the springs form individual wetlands, while others form the headwaters of permanent and ephemeral creek systems, particularly in the west of the peninsula. Most freshwater springs support dense wetland vegetation including monsoon rainforest communities and riparian communities dominated by species of *Melaleuca*, *Hydristele* and *Pandanus spiralis* (AECOM 2011).

Water levels within each spring are likely to be regulated by groundwater height, which is influenced by seasonal patterns of rainfall and infiltration. Little variation in water level was observed in seasonal surveys conducted in 2010 (AECOM 2011).

Figure 2-18 Wolfs claw spring (source: BMT WBM) © Copyright, Simon Drummond

2.5 Nomination Criteria Met by the Site

2.5.1 Criteria Under which the Site was Designated

When Cobourg Peninsula was designated as a Wetland of International Importance in May 1974, formal criteria outlining the minimum expectations of a Ramsar site were yet to be developed. Recommendations for potential selection criteria were presented at the 1974 International Conference on the Conservation of Wetlands and Waterfowl in Heligenhafen, Germany ('Heligenhafen' Criteria). However, it was not until 1980 that formal listing criteria were established during the First Meeting of Contracting Parties (COP 1).

The documentation supporting the original listing of the Cobourg Peninsula Ramsar site (Department of Foreign Affairs 1974) outlines the following justification for the declaration of the site:

1. *[Cobourg Peninsula is] of very great interest to systematic zoology, as the type locality of many reptiles, mammals, birds, other animals and plants (due to being the only settlement in northern Australia and was therefore visited by several naturalists)*

2. *it is one of the largest and most significant wildlife sanctuaries in the tropics of Australia and has been little affected by earlier development. The peninsula is remote, difficult [to] access by land, and has therefore remained relatively unaffected by man's activity. Its protection is now ensured by its declaration as a Sanctuary under the Wildlife Conservation and Control Ordinance, 1962.*

The flora and fauna surveys documented in Frith and Calaby (1974) also served as a reference for the site's nomination.

Table 2-3 lists the proposed criteria (as of 1974) and their likely applicability to the Cobourg Peninsula Ramsar site at the time of listing based upon the original nomination document (Department of Foreign Affairs 1974), Frith and Calaby (1974) and information collated for this ECD. It is notable that several of the proposed criteria (that is criteria 3 and 4) have no comparable criteria in the current Ramsar nomination framework. These criteria relate directly to the primary justification provided for listing of Cobourg Peninsula, recognising the scientific value of the wetlands through the large number of type localities for tropical Australian species, and the ability to effectively conserve the site as it was bounded within an existing protected area.

Table 2-3 Potential Ramsar criteria recommended in 1974, and their likely applicability to Cobourg Peninsula Ramsar site

Criterion		Applicability to Cobourg Peninsula in 1974
1	**Criteria pertaining to a wetland's importance to populations and species**	
	(i) regularly supports one per cent (being at least 100 individuals) of the flyway or biogeographical population of one species of waterfowl, or (ii) regularly supports either 10 000 ducks, geese and swans; or 10 000 coots; or 20 000 waders, or (iii) supports an appreciable number of an endangered species of plant or animal, or (iv) is of special value for maintaining genetic and ecological diversity because of the quality and peculiarities of its flora and fauna, or (v) plays a major role in its region as the habitat of plants and of aquatic and other animals of scientific or economic importance.	Not met
2	**Criteria concerned with the selection of representative or unique wetlands**	
	(i) is a representative example of a wetland community characteristic of its biogeographical region, or (ii) exemplifies a critical stage or extreme in biological or hydromorphological processes, or (iii) is an integral part of a peculiar physical feature.	Likely to have been met
3	**Criteria concerned with the research, educational or recreational values of wetlands**	
	(i) is outstandingly important, well-situated and well-equipped for scientific research and for education, or (ii) is well-studied and documented over many years and with a continuing programme of research of high value, regularly published and contributed to by the scientific community, or (iii) offers special opportunities for promoting public understanding and appreciation of wetlands, open to people from several countries.	Likely to have been met
4	**Criteria concerned with the practicality of conservation and management**	
	(i) is physically and administratively capable of being effectively conserved and managed, or (ii) is free from the threat of a major impact of external pollution, hydrological interferences and land use or industrial practices.	Met

2.5.2 Assessment Based on Current Information and Ramsar Criteria

Ramsar criteria have undergone significant revision and refinement since being formally introduced in 1980. There have also been a number of developments in the past decade that influence the application of the Ramsar criteria to wetland sites:

- a decision with respect to the appropriate bioregionalisation for aquatic systems in Australia, which for inland systems are now based on drainage divisions and for marine systems the interim marine classification and regionalisation for Australia (IMCRA). This affects the application of criteria one and three
- updating of threatened species listings, which affects criterion two
- revision of population estimates for waterbirds (Wetlands International 2006; Bamford et al. 2008), which influences the application of criterion six
- additional data have been collected for the site, which could potentially influence the application of all criteria.

Therefore an assessment of the Cobourg Peninsula Ramsar site against the current nine Ramsar criteria has been undertaken. The Nomination Criteria have been reconsidered in this ECD, with specific reference to more up-to-date requirements outlined in "Handbook 14 Designating Ramsar Sites" (Ramsar Convention Secretariat 2007) and the National Framework for ECDs (DEWHA 2008b).

The 1998 RIS (PWCNT 1998) assessed the site against the 8 criteria adopted at the 6th Conference of Contracting Parties in Brisbane in 1996. Cobourg Peninsula was believed to satisfy four of the thirteen Ramsar criteria, though no justifications for these criteria were provided.

The Ramsar criteria were further refined in 2005 at the 9th Conference of Contracting Parties in Kampala. Table 2-4 summarises the criteria that were considered to have been met by the Ramsar site in 1998, and those that are considered to be met by the current ECD (justified in subsequent sections).

Table 2-4 Nomination criteria met by Cobourg Peninsula Ramsar site

Criteria recommended in 1974	Pre-1999 criteria	Current criteria		PWCNT 1998	Current ECD
		Group A. Sites containing representative, rare or unique wetland types			
2(i) is a representative example of a wetland community characteristic of its biogeographical region. **2(iii)** is an integral part of a peculiar physical feature.	**1(a)** it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region. **1(b)** it is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region. **1(c)** it is a particularly good representative example of a wetland, which plays a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system, especially where it is located in a trans-border position. **1(d)** it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.	**1**	A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.	**Met as 1a** - *No justification provided.*	**Met**
		Group B. Sites of international importance for conserving biological diversity			
1(iii) supports an appreciable number of an endangered species of plant or animal.	**2(a)** it supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species.	**2**	A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	**Met as 2a** - *No justification provided.*	**Met**

Criteria recommended in 1974	Pre-1999 criteria	Current criteria		PWCNT 1998	Current ECD
1(iv) is of special value for maintaining genetic and ecological diversity because of the quality and peculiarities of its flora and fauna. **1(v)** plays a major role in its region as the habitat of plants and of aquatic and other animals of scientific or economic importance.	**2(b)** it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna. **2(d)** it is of special value for one or more endemic plant or animal species or communities. **3(b)** it regularly supports substantial numbers of individuals from particular groups of waterbirds, indicative of wetland values, productivity or diversity.	**3**	A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	**Met as 3b** - *No justification provided.*	**Met**
2(ii) exemplifies a critical stage or extreme in biological or hydromorphological processes	**2(c)** it is of special value as the habitat of plants or animals at a critical stage of their biological cycle.	**4**	A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.	**Not met**	**Met**
1(ii) regularly supports either 10 000 ducks, geese and swans; or 10 000 coots; or 20 000 waders	**3(a)** it regularly supports 20 000 waterbirds	**5**	A wetland should be considered internationally important if it regularly supports 20 000 or more waterbirds.	**Met as 3a** - *No justification provided.*	**Not met**
1(i) regularly supports one per cent (being at least 100 individuals) of the flyway or biogeographical population of one species of waterfowl	**3(c)** where data on populations are available, it regularly supports one percent of the individuals in a population of one species or subspecies of waterbirds.	**6**	A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of waterbird.	**Not met**	**Not met**

Criteria recommended in 1974	Pre-1999 criteria	Current criteria		PWCNT 1998	Current ECD
No comparable criteria.	**4(a)** it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.	**7**	A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.	**Not met**	**Not met**
No comparable criteria.	**4(b)** it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	**8**	A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	**Not met**	**Met**
No comparable criteria.	No comparable criteria.	**9**	A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	Criterion did not exist at time of RIS compilation	**Not met**
3(i) is outstandingly important, well-situated and well-equipped for scientific research and for education. **3(ii)** is well-studied and documented over many years and with a continuing programme of research of high value, regularly published and contributed to by the scientific community. **3(iii)** offers special opportunities for promoting public understanding and appreciation of wetlands, open to people from several countries.	No comparable criteria.		No comparable criteria.		

Criteria recommended in 1974	Pre-1999 criteria	Current criteria		PWCNT 1998	Current ECD
4(i) is physically and administratively capable of being effectively conserved and managed. **4(ii)** is free from the threat of a major impact of external pollution, hydrological interferences and land use or industrial practices.	No comparable criteria.		No comparable criteria.		

Note: Conversion of Pre-1999 criteria follows the National Framework for ECDs (DEWHA 2008). Conversion of 1974 criteria is based on the author's professional judgment.

2.5.3 Criterion 1

A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

Met based on current assessment

Criterion 1 considers habitat types and their representativeness within a given biogeographic region (bioregion). As outlined in Section 1.4.5, the site occurs in the Timor Sea Drainage Division and the Northern IMCRA Provincial Bioregion. The Timor Sea Drainage Division contains several major river systems which include (proceeding northward then eastward) the Fitzroy, Isdell, Prince Regent, Mitchell, Drysdale, King George, Ord, Victoria, Daly, Adelaide, Mary, West, South and East Alligator, Mann and Goyder Rivers. Of these, the Ord, Victoria, Daly and Fitzroy Rivers are the largest by area and flow volumes (CSIRO 2009). The Ramsar site, however, contains no major river system despite being nominally included within the East Alligator River basin.

The Ramsar site boundary covers an area in excess of 220 000 hectares, approximately 25 percent of which have been mapped as Ramsar wetland types (Appendix A; AECOM 2011). This includes representation from ten (out of twelve) marine/coastal wetland types and ten (out of twenty) inland wetland types (see Section 2.4). No human-made wetlands have been identified within the site. This is a diverse array of wetland types in a confined area; there are few areas within the Peninsula that are further than two kilometres from a defined wetland. The coastline is represented by a variety of different wetlands: in broad terms the north contains rocky shores, sandy beaches, coral reef and seagrass beds while the south harbours large tracts of mangrove, saltflats and estuarine waters. There are no particularly unique or rare wetland types within the site, and the range of landscape and wetland habitat types are found in other catchments within the bioregion (for example, Mary River, Adelaide River). However, the juxtaposition and diversity of wetlands across a compact area is not common in the bioregion, and considered an important aspect of the site's ecological value.

One example from within the site demonstrating this aspect is the association of coral communities and mangroves within the tidal channel system known as Popham Creek. While there may be similar but less spectacular associations found on fringing reefs both locally and elsewhere, the occurrence of corals in mangrove channels beneath a dense canopy of *Rhyzophora stylosa* is unusual and has been considered to be of Northern Territory and national significance (Billyard 1995).

The wetlands of Cobourg Peninsula are considered to represent some of the better protected and near-natural wetlands in the bioregion. As documented in Section 1.3.1.2, the site has been under some level of formal government protection since 1924. Prior to this, any major development was restricted to several failed European settlements that introduced exotic ungulates still present within the site (see Section 3.9.4). While other areas within the bioregion experienced considerable pressure from pastoral developments (such as the Alligator Rivers region), these industries did not prosper on Cobourg Peninsula.

The catchment of the Ramsar site is encapsulated entirely within the National Park boundary, and therefore, unlike other catchments within the bioregion, the site is subject to limited direct development pressure. Areas of moderate degradation occur in places as a result of impacts of

weeds and feral animals (see Section 5). Generally, most catchments, rivers and estuaries in the Timor Sea drainage division, including those within the Cobourg Peninsula Ramsar site, are considered in a natural or near-natural condition (National Land and Water Resources Audit 2002; see Figure 2-19).

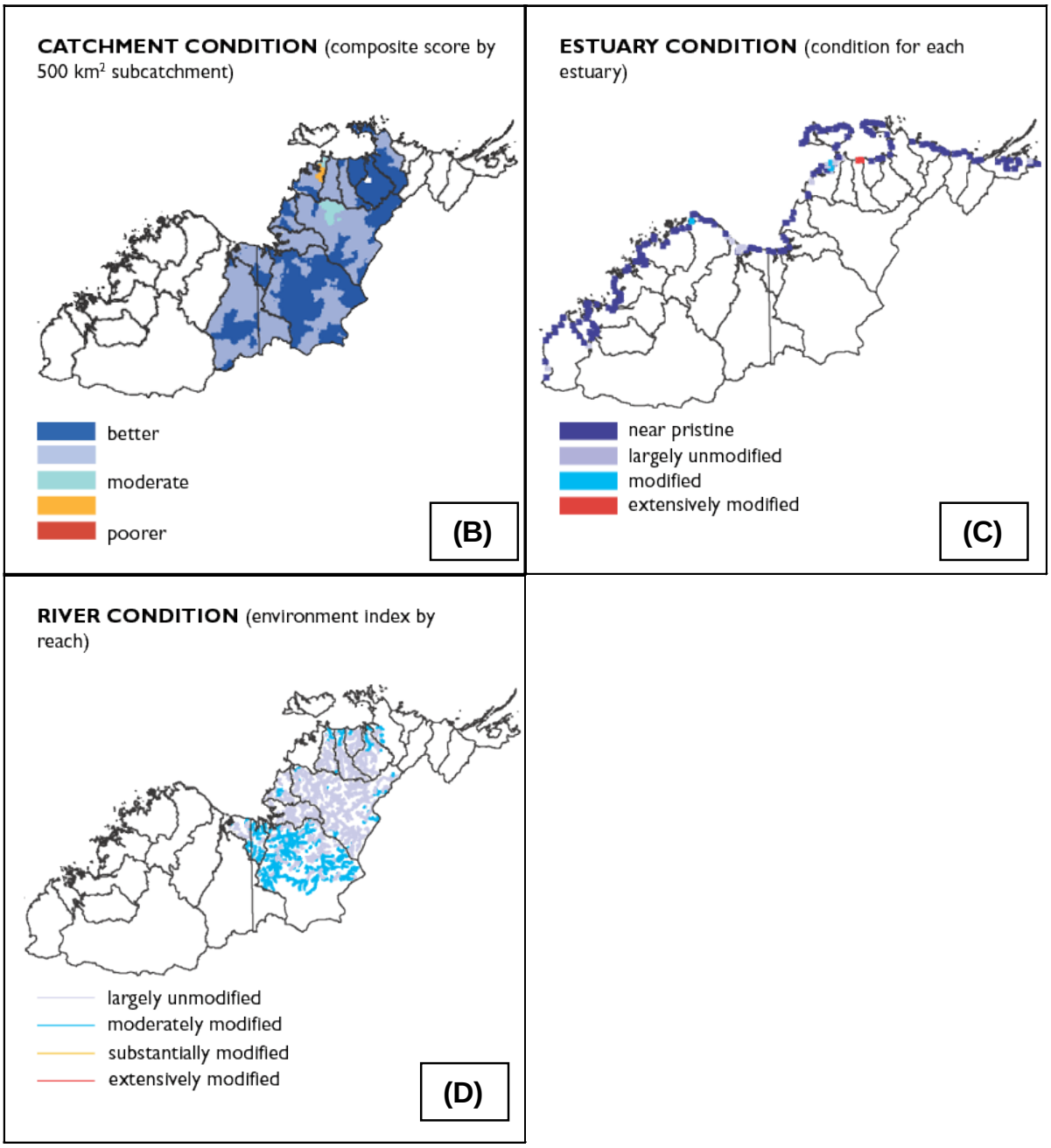


Figure 2-19 (B) Catchment condition (C) estuary condition and (D) river condition at a bioregional scale (source: NLWRA 2002)

2.5.4 Criterion 2

A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Met based on current assessment

The ECD Framework (DEWHA 2008) indicates that 'wetland' flora and fauna species should be considered in the context of this Criterion. This has been interpreted here as 'wetland-dependent' species, and therefore does not include terrestrial species that are not reliant on aquatic/wetland habitats (see Appendix D for complete species lists as well as a list of wetland-dependent vertebrate fauna). It is also possible that threatened aquatic invertebrate species also occur with the site (for example, species of dragonfly, see Clausnitzer et al. 2009), however these are either not listed as nationally or internationally threatened, or there are no published records of these species within the site.

Section 62 of the *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) indicated that regard should be given to wetlands that support globally threatened species at any stage of their life cycle, notwithstanding the small number of individuals or sites that may be involved.

There are six internationally (and nationally) threatened wetland-dependant fauna species known to occur within the site (that is, five marine turtle species and dugong; see Table 2-5), and one species that is considered threatened at a national level (that is, the flatback turtle). Cobourg Peninsula is considered to be of particular importance to Australia for the green and flatback turtles due to the significant nesting numbers recorded within the Ramsar site (Chatto and Baker 2008). Similarly, leatherback turtle nesting has only been recorded sporadically around Australia's coastline, and therefore any nesting site is considered critical. Note that Cobourg Peninsula is listed as a key turtle monitoring site in the Commonwealth Recovery Plan for flatback, green, hawksbill and Olive Ridley turtles (Environment Australia 2003). There are four species of fish considered threatened at an international level that are found in the marine areas adjacent the Ramsar site, and are likely to utilise intertidal and reef wetlands on a regular basis (great hammerhead *Sphyrna mokarran*, leopard shark *Stegostoma fasciatum*, giant groper *Epinephelus lanceolatus* and blotched fantail ray *Taeniura meyeni*).

It is important to note that these species move between the wetlands within the Ramsar site and the marine areas beyond the boundary. The Ramsar site provides habitat that is important for particular life stages. For instance, dugong feed on seagrass beds and calve in shallow sandbanks and many marine turtles migrate large distances between nesting cycles. Further information on these species has been provided in Section 3.8.2 in the context of the threatened species supporting service.

No internationally or nationally threatened wetland-dependant flora species are known to occur within the Cobourg Peninsula Ramsar site.

Table 2-5 Internationally threatened wetland species that have habitats within the Ramsar site

Species	Common name	Status	Habitats	Site Usage
Chelonia mydas	green turtle	EPBC – V IUCN – EN	• Feeds on seagrass and mangroves. • Nesting on open coastline (sand beaches).	Black Point and Smith Point are significant nesting sites, while Cape Don and Greenhill Island are important feeding grounds (Chatto and Baker 2008)
Natator depressus	flatback turtle	EPBC –V IUCN – DD	• Nesting on open coastline (sand beaches). • Feeds in turbid coastal waters, mostly on benthic fauna.	Greenhill Island, Mogogout Island and Danger Point are significant nesting sites(Chatto and Baker 2008).
Dermochelys coriacea	leatherback turtle	EPBC – V IUCN – CR	• Forages on invertebrates in inshore waters, including intertidal areas, and open ocean. • Nesting on open coastline (sand beaches).	Nesting in low numbers at Danger Point (Chatto and Baker 2008), and possibly Trepang Bay (Gomelyuk pers. comm. 2010)
Lepidochelys olivacea	Olive Ridley turtle	EPBC – EN IUCN – EN	• Forages over shallow, soft bottom habitats on molluscs. • Nesting on open coastline (sand beaches).	Nesting sites recorded across Cobourg Peninsula, albeit in low numbers (Chatto and Baker 2008, Limpus 2008)
Eretmochelys imbricata	hawksbill turtle	EPBC – V IUCN – CR	• Nests on smaller islands. • Feeds on sponges, algae and cnidarians, often associated with coral communities.	Probable nesting sites recorded along the north coast, at Vashon Head and Black Point (Chatto and Baker 2008).
Caretta caretta	loggerhead turtle	EPBC – EN IUCN – EN	• Wide variety of foraging habitats including muddy bays and seagrass meadows, rocky and coral reefs and estuaries.	Occasional foraging grounds, site records from Gumeragi and Trepang Bay (Woinarski and Baker 2002)
Dugong dugon	dugong	IUCN - V	• Feeds on seagrass (particularly *Halophila* and *Halodule*). • Calves in shallow waters, such as around sandbanks.	Seagrass beds around Cape Don, and from Aiton Bay to Wurgurla Bay and surrounding Greenhill Island support a large dugong populations (NRETAS 2007)

The site also supports the following nationally threatened species:

Species	Common name	Status
Dasyurus hallucatus	northern quoll	EPBC - EN
Conilurus pencillatus	brush-tailed rabbit-rat	EPBC -V
Xeromys myoides	water mouse	EPBC -V
Varanus metoni	Merten's water monitor	EPBC -V
Erythrotiorchis radiate	red goshawk	EPBC -V
Geophaps smithii smithii	partridge pigeon (eastern)	EPBC -V
Tyto novaehollandiae kimberli	masked owl (northern)	EPBC -V

Status under the EPBC Act and IUCN Red List where CR = critically endangered, EN = endangered, VU = vulnerable, DD = data deficient.

2.5.5 Criterion 3

A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

Met under current assessment

The site meets Criterion 3 for three of the key elements outlined in Section 70 of *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007), namely:

Section 70 (i): are "hotspots" of biological diversity and are evidently species-rich even though the number of species present may not be accurately known

The site supports a diverse assemblage of flora and fauna species, including:

- over 800 plant species (Brocklehurst 2010)
- thirty-five mammal species, including three species regarded as wetland-dependant (Appendix D)
- seventy-one reptile species, including nine species regarded as wetland-dependant (Appendix D)
- nineteen frog species (all wetland dependant species) (Appendix D)
- two hundred and thirty-six bird species, comprising eighty-nine waterbird species (including twenty-one migratory and ten resident shorebird species, and nine gull and tern species) and fifteen species (other than waterbirds) which are regarded as wetland-dependant (Appendix D)
- over six hundred fish species within Garig Gunak Barlu national park (Appendix D), of which 165 species are associated with coral and rocky reefs habitats found within the Ramsar site (Gomelyuk 2003, 2009)
- sixty-four species of coral (Billyard 1995)
- four hundred and six marine invertebrates recorded from coral reefs or the intertidal zone (Appendix D).

Species lists for fauna recorded within the site, together with the citation reference, are provided in Appendix D.

Section 70 (iii): contain the range of biological diversity (including habitat types) occurring in a region, and **Section 70 (v):** elements of biodiversity that are rare or particularly characteristic of the bioregion.

In terms of species, the site contains the range of tree and shrub mangrove species for the bioregion. However, of note for the bioregion is the occurrence of a pocket of mangrove palm *Nypa fruticans* in the south eastern corner of Trepang Bay. This species is uncommon in Australia, but common in areas north of Australia (Brocklehurst 2010).

Regarding habitat types, the site supports almost all Ramsar wetland types known to occur within the bioregion. As detailed in Section 2.5.3, this includes ten (out of twelve) marine/coastal wetland types, noting that one of the absent wetland types (Type A – permanent shallow marine waters) occurs

immediately adjacent the Ramsar site and is absent only through the administrative positioning of the boundary. The remaining marine/coastal wetland type is not present anywhere within the bioregion (Type Zk(a) – Karst systems). The Ramsar site also supports ten (out of twenty) inland wetland types, noting that at least four of the inland wetland types absent from the site are not represented anywhere in the bioregion (Types U, Va, Vt and Zg).

There is no documented evidence in support of the other two key elements: ii) centre of endemism and iv) species adapted to special environmental conditions. However, it is noted that two species of shrimp, *Thorella cobourgi* and *Thor spinipes* have been described from Cobourg Peninsula alone (type locality of Black Point and Burford Island, respectively). Both species inhabit the intertidal zone, in coral reef and seagrass (Bruce 1982; Davie 2002). While it is possible they may be endemic to the region, there is no unique landform or habitat restricting their distribution to Cobourg Peninsula.

2.5.6 Criterion 4

A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Met under current assessment

Based on *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007), there are two elements that need to be considered for this Criterion:

1. Section 74. Whether the site has high proportions of the population of mobile or migratory species gathered in small areas at particular stages of their life-cycle, and

2. Section 75. For non-migratory species, whether the site supports habitats for species that are unable to evade unfavourable climatic or other conditions (that is the site contains critical refugia areas).

In the context of Section 74 of Ramsar Convention Secretariat (2007), the following are relevant in addressing this Criterion:

1. Nesting habitat for significant populations of marine turtles, particularly green and flatback turtles, as well as the only recent recorded nesting site for leatherback turtles in Australian waters. Examples include (see Section 3.6.1 for further detail):

    - Flatback turtle *Natator depressus* nesting on Greenhill Island, Mogogout Island and Danger Point (Hope and Smit 1998, Woinarski and Baker 2002, Chatto and Baker 2008), considered to be some of the most important nesting areas in the Northern Territory and the bioregion (NRETAS 2007).
    - Green turtle *Chelonia mydas* nesting at Black Point and Smith Point (Hope and Smit 1998, Chatto and Baker 2008).
    - Leatherback turtle *Dermochelys coriacea* nesting at Danger Point (Chatto and Baker 2008).

2. Significant waterbird (seabird) breeding colonies (Woinarski and Baker 2002). Indications of population size and significance are discussed in Section 3.6.2. Examples include:

- Colony on Sandy Island No. 2, approximately five kilometres west of Danger Point. This is a large multi-species colony dominated by crested terns *Sterna bergii*, but with significant numbers of bridled terns *S. anaethetus*, silver gulls *Chroicocephalus novaehollandiae* and possibly Caspian terns *S. caspia* (Chatto 2001). More than 6000 crested terns were recorded on the island in 1967 (Frith and Calaby 1974).
- Colony on Sandy Island No. 1, approximately 1.5 kilometres north-west of Smith Point campsite. Breeding colony of roseate terns *S. dougallii* and black-naped terns *S. sumatrana* has also had low thousands of crested terns recorded breeding during the 1970s and 1980s, and possibly low numbers of Caspian terns (Frith and Calaby 1974).
- Colony at Edwards Point in Port Bremer. Remote sand and rocky point used for breeding by roseate terns and black-naped terns (Chatto 2001).
- Colony near Cape Don on an unnamed sand and grass island (possibly known as Wurrurrlarnbi by Arrarrkbi) 1.5 kilometres north of Ngadijbiri (formerly Ardigbiyi Point). Used primarily by crested terns (200 reported in 1994), black-naped terns and/or roseate terns (150 reported in 1994) and possibly little terns *S. albifrons*.
- Colony of little terns in Coral Bay on a sand island approximately two kilometres north of Seven Spirits Bay Resort (Chatto 2001).
- Colony of black-naped terns and roseate terns on Warla Island, small sand and coral rubble island approximately four kilometres north-west of Greenhill Island.

3. Several cetaceans, the Australian snubfin *Orcaella heinsohni*, Indo-Pacific humpback *Sousa chinensis,* the Indo-Pacific bottlenose *Tursiops aduncus* dolphins and the false killer whale *Pseudorca crassidens*, are regularly recorded within Port Essington (Palmer et al. 2010). The first three species are considered resident or semi-resident to the area. While much of their range falls outside the Ramsar site in deeper waters, they also feed over intertidal seagrass beds and breed in shallow water, particularly in Berkeley Bay (Palmer et al. 2010). It is unknown at this stage how significant the Ramsar site is to the life cycles of these cetaceans.

In the context of Section 75 in Ramsar Convention Secretariat (2007), the following are relevant in addressing this Criterion:

4. The permanent billabongs and river channel environments provide dry season refugia for aquatic species such as fish, and many aquatic invertebrates and macrophyte species as well as numerous terrestrial vertebrate fauna species (other than waterbirds) regarded as wetland-dependent including:
   - A wide variety of reptiles are known to depend on aquatic or semi-aquatic habitats of the site during the dry season. This includes saltwater crocodile *Crocodylus porosus*, northern snake-necked turtle *Macrochelodina rugosa,* Merten's water monitor *Varanus mertensi*, floodplain monitor *V. panoptes,* mangrove monitor *V. indicus*, striped water dragon *Lophognathus temporalis*, water python *Liasis fuscus*, bockadam *Ceberus rynchops*, white-bellied mangrove snake *Fordonia leucobalia,* Richardson's mangrove snake *Myron richardsonii* and keelback *Tropidonophis mairii* (see Appendix D).
   - Nineteen frog species have been recorded on the site (Frith and Calaby 1974, see Appendix D).

- Twenty-two bird species (other than waterbirds): osprey *Pandion haliaetus*, white-bellied sea-eagle *Haliaeetus leucogaster*, brahminy kite *Haliastur indus*, swamp harrier *Circus approximans,* azure kingfisher *Alcedo azurea*, little kingfisher *Alcedo pusilla*, red-backed kingfisher *Todiramphus pyrrhopygius*, collared kingfisher *Todiramphus chloris*, forest kingfisher *Todiramphus macleayii,* sacred kingfisher *Todiramphus sanctus,* yellow chat *Ephthianura crocea,* lesser frigatebird *Fregata ariel,* barn swallow *Hirundo rustica,* mangrove gerygone *Gerygone levigaster,* green-backed gerygone *Gerygone chloronata,* large-billed gerygone *Gerygone magnirostris,* white-breasted whistler *Pachycephala lanioides*, rufous fantail *Rhipidura rufifrons,* mangrove golden whistler *Pachycephala melanura*, and shining flycatcher *Myiagra alecto*, (see Appendix D).

It should be noted however that these same refugial functions would also take place in other permanent waterbodies in wetlands throughout the bioregion. It is uncertain how critical the Ramsar site is in terms of maintaining viable populations of most of the non-migratory/non-mobile species. The marine turtle nesting habitat and seabird breeding colonies are the principal elements supporting this Criterion.

2.5.7 Criterion 5

A wetland should be considered internationally important if it regularly supports 20 000 or more waterbirds.

Not met under current assessment

When addressing Criterion 5, the *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) provides guidance that:

1. Section 79. Multi-species and single-species assemblages should be assessed
2. Section 81. Turnover of individuals, especially during migration periods, should be considered, but
3. Section 82 and 83. Only statistically reliable methods, such as capture/marking programs will yield reliable turnover estimates.

This criterion was listed in the 1998 RIS (PWCNT 1998), however there was no supporting justification. A reassessment of available data was made when preparing this document. There are records of sporadically high numbers of waterbirds, though less significant than other areas in the bioregion (Woinarski and Baker 2002, Chatto 2003). During one survey period in September/October 1993, a total of 12 200 shorebirds was recorded around Cobourg Peninsula and southern islands (Chatto 2003). One of the largest recordings of migratory waterbirds was of approximately 5000 magpie geese *Anseranas semipalmata* on Banteng Lagoon near Danger Point in 1961 (Frith and Calaby 1974), although such large bird counts have not been reported since.

There is no empirical evidence in the form of periodic surveys to suggest the Cobourg Peninsula Ramsar site supports in excess of 20 000 waterbirds. Several researchers in the area have also expressed little confidence in congregations of these sizes being recorded across the site (R. Chatto pers. comm. 2010; D. Lindner pers. comm. 2010).

It is acknowledged that with further survey effort, it may be possible that this Criterion is met. However, based on available information, and with consideration of the elements listed by Ramsar Convention Secretariat (2007), there is presently insufficient information to support this Criterion having ever been met.

2.5.8 Criterion 6

A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of waterbird.

Not met under current assessment

When addressing Criterion 6, the *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) provides guidance that:

1. Section 85. The one percent threshold refers to the biogeographical population of a waterbird species

2. Section 86. Turnover of waterbirds at migratory periods can be used, if such data are available

3. Section 87. Wherever possible, international population estimates as published and updated every three years by Wetlands International should be used as the basis for evaluating sites.

As documented in response to Criterion 6, there is little periodic survey effort focussing on waterbirds of Cobourg Peninsula. From the data available, the most populous species, that is those that may approach a one percent threshold, include the terns and magpie geese outlined in response to Criterion 4 (Section 2.5.6). Published one percent thresholds only exist for the Caspian tern, little tern and magpie goose (1000, 1000 and 20 000 birds, respectively: Wetlands International 2006). There have been no documented recordings of these species approaching these population densities on Cobourg Peninsula.

It is acknowledged that with further survey effort, it may be possible that this Criterion is met. However, based on available information, and with consideration of the elements listed by Ramsar Convention Secretariat (2007), there is presently insufficient information to support this Criterion.

2.5.9 Criterion 7

A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

Not met under current assessment

When addressing Criterion 7, *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) provides guidance that:

1. Section 94. High diversity of fish/shellfish species, usage at different life-history stages and the complexity of interactions between taxa and the external environment.

2. Section 95. High level of endemism and biodisparity.

The habitats within the site support a high degree of fish diversity. Surveys of the marine/coastal wetlands of the site have identified 185 species of fish (Gomelyuk 2003, 2009; AECOM 2011; Appendix D). While associated with wetlands within the Ramsar site, these fish will move between the marine components of the site (that is the reefs and seagrass beds), the freshwater reaches (for spawning and feeding) and the adjacent marine areas. The marine fish assemblage, although diverse, is composed of fish with a wide distribution. There are no known marine endemic fish species within the site (Gomelyuk, pers. comm. 2010). Two internationally threatened species, the spot-tail shark *Carcharhinus sorrah* and lemon shark *Negaprion actuidens*, occur within and adjacent to the site (AECOM 2011). No nationally threatened species have been recorded, though note the unconfirmed reports of large numbers of sawfish in Section 2.5.11.

Inland wetlands appear to support very few fish species, though there is limited documented evidence of freshwater or inland fish surveys. Three freshwater species occur in inland springs: black-striped rainbowfish *Melanoteania nigrans*, poreless gudgeons *Oxeleotris nullipore* and spotted blue-eyes *Pseudomugil gertrudae* (AECOM 2011). Two saline-tolerant species, empire gudgeon *Hypseleotris compressa* and swamp eel *Ophistemon guttural*, also occur within the site.

It is acknowledged that with further survey effort, it may be possible that this Criterion is met. However, based on available information, and with consideration of the elements listed by Ramsar Convention Secretariat (2007), there is presently insufficient information to support this Criterion.

2.5.10 Criterion 8

A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Met under current assessment

Cobourg Peninsula provides a wide range of habitats, feeding areas, dispersal and migratory pathways, and spawning sites for numerous fish species of direct and indirect fisheries significance. These fish have important fisheries resource values both within and external to the Ramsar site.

Section 70 of the *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) recognises two key elements under Criterion 8:

1. Section 100. Identification of shallow coastal wetland habitats that are important spawning, nursery and feeding grounds.
2. Section 101. Identification of riverine, swamp and lake fish habitat that are important spawning and migratory pathways.

With regard to the first element, the site supports many species of fish (for example barramundi, giant trevally, mangrove jack, black bream, barracuda, mullet species; Appendix D) and crustaceans (for example mud crabs, prawns) of direct fisheries importance. All of these species spend their juvenile stages in shallow nearshore waters of the site, particularly around mangroves, saltmarsh, rocky reef and seagrass habitats. Species such as barramundi also inhabit freshwater floodplain, freshwater lakes and billabongs.

The 26 000 hectares of mangrove mapped within the Ramsar site represents approximately 6.5 percent of the 400 000 hectares of mangrove habitat found in the Northern Territory (AECOM 2011). This site is considered to contain a large proportion of the Northern Territory's seagrass habitat, though data on this wetland type is not complete (see Section 2.4.1). Positive relationships between these habitats and fisheries resources have been well documented (see Section 3.9).

In terms of the second element, the brackish marshes, lakes and creeks are known to support important spawning, nursery and migratory pathways for numerous species. Many of the species listed above spawn in inshore waters, although there is no information on specific spawning habitats within the site (see Section 3.5.5).

2.5.11 Criterion 9

A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Not met under current assessment

Criterion 9 relates to non-avian wetland taxa including, *inter alia*, mammals, reptiles, amphibians, fish and aquatic macroinvertebrates. In interpreting the application of Criterion 9 to these species, *Ramsar Handbook for Wise Use of Wetlands 14* (Ramsar Convention Secretariat 2007) indicates that reliable population size limits from published sources must be included in the justification for the application of this Criterion.

There is anecdotal evidence of the occasional presence of large numbers sawfish in the bays of the site, though the specific species is not known (D. Lindner pers. comm. 2010). These may be either of the vulnerable species: green sawfish *Pristis zijsron* or freshwater sawfish *Pristis microdon*.

Saltwater crocodile are common within the site. Although saltwater crocodiles have historically had a wide distribution throughout south-east Asia and Australasia, the species is currently thought to be extinct throughout most of Asia. Isolated, relatively small populations are known to remain in Myanmar (Burma), eastern India, Indonesia, Malaysia, Philippines and the Solomon Islands. The vast majority of the global population of saltwater crocodiles occurs in northern Australia, and they are also common in New Guinea and Timor. In Australia, the saltwater crocodile population has been thriving since the species was protected from hunting, particularly in the Northern Territory, which has the largest population and densities in Australia (Fukuda et al. 2007), with an estimated population size of up to 75 000 individuals in 1994 (Webb et al. 1994 in Leach et al. 2009). This implies a one percent threshold for this species of at least 750 animals. There are no documented estimates of actual population size. Two crocodile nesting surveys (2007-2008 and 2009) have been conducted at the behest of the Board of Management. Between 50 and 55 nests were recorded in each instance (J. Wilson pers. comm. 2010).

There is no empirical evidence to support this Criterion. However further research, particularly involving the potential candidate species discussed above, may provide evidence supporting this Criterion in the future.

2.5.12 Cultural Resolutions

2.5.12.1 Recognition of Cultural Values in the Ramsar Convention

At the time of establishment of the Ramsar Convention, the negotiating Parties recognised the importance of the cultural and socio-economic values of wetlands (Papayannais and Pritchard 2008). As a result, the text of the Preamble of the Convention was drafted to include reference to the broader non-ecological values of wetlands:[5]

"…Being convinced that wetlands constitute a resource of great economic, cultural, scientific and recreational value, the loss of which would be irreparable……

However, when the original Ramsar site nomination criteria were finalised, no cultural criteria were included. In 1990, the standard data sheet (RIS) for Ramsar sites was developed and a section was included for information on social and cultural aspects of nominated wetlands. Cultural issues were again on the agenda at the Conference of Parties during the 1990s, resulting in two Cultural Resolutions being agreed (VIII.19 and IX.21) (Papayannais and Pritchard 2008).

In *Resolution IX.21: Taking into account the cultural values of wetlands*,[6] the Parties to the Convention agreed:

"...in the application of the existing criteria for identifying Wetlands of International Importance, a wetland may also be considered of international importance when, in addition to relevant ecological values, it holds examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning."

As a result, Resolution IX.21 outlined the following cultural characteristics as relevant in the designation of Ramsar sites:

i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland;

ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland;

iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples; and

iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland.

A guidance document was also developed to aid in the application and implementation of these cultural characteristics.

[5] The Convention on Wetlands text, as originally adopted in 1971, http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on-20708/main/ramsar/1-31-38%5E20708_4000_0__, accessed 1 March 2011.
[6] http://www.ramsar.org/pdf/res/key_res_ix_21_e.pdf, accessed 1 March 2011.

2.5.12.2 Recognition of the Cultural Values of Cobourg Peninsula Ramsar site

At the time of establishment of the Ramsar Convention, Cobourg Peninsula was being considered for nomination as a Wetland of International Importance. While the original nomination criteria under which Cobourg Peninsula was listed did not include cultural aspects (see Section 2.5.1), it is considered likely that the cultural values of Cobourg Peninsula including the unique 'three cultures heritage' of Indigenous, Macassan and European history) are among the main reasons the site was nominated for listing.

In the context of the importance of cultural heritage and the maintenance of living culture to the site, it is imperative that the cultural characteristics from Resolution IX.21 and the associated guidance documents are considered within the ECD and all other wetland management documents (e.g. management plans).

3 CRITICAL COMPONENTS, PROCESSES AND SERVICES/BENEFITS

3.1 Background

The Millennium Ecosystem Assessment (2003) provides definitions and descriptions of the characteristics of ecosystems and ecosystem services that should be used in the wise use of Ramsar wetlands. These definitions and concepts have been adopted by the National Framework for ECDs (DEWHA 2008). Specific definitions of commonly used terms are described in the following sections and contained in the Glossary in Section 9.

3.1.1 Wetland Elements

As defined in the National Framework for ECDs, wetland ecosystems can be described through three elements: components, processes and services/benefits. Wetland components are the physical, chemical and biological parts or features of a wetland. Wetland processes are defined as the dynamic forces within the ecosystem between organisms, populations and the non-living environment. Interactions can be physical, chemical or biological. Wetland benefits or services are the benefits that people receive from wetland ecosystems. The National Framework for ECDs notes that wetland ecosystem services and benefits are generally, but not always, based on or underpinned by wetland components and processes and can be both of direct benefit to humans (for example, food for humans or livestock) or of indirect benefit (for example, wetland provides habitat for biota which contribute to biodiversity).

3.1.2 Interaction of Wetland Elements

Figure 3-1 from the National Framework for ECDs document provides a generic conceptual model of the interaction between ecosystem components, processes and services/benefits for a wetland. In general terms, the model shows how wetland ecosystem processes interact with wetland components to generate a range of wetland services/benefits. These services/benefits can be broadly applicable to all wetlands ecosystems (such as primary productivity) or specific to a given site (for example, breeding habitat for an important bird species or population).

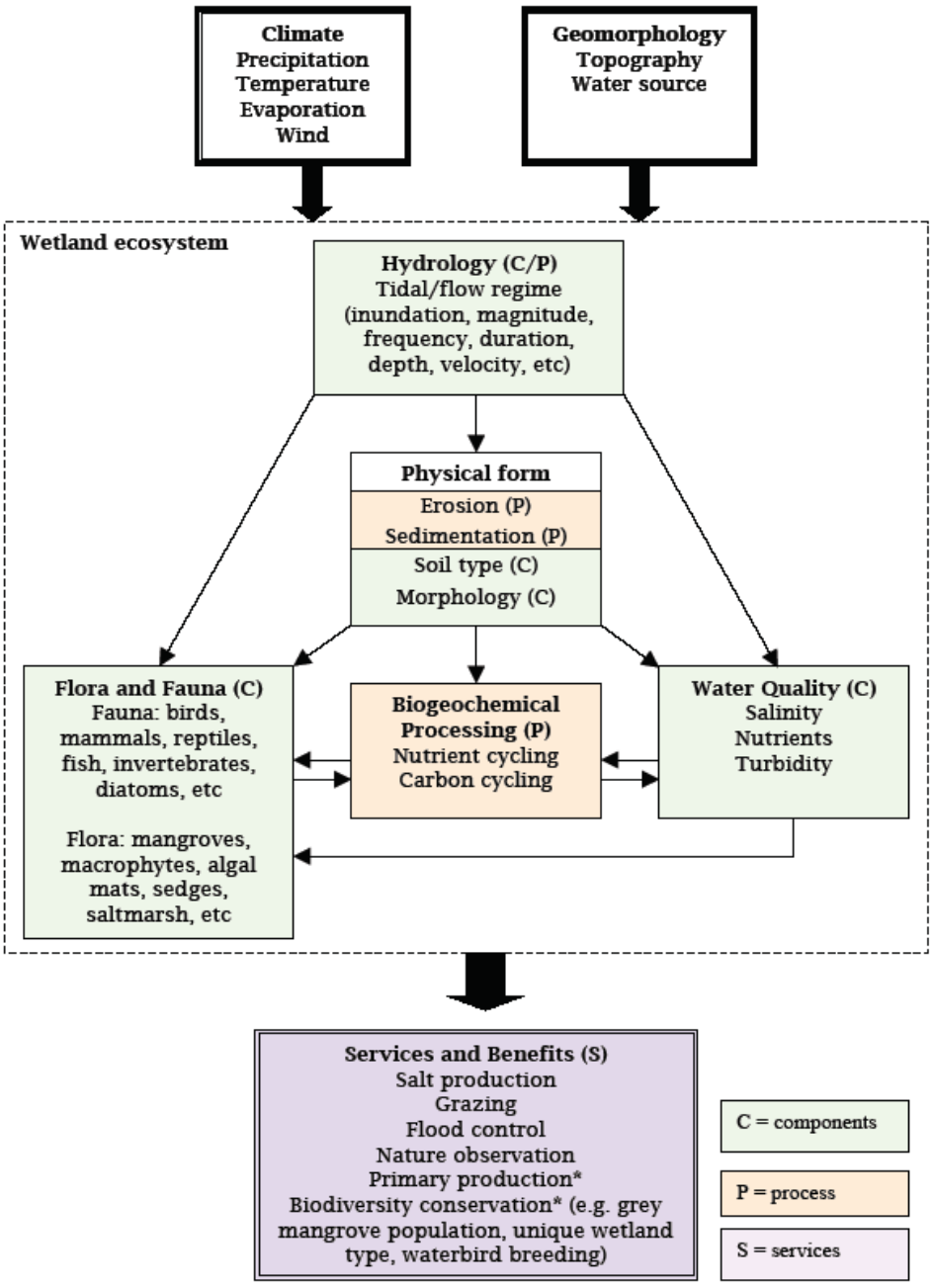


Figure 3-1 Generic conceptual model showing interactions between wetland ecosystem processes, components and services/benefits (source: DEWHA 2008)

3.2 Study Approach

The method employed to identify critical components, processes and services/benefits is presented in Appendix C. Following the method within the National Framework for ECDs (DEWHA 2008), the assignment of a given wetland component, process or service/benefit as critical was guided by the following considerations:

- the component, process or service/benefit is an important determinant of the unique character of the site
- the component, process or service/benefit is important for supporting one or more of the Ramsar Nomination Criteria under which the site was listed
- a change in a component, process or service/benefit is reasonably likely to occur over short or medium timescales (less than 100 years), and/or
- a change to the component, process or service/benefit will cause significant negative consequences.

Additionally, a second tier of supporting components, processes and services/benefits has been identified. These supporting components, processes and services/benefits, while important to wetland functioning, in isolation were not considered to directly address the criteria listed above (see Appendix C).

For each of the critical components, processes and services/benefits (C, P, S/B), a brief description is provided for (i) the rationale for inclusion as critical; (ii) a description of the element; and (iii) a description of patterns in variability over time. It should be noted that in nearly all cases, there was no actual baseline data-set describing the wetland indicator before or at the time of declaration of the sites (that is, 1974). Therefore, in the following sections, both pre-listing and post-listing data have been used to describe patterns in variability in space or over time. The specific years in which the data were collected are noted in the following sections, together with a description of whether the numerical values are likely to be representative of conditions at the time of listing.

3.3 Overview of Critical Components, Processes and Services/Benefits

A summary of the critical and supporting wetland components, processes and services/benefits for the Cobourg Peninsula Ramsar site as determined in the present study is shown in Table 3-1. In summary, the following have been identified:

1. one critical component and five supporting components
2. two critical processes and six supporting processes
3. two critical service/benefit and five supporting services/benefits.

The broad interaction of wetland components, processes and services/benefits (both critical and supporting) at a whole-of-site level is shown in Figure 3-2. The figure shows three supporting processes (climate, geology/geomorphology and regional-scale hydrodynamic and hydrological processes) that together have shaped the topography, marine and freshwater flow regime and other important aspects of the site. At the local habitat scale, there is a mix of physical and chemical processes as well as biological processes that control the wetland habitats and associated biota. The interaction of the wetland components with the wetland processes yields a range of wetland services/benefits that are characterised as biodiversity (ecosystem services) and cultural services (relevant to providing a social or economic benefit to humans) using the terminology in the National Framework for ECDs and Millennium Ecosystem Assessment.

Table 3-1 Summary of critical and supporting components, processes and services/benefits

	Components	Processes	Services/Benefits
Critical	C1 – Diversity and Connectivity of Wetlands	P1 – Marine Turtle Nesting P2 – Waterbird Breeding Colonies	S1 – Contemporary Living Culture S2 – Maintenance of Global Biodiversity
Supporting	Populations of Migratory and Resident Waterbirds and Seabirds Monsoon Rainforests Terrestrial Habitats Aquatic Invertebrates Fish Populations	Climate Geology/Geomorphology Hydrology (tidal, surface, groundwater) Water Quality Fire Regime Other Notable Biological Processes	Fisheries Resource Values Recreation and Tourism Scientific Research and Education Historical Indigenous and Non-Indigenous Cultural Heritage Biological Products

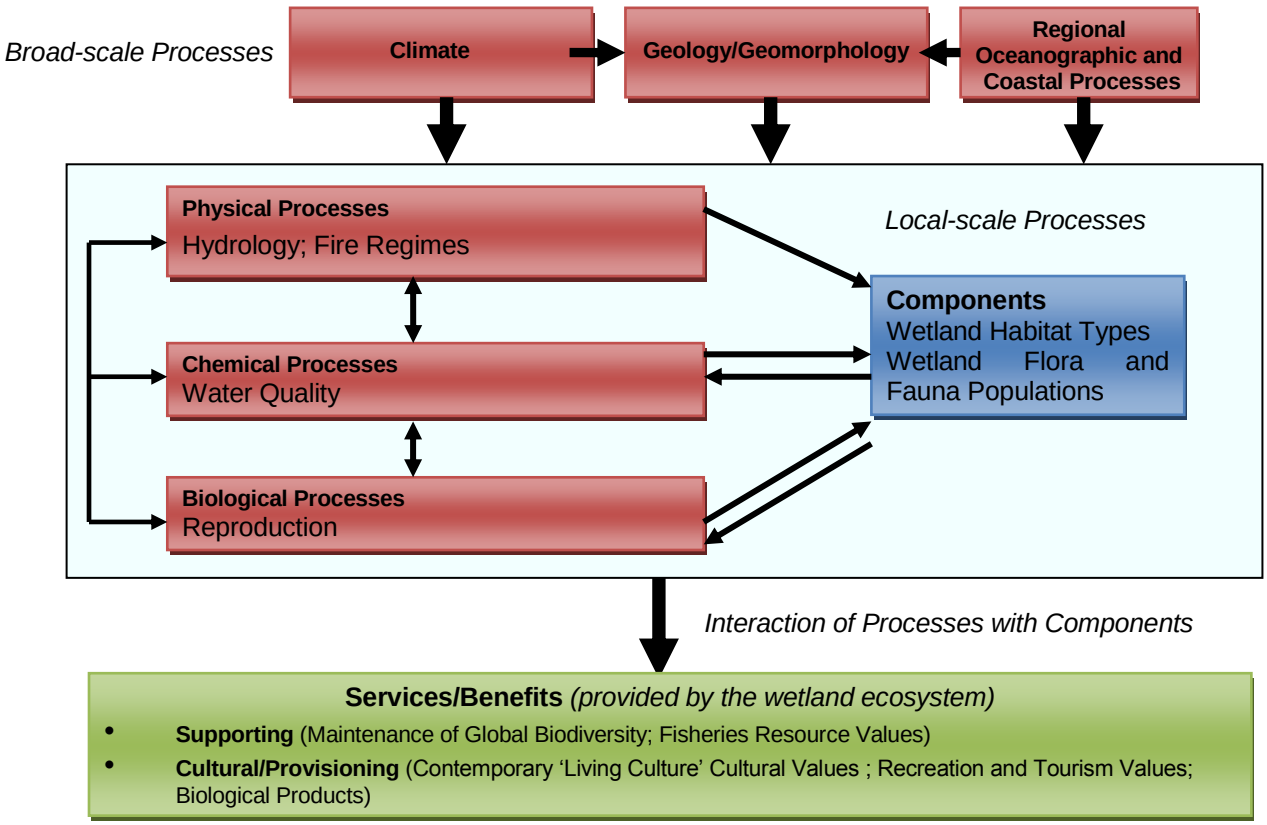


Figure 3-2 Conceptual model showing interactions between critical and supporting components, processes and services/benefits within the Ramsar site

The following sections provide a more detailed description of critical components, processes and services for Cobourg Peninsula that form the basis of this ECD. Where possible, information on natural variability for the components, processes and services at the time of listing is given.

3.4 Critical Components

A single critical component has been identified for Cobourg Peninsula on the basis of its support for the key species and wildlife populations that are fundamental in determining the site's ecological character and underpinning the critical services/benefits as described below. Rather than identify numerous critical components based upon perceived values of particular wetland types, this approach recognises the input from all the wetland habitats and the synergies achieved from a contiguous landscape.

3.4.1 Diversity and Connectivity of Wetlands

Reasons for Selection as 'Critical'

Cobourg Peninsula contains an extraordinary variety of wetland types. As discussed in Section 2.3, 20 wetland types, using the Ramsar typology, occur across the site. The juxtaposition of these wetlands to each other provides a high degree of spatial connectivity between inland and coastal habitat types at local and landscape scales. Connectivity has been positively correlated with high biodiversity and productivity, though landscape-scale studies in wetland and marine environments are currently scarce.

In terrestrial systems, habitat heterogeneity has been linked with a high degree of species richness (Nichols et al. 1998). Similar conclusions have been reached for riverine floodplain systems (Ward et al. 1999) and marine soft-sediment systems (Hewitt et al. 2008). Meynecke et al. (2008) demonstrated an association between broad-scale habitat connectivity and productivity, using fish catch as a surrogate for productivity. Several habitat-specific studies have shown that abundance and species richness of nekton within seagrass beds have varied depending on their distance from mangroves (Skilleter et al. 2005, Jelbart et al. 2007). Melville and Connolly (2003) demonstrated that organic matter, particularly from seagrasses, was important as the base of food webs for fish species on adjacent unvegetated mudflats.

The Ramsar site contains representative examples of many of the wetland types found within the biogeographic region. At Cobourg Peninsula, the habitats are relatively undisturbed and the site's catchments are largely free from development. The loss of some of the wetland elements that comprise this component may have significant negative consequences for the value of the wetland as a whole.

This diversity of wetlands is fundamental to defining the site's ecological character, and underpins Ramsar Nomination Criteria 1, 2, 4 and 8.

Description

The majority of wetland types present in the bioregion are represented on Cobourg Peninsula. This includes more than 46 000 hectares of marine/coastal wetlands and 10 000 hectares of inland wetlands (AECOM 2011). Intertidal areas are spatially dominant, with some 42 000 hectares of mangroves, marshes, salt flats and estuarine waters. Numerous seasonal creeks drain the interior of the peninsula, occupying nearly 8000 hectares. Many of the other wetland types, while occupying smaller total areas, contribute greatly to the heterogeneity of the wetland landscape. There are numerous examples of habitat transitions from rocky reef, to sandy beaches, dunes, coastal marshes and freshwater lagoons.

Detailed descriptions of each wetland type are given in Section 2.4.

Patterns in Variability

Wetlands are dynamic systems, and the distribution and extent of many wetland types is expected to vary over short and long time scales. Seasonal variation in moisture context and water quality has been described by AECOM (2011) for each Ramsar wetland type (with the exception of underwater wetlands, types B, C and F). Seasonal variation in water quality for each wetland type is discussed in Section 3.7.3. Systems undergoing large seasonal variations would be expected to support flora and fauna tolerant of a wide variety of conditions.

Within marine/coastal wetlands, the greatest variation in moisture content is exhibited by intertidal salt flats. These habitats are present throughout the site, typically landward of mangroves. They exhibit a large increase in moisture content early in the wet season, through rainfall and stream run-off. For these and surrounding habitats, this mobilises nutrients and can expand foraging grounds for a wide variety of fauna. Other marine/coastal wetlands exhibit less variation between seasons, with coastal freshwater and saline lagoons maintaining moisture levels, presumably through recharge from streams and narrow tidal connections (AECOM 2011). Mangrove and saltmarsh habitats are moderated by tidal influences.

For inland habitats, seasonal wetlands display the greatest variation in moisture content. Permanent freshwater systems therefore provide important refugia for wetland dependant fauna. Smaller freshwater pools retain moisture longer than freshwater lakes due to reduced evaporation rates. Freshwater, tree-dominated wetlands (that is, *Melaleuca* forest) do not undergo large fluctuations in moisture content (AECOM 2011).

For several coastal wetland habitat types, there is some evidence of long-term (that is, years to decades) cyclical change induced by storm surge and cyclone activity. While the processes involved have not been directly observed, it is presumed seawater is transported into coastal, freshwater wetlands through storm and cyclone activity. The freshwater wetland gradually recovers over the course of several years. At Danger Point, there is evidence of this process with large numbers of dead *Melaleuca* in a (now) saline wetland (AECOM 2011). See Section 3.7.1.3 for further discussion.

There is insufficient information to provide a definitive description of variability in wetland habitats in the longer term. AECOM (2011) mapped wetland habitats for two time periods: 1973 (using historical satellite imagery around the time of listing) and 2010 (Appendix A), and represents the only study of this type to date. Only dominant marine/coastal wetland types could be confidently identified and only

one inland wetland type (Xf). Despite apparent differences in calculated areas (see Table 3-2), when overlaid the distributions of wetland types were generally similar (AECOM 2011). Of note were some small-scale changes in mangrove versus marsh distribution, where mangroves in 1973 have now been succeeded by marsh habitat, and vice versa. The most prominent example of this natural progression is the southern end of Port Bremer (AECOM 2011).

Some irregularities in this mapping preclude a definitive assessment of changes over time. For example, large differences in calculated areas of estuarine waters in 1973 and 2010 may be a result of actual changes in shoreline, however, when maps are compared, the estuarine waters mapped around the Ilmaryi system vary greatly in offshore extent. That is, the much greater area of estuarine habitat in 2010 is probably due to the manual delineation of where the habitat ended, and not respresentative of any actual change. Another example is Alcaro Bay in the site's west. In 1973 it is mapped with a large sandy beach. In 2010, no such habitat is mapped though an inspection of available aerial photography suggests the beach still exists (Google Earth, imagery dated 2011, accessed 8 March 2011).

Table 3-2 Wetland extent in 1973 and 2010 (AECOM 2011)

Ramsar wetland type	1973 area (ha)	2010 area (ha)
E - Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.	4431	2070
F - Estuarine waters; permanent water of estuaries and estuarine systems of deltas.	3194	7592
G - Intertidal mud, sand or salt flats.	4377	6212
H - Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.	1869	2734
I - Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests. (that is, mangroves and Melaleuca).	26 593	26 207
J - Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.	842	1314
Xf - Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.	110	770

3.5 Supporting Components

3.5.1 Populations of Migratory and Resident Waterbirds

The Cobourg Peninsula supports moderate numbers of waterbirds and shorebirds, however the numbers are dwarfed by bird numbers recorded beyond the site in areas such as the Murganella floodplain and Kakadu National Park (Chatto 2003, 2006). Specific details of high densities have been described for justification of the Ramsar nomination criteria 5 in Section 2.5.7. Bird species richness is high with records of two hundred and thirty-six bird species, comprising eighty-nine

waterbird species (including twenty-one migratory and ten resident shorebird species, and nine gull and tern species) and fifteen species (other than waterbirds) which are regarded as wetland-dependant (Appendix D).

Waterbird distribution is coastal, reflecting the general paucity of inland wetlands (excluding seasonal creeks). Magpie geese, one of the more abundant waterbirds (Chatto 2006), can typically be found during the early dry season on the larger lagoons along the north coast, particularly Banteng Lagoon (Frith and Calaby 1974). Other relatively common waterbird species: great, little, intermediate and cattle egrets, are also reported from these lagoons. Ilmaryi Creek in the south east is an important site for radjah shelduck (SCRSR cited in Chatto 2006). Several shorebird species use nearshore islands and coastal promontories for breeding (see Section 3.6.2).

Waterbirds feed on aquatic invertebrates, vertebrates such as fish and frogs, and plant material. As such, populations of migratory and resident waterbirds are important to ecosystem functioning, particularly with respect to wetland nutrient cycling processes. Waterbirds are also important with respect to plant recruitment processes. Specifically, waterbirds may disperse seeds through endozoochory (ingestion of seeds) or epizoochory (for example, transportation of seeds in mud stuck to feet).

There is a range of biological processes that, together with physical (abiotic) processes described elsewhere, are critical to the maintenance of wetland ecosystem functioning and waterbird values. The availability of food sources will affect the frequency and intensity of use of the site as a feeding habitat by waterbirds, noting that a broad range of feeding techniques are used by the array of waterbirds that use the site. These feeding adaptations range from shorebirds feeding on macroinvertebrates within intertidal habitats to herbivorous waterbirds of the freshwater floodplain wetlands.

3.5.2 Monsoon Forests

Monsoon forests in Cobourg Peninsula are found in coastal and sub-coastal regions. Monsoon forests are typified by a higher stem density, greater basal area, more tree species, higher litter cover and lower grass cover than surrounding vegetation (Brocklehurst 2010). Dry coastal thickets are more common across the peninsula, and are not generally associated with water sources or creek lines. Wet monsoon forests occur around springs and seeps, and in riparian strips and are characteristic of Cobourg Peninsula and adjacent Croker Island (Brocklehurst 2010).

On Cobourg, wet monsoon forests are less floristically diverse than on the Tiwi Islands. They generally occur in small patches of less than one hectare. The best occurrence of wet monsoon forest occurs on springs at the head of Mawuwu Creek where it forms closed forests dominated by canopy species such as *Fragraea racemosa, Syzygium angophoroides, Melicope elleryana* and *Gmelina dalrympleana*. The palm *Hydriastele wendlandiana* forms a dense secondary layer, and characterises the community. Other common species include *Buchania obovata, Alstona actinophylla, Vitex glabrata, Sterculia quadrifidia, Canarium australanium,* and *Parinari coymbosum* (Frith and Calaby 1974).

Monsoon rainforests form a higher proportional land area in the Tiwi-Cobourg bioregion than anywhere else in the Northern Territory (Woinarski and Baker 2002). In the context of supporting wetland function, monsoon rainforests provide additional habitat heterogeneity, supporting a variety

of species that will move between wetland habitats and transitional terrestrial habitats. During fires and drought, they will also provide refugia to a variety of species. There are no broad-scale empirical data describing variability over time in extent of monsoon rainforests within the Ramsar site.

3.5.3 Terrestrial Habitats

The terrestrial (that is, non-wetland) habitats of Cobourg Peninsula are dominated by tropical eucalypt open-forests, composed of Darwin stringybark *Eucalyptus tetrodonta*, Darwin woollybutt *E. miniata,* Melville Island bloodwood *Corymbia nesophila,* with *Hydriastele ramsayii* sometimes forming small monospecific stands (Brocklehurst 2010). The site contains some of the best developed eucalypt forests in the Northern Territory (Woinarski and Baker 2002). Structurally, the forests of Cobourg Peninsula are generally taller, with a denser canopy and a more diverse mid-layer than eucalypt forests elsewhere in the bioregion (Brocklehurst 2010).

The understorey varies depending upon soils, landscape position and fire frequency, though annual and perennial *Sorghum* grass, *Cycas* spp., *Terminalia* spp. and *Acacia* spp. are common elements. Small grassland plains occur in some areas adjacent to the coast behind beach ridges. The terrestrial habitats support a variety of fauna species, many of which use resources from a combination of terrestrial and wetland habitats. Terrestrial flora and fauna species are an integral part of the wetland ecosystems, contributing significantly to wetland functions and processes such as energy and nutrient cycles.

3.5.4 Aquatic Invertebrates

The composition of invertebrate fauna is greatly influenced by the physical conditions in the local habitats in which the animals live. On Cobourg Peninsula, over 220 species of aquatic macroinvertebrate have been identified from inland wetlands including fresh and brackish lagoons, to small freshwater streams and springs (AECOM 2011). Notably, the invertebrate fauna assemblage was characterised by the virtual absence of any species that are typically associated with flowing waters. This held true even for 'flowing' sites such as streams and seasonal creeks. Invertebrate assemblages varied widely between wetland types, though some similarities were detected. Freshwater springs supported a similar assemblage to seasonal streams; seasonal brackish lakes were similar to permanent freshwater lakes. No endemic freshwater invertebrates have been identified from the site (AECOM 2011).

It has been suggested that the freshwater macroinvertebrate species diversity of the site is comparable to other areas in the bioregion. Kakadu, in comparison, has been estimated to support in excess of 600 freshwater macroinvertebrate species (Finalyson et al. 2006). This represents a collection effort dating over several decades (versus a single sampling event in Cobourg Peninsula), and includes taxa associated with flow, and the sandstone plateau.

The marine invertebrate fauna of the broader marine area includes records of some ten to fifteen species of bryozoa, 300 species of annelid, 75 species of crustacean, 331 species of mollusc and 100 species of echinoderm (Frith and Calaby 1974; Billyard 1995; NRETAS 2007). The majority of these species would reside predominantly in the intertidal areas and reefs within the site. Some of the notable invertebrates associated with the Popham Creek system include the characteristic fluted giant clam *Tridacna squamosa* and the gastropod *Clypeomorus admirabilis* which while not endemic has only been recorded once before in the Northern Territory (Billyard 1995). The mud crab *Scylla*

serrata is commonly encountered around the coastline particularly associated with mangroves. Rock oyster beds *Saccostrea cucculata amasa* are found along rocky intertidal shelves along the northern coastline (Gomelyuk 2000). These latter two species are also discussed in Section 3.9 in terms of their fisheries resource values.

There are two species of shrimp, *Thorella cobourgi* and *Thor spinipes* that have been described from Cobourg Peninsula alone (type locality of Black Point and Burford Island, respectively). Both species inhabit the intertidal zone, in coral reef and seagrass (Bruce 1982; Davie 2002). While it is possible they may be endemic to the region, there is no unique landform or habitat restricting their distribution to Cobourg Peninsula.

Aquatic invertebrates are consumers that have a vital role in the decomposition and uptake of nutrients in aquatic ecosystems, such that nutrients are processed and available for higher consumers (that is species that prey on aquatic invertebrates). As discussed in Section 3.7.6, some aquatic invertebrate species such as shrimp can have a particularly strong influence on benthic foodwebs by influencing/processing benthic sediments, detritus and algal communities.

In terms of aquatic invertebrates providing a valuable prey resource, almost half of the wetland bird species eat swimming or bottom-dwelling aquatic invertebrates (Cowie et al. 2000). These food resources are shared between species on the basis of foraging zones, foraging techniques and prey size. A significant feature of the freshwater fish communities in the region is that they typically lack specialist herbivorous species. Most fish species are largely carnivorous, feeding on aquatic invertebrates (Cowie et al. 2000). MacFarlane (1996) analysed community-based data and found that predation by fish is non-selective of macroinvertebrate taxa. Invertebrates also provide food for aquatic reptiles, with crustaceans in particular comprising a significant proportion of the diets of juvenile saltwater crocodiles.

3.5.5 Fish Populations

3.5.5.1 Freshwater Fish

Freshwater fish diversity on the Cobourg Peninsula is largely unknown. To date, a total of eight freshwater species have been recorded within freshwater habitats (AECOM 2011). Additionally, a further eight estuarine / marine species that use freshwater habitats have also been recorded within the adjacent Marine Park (AECOM 2011) (refer to Table 3-3). There is no current data available describing the temporal or spatial patterns in freshwater fish abundance on the Cobourg Peninsula.

Consistent with many tropical catchments of Australia, poor recorded species richness may reflect the low survey effort, and additional species are likely to be recorded with further surveys (Burrows 2008). The adjacent catchment of East Alligator River has the greatest diversity of freshwater fish within the Northern Territory (58 species: Bishop et al. 2001, Burrows 2008). Given the proximity of the two catchment areas, it is likely that freshwater fish assemblages of the Cobourg Peninsula would show similarities in assemblage structure to fish communities recorded within the East Alligator River.

However, it would be expected that species diversity would be lower on the Cobourg Peninsula given the there are little available permanent freshwater bodies and a lack of connectivity with larger river systems.

With the exception of freshwater springs and seasonal creeks, permanent and semi-permanent freshwater waterbodies are located within close proximity to the coastline. These waterbodies are susceptible to periodic storm surges induced by cyclonic winds. This would result in saline intrusion for which a large portion of freshwater fish species would be intolerant. Considering this, it is notable that five of the eight species (*Ophisternon gutturale, Lates calcarifer, Glossamia aprion, Hypseleotris compressa, Mogurnda mogurnda*) are tolerant of higher saline conditions (Pusey et al. 2004).

Table 3-3 Freshwater and estuarine/marine fish species recorded within the site (from AECOM 2011)

Latin name	Common name
Freshwater Species	
Melanotaeniidae	
Melanotaenia nigrans	black-banded rainbowfish
Pseudomugilidae	
Pseudomugil gertrudae	spotted blue-eye
Synbranchidae	
Ophisternon gutturale	swamp eel
Centropomidae	
Lates calcarifer	barramundi
Apogonidae	
Glossamia aprion	mouth almighty
Eleotrididae	
Hypseleotris compressa	empire gudgeon
Mogurnda mogurnda	purple-spotted gudgeon
Oxyeleotris nullipora	poreless gudgeon
Estuarine/ marine species	
Mugilidae	
Liza vaigiensis	diamond-scale mullet
Mugil cephalus	sea mullet
Gobiidae	
Glossogobius biocellatus	sleepy goby
Toxotidae	
Toxotes chatareus	common archerfish
Elopidae	
Elops hawaiensis	giant herring
Megalopidae	
Megalops cyprinoides	oxeye herring
Lutjanidae	
Lutjanus argentimaculatus	mangrove jack
Scatophagidae	
Scatophagus argus	scat

Permanent freshwater pools, freshwater coastal lagoons and semi-permanent isolated waterholes along perennial creeks provide essential refugial habitat to fish assemblages and other aquatic fauna during dry periods. At the beginning of the wet season, freshwater fish migrate out of dry season refuges to colonise temporally inundated floodplains, benefiting from increased food availability during the wet season (Griffin 1995; Cowie et al. 2000).

Densities of freshwater fish are highly seasonal and are related to flooding and water depth. The proliferation of freshwater fish during the wet season and their progressive concentration in shrinking water bodies from mid to late dry season presents ideal feeding conditions for fish-eating birds (Cowie et al. 2000). Exclusively fish-eating species include darters *Anhinga novaehollandiae*, little black cormorants *Phalacrocorax sulcirostris*, Australian pelicans *Pelecanus conspicillatus*, ospreys *Pandion haliaetus* and great egrets *Ardea alba*.

Freshwater fish are a key dietary component for the top aquatic predators in the site (for example crocodiles, fishing eagles) and therefore contribute to controlling ecosystem processes and biological interactions. Barramundi are also opportunistic predators, primarily feeding on aquatic invertebrates and fish. Typically the diet of larger barramundi consists of 60 percent fish and 40 percent crustaceans (predominantly prawns/shrimp), whilst smaller barramundi primarily feed on crustaceans (Allsop et al. 2006).

3.5.5.2 Marine Fish

The Cobourg Marine Park is known to contain a large number of marine fish species; a total of 595 species from 117 families including sharks, manta rays and stingrays have been recorded (Table 3-4, refer Appendix D). This is likely a reflection of the wide variety of habitat types found within close proximity to each other, including coral reefs, rocky reefs, sand and mudflats, mangroves, seagrass and algae beds (mostly the brown alga *Sargassum*). Many of these species will rely, in part, on the habitats within the site for feeding, breeding and other stages of their life cycle.

Certain areas of the Marine Park are thought to contain greater species diversity and abundance than other areas, including Orontes Reefs, *Sargassum* beds near Danger Point, and fringing reefs near Black Point, Smith Point, Sandy Island No. 1 and Caiman Creek (NRETAS 2007). Semi-enclosed water such as Port Essington and various bays along the Peninsula support a diverse range of habitats and important nursery areas for marine life. These habitats are considered to be unique to other semi-enclosed habitats along the Northern Territory coastline as they are subject to minimal freshwater runoff (NRETAS 2007).

Habitat degradation through coral bleaching, siltation and anthropogenic influences are considered to be a key threat to coral and fish communities of Coral Bay and other habitats within the Marine Park (see Section 5.3.1). In 2003 a decline of up to 90 percent coral cover was recorded in areas of Coral Bay previously attributed with diverse and extensive communities (NRETAS 2007). A survey undertaken by Gomelyuk in 2008 of sandy banks, rocky reefs and degraded coral reefs in Port Essington found species richness at each habitat type to be less than fish assemblages recorded within adjacent coral reef habitats at the mouth of the bay. However, rocky reefs and sandy banks represent key habitats areas for which many fish congregate within Coral Bay, with the family Carangidae representing 35 percent of fish species recorded (Gomelyuk 2008).

Four fish species of conservation significance according to the IUCN red list are known to occur within the marine areas of Garig Gunak Barlu National Park (NRETAS 2007): great hammerhead *Sphyrna mokarran* (Endangered), leopard shark *Stegostoma fasciatum*, giant groper *Epinephelus lanceolatus* (Vulnerable) and blotched fantail ray *Taeniura meyeni* (Vulnerable).

Table 3-4 Dominant marine fish families recorded on the Cobourg Peninsula (see Appendix D)

Family	Common names	Number of species occurring
Gobiidae	gobies	54
Carangidae	jacks, pompanos, jack mackerels and scads	31
Chaetodontidae	butterflyfish	21
Apogonidae	cardinalfishes	20
Lutjanidae	snappers	19
Serranidae	seabasses and groupers	17
Pomacentridae	damselfishes and clownfishes	16
Tetraodontidae	pufferfish and allies	16
Blenniidae	combtooth blennies	14
Haemulidae	grunts	14
Labridae	wrasses	14
Carcharhinidae	requiem sharks	13
Leiognathidae	ponyfishes	13
Cepolidae	bandfishes	12
Scorpsaenidae	scorpionfish	12
Nemipteridae	threadfin bream	10

3.6 Critical Processes

The present study identifies two critical processes for the Cobourg Peninsula Ramsar site (Table 3-1):

- P1 – Marine turtle nesting
- P2 – Waterbird breeding colonies

3.6.1 Marine Turtle Nesting

Reasons for Selection as 'Critical'

Breeding is a critical life stage of species (as reflected in Criterion 4) that is essential in order to ensure the long-term persistence of populations that are fundamental to determining the site's ecological character. There are seven sea turtle species recognised across the world. Six of these occur in Australia, all of which are protected under national legislation or international agreement, and are listed as vulnerable, endangered or critically endangered (DEWHA 2009b). Five of these six sea turtles have been confirmed as having nested, or currently nest on Cobourg Peninsula: the green turtle *Chelonia mydas*, the flatback turtle *Natator depressus*, the Olive Ridley turtle *Lepidochelys olivacea*, the hawksbill turtle *Eretmochelys imbricata* and the leatherback turtle *Dermochelys coriacea*. This process underpins Ramsar nomination criteria 2 and 4.

Description

Cobourg Peninsula is considered critical in the context of maintaining the long-term viability of these turtles, particularly the vulnerable (under the EPBC Act) flatback turtle and endangered (under the EPBC Act and listed on the IUCN Red List in1982) green turtle. Valuable nesting habitat, albeit in lower numbers, is also provided for the hawksbill, Olive Ridley and leatherback turtles. It is notable that Cobourg Peninsula is home to the only confirmed nesting activity of leatherback turtles in Australia since 2004, and can therefore be considered particularly important for this species at a

national but not international scale (Chatto and Baker 2008). The Cobourg Peninsula is identified as a 'key marine-turtle monitoring site within a national monitoring framework' for the flatback turtle, green turtle, hawksbill turtle and Olive Ridley turtle (Environment Australia 2003).

In general, female flatback and green turtles display strong fidelity to their chosen nesting beach, with most females returning to the same beach within a nesting season and in successive nesting seasons (Limpus 2008). Flatback turtles are believed to nest solely within Australia (Limpus 2008), with the islands and waters of the Ramsar site considered to be the most important nesting areas in the Northern Territory (along with Bare Sand Island and Quail Island of Bynoe Harbour: (NRETAS 2007). Continuous nesting of flatback turtles from February to November has been confirmed on Greenhill Island, and inferred for other important nesting sites on Mogogout Island and Danger Point (Hope and Smit 1998, Chatto and Baker 2008). Survey data has not been sufficient to suggest a peak nesting period, though the months of May to September have been reported elsewhere in the Northern Territory (Fry in Limpus 2008). This dry season peak of nesting activity may be adaptive to protect the eggs from the high sand temperatures that occur in the wet season (Guinea in Limpus 2008).

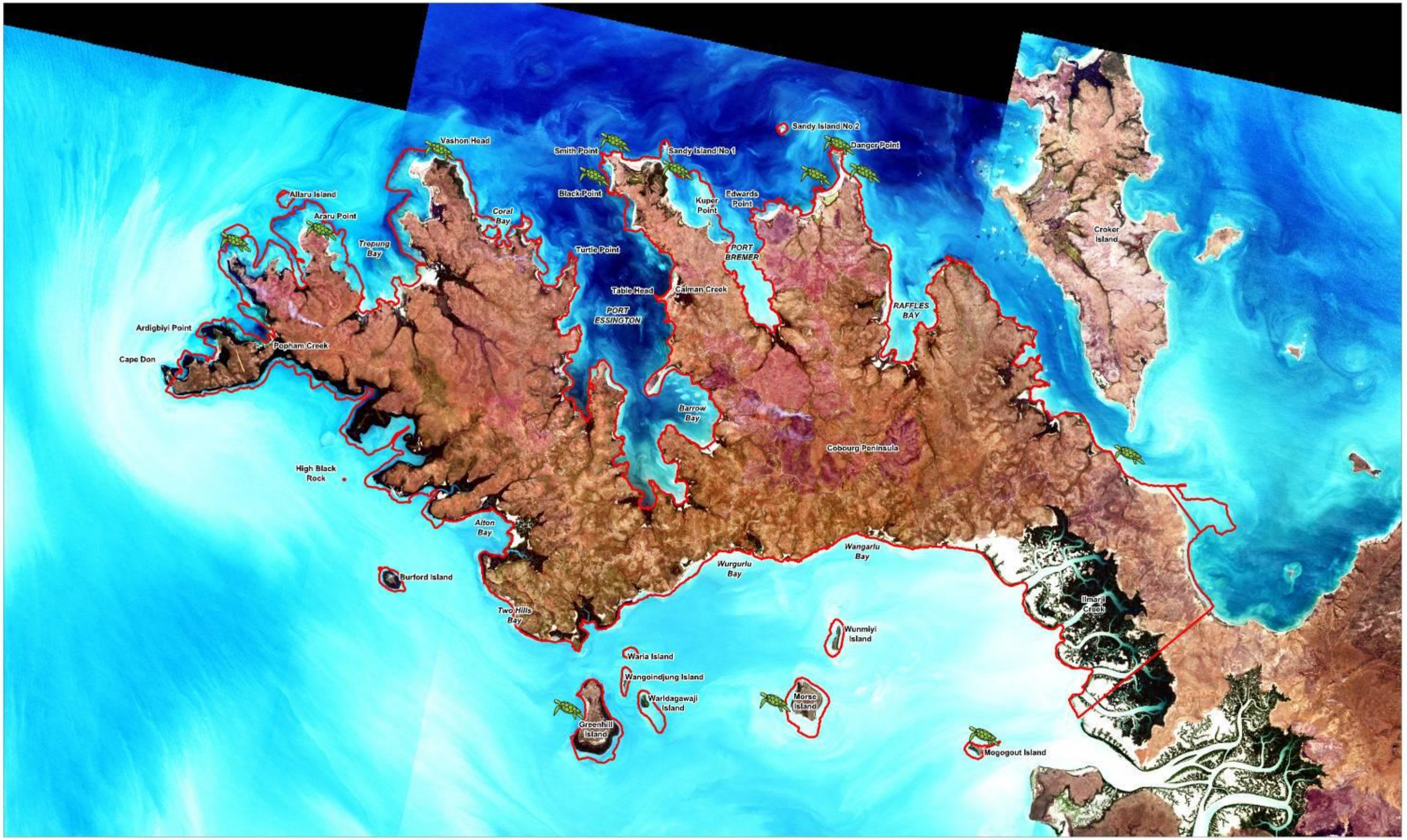
Green turtles nesting within Australia have been broadly classified into separate genetic stocks, representing different breeding distributions despite sharing common feeding areas (Limpus 2008). The turtles nesting in the Cobourg Peninsula Ramsar site and nearby western Northern Territory have not been classified into a genetic stock, though they are believed to be separate from the Gulf of Carpentaria breeding unit and may represent a unique genetic stock (S. Whiting pers. comm. 2010). Green turtles have been confirmed nesting throughout the year across the Northern Territory. Limited survey effort around Cobourg Peninsula has suggested peak nesting activity for green turtles occurs during the wet season, from late September to May (Gomelyuk in Chatto and Baker 2008). Hope and Smit (1998) recorded 230 of 246 nesting events on Cobourg Peninsula in the months of January and February, with the remainder during April to June, and September to December. However there was no indication of survey effort, which may have biased these results. The main nesting areas for green turtles are the Black Point and Smith Point beaches (Chatto and Baker 2008).

Leatherback turtle nesting has been positively identified from Danger Point only, during the period of December to January (Chatto and Baker 2008). The first confirmed nesting was in 2005, though this does not indicate that nesting did not occur earlier. Genetic analysis of the Australian breeding population of leatherbacks has not been undertaken, but it is presumed to be distinct from the larger breeding stock of Papua New Guinea, West Papua and the Solomon Islands due to its regional isolation (Limpus 2008). Studies elsewhere have indicated that leatherback turtles display strong fidelity to particular nesting beaches (see Eckert et al. 1989 and Behler et al. 1996 in Limpus 2008), highlighting the importance of the nesting sites at Cobourg Peninsula.

Figure 3-3 Marine turtle tracks near Danger Point (source: BMT WBM)
© Copyright, Simon Drummond

Patterns in Variability

There are no available data to describe nesting densities and reproductive success, either before or after declaration of the Ramsar site. The key parameters needed to describe this component are: (i) turtle nesting intensity indicators (number of nesting attempts per night or individuals nesting per survey night) and (ii) clutch size and clutch success. Survey effort within the Cobourg Peninsula Ramsar site has been sporadic. Some of these parameters have been recorded, particularly for flatback turtles on Greenhill Island, and green turtles at Black Point/Smith Point (Hope and Smit 1998). There is a current, long-term project underway involving green turtles however results are still several years away from defining some of these patterns in variability (pers. comm. G. McFarlane 2010). Cogger and Lindner (1969) reported general notes on abundance in the 1960s. There are indications of peak nesting activity throughout the year as documented above. However, studies have been predominantly opportunistic; they provide snapshots of nesting activity collected during a single time period.



LEGEND

Cobourg Peninsula Ramsar Site

Significant Turtle Breeding Site

Title:

Major Breeding Sites for Marine Turtles

Figure: 3-4

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

3.6.2 Waterbird Breeding Colonies

Reasons for Selection as 'Critical'

Cobourg Peninsula Ramsar site supports habitat and conditions that are important for a variety of waterbird species at critical stages in their life cycles (for example breeding, overwintering, moulting). If these stages are interrupted or prevented from occurring, the long-term conservation of these species would be threatened. Of these life cycle functions, breeding is considered to be the most prominent and therefore critical (as reflected in Criterion 4).

Description

The most notable waterbird breeding colonies are found on sandy, coral rubble islands and headlands (Figure 3-5). They are composed primarily of six seabird species: crested tern *Sterna bergii*, bridled tern *S. anaethetus*, Caspian tern *S. caspia*, roseate tern *S. dougallii*, black-naped tern *S. sumatrana* and silver gull *Chroicocephalus novaehollandiae*. Sandy Islands No. I and No. II, together with Seagull Island (off Melville Island) are the only regular crested tern breeding sites between Cobourg Peninsula and the Western Australian border (NRETAS 2007). The location of key breeding sites is discussed in Section 2.5.6, and summarised in Table 3-5. No significant (other) waterbird colonies, or shorebird colonies have been recorded within Cobourg Peninsula Ramsar site (Chatto 2003, 2006).

Table 3-5 Important Seabird Breeding Colonies at Cobourg Peninsula

Site	Significance*	Species	Colony counts
Sandy Island No. 2	National	crested tern bridled tern silver gull Caspian tern	• 6000 crested tern in 1967 (Frith and Calaby 1974) • 2400 multi-species in 1994 • 160 in 1995^ • 100 in 1996^
Sandy Island No. 1	National	roseate tern black-naped tern Caspian tern	• 100 in 1993 • Nil in 1994 • Birds present in 1996 but not yet breeding
Edwards Point, Port Bremer	National	black-naped tern roseate tern	• 100 in 1993 • Some present in 1994 but unable to give reliable estimate
Unnamed island near Cape Don (possibly known as Wurrurrlarnbi)	Regionally high	crested tern roseate tern black-naped tern	• 100 in 1993^ • 100 in 1994 • 10 in 1996^
Unnamed island in Coral Bay	National	little tern	• 28 in 1994
Warla Island	National	black-naped tern roseate tern	• 100 in 1994 • 80 in 1996

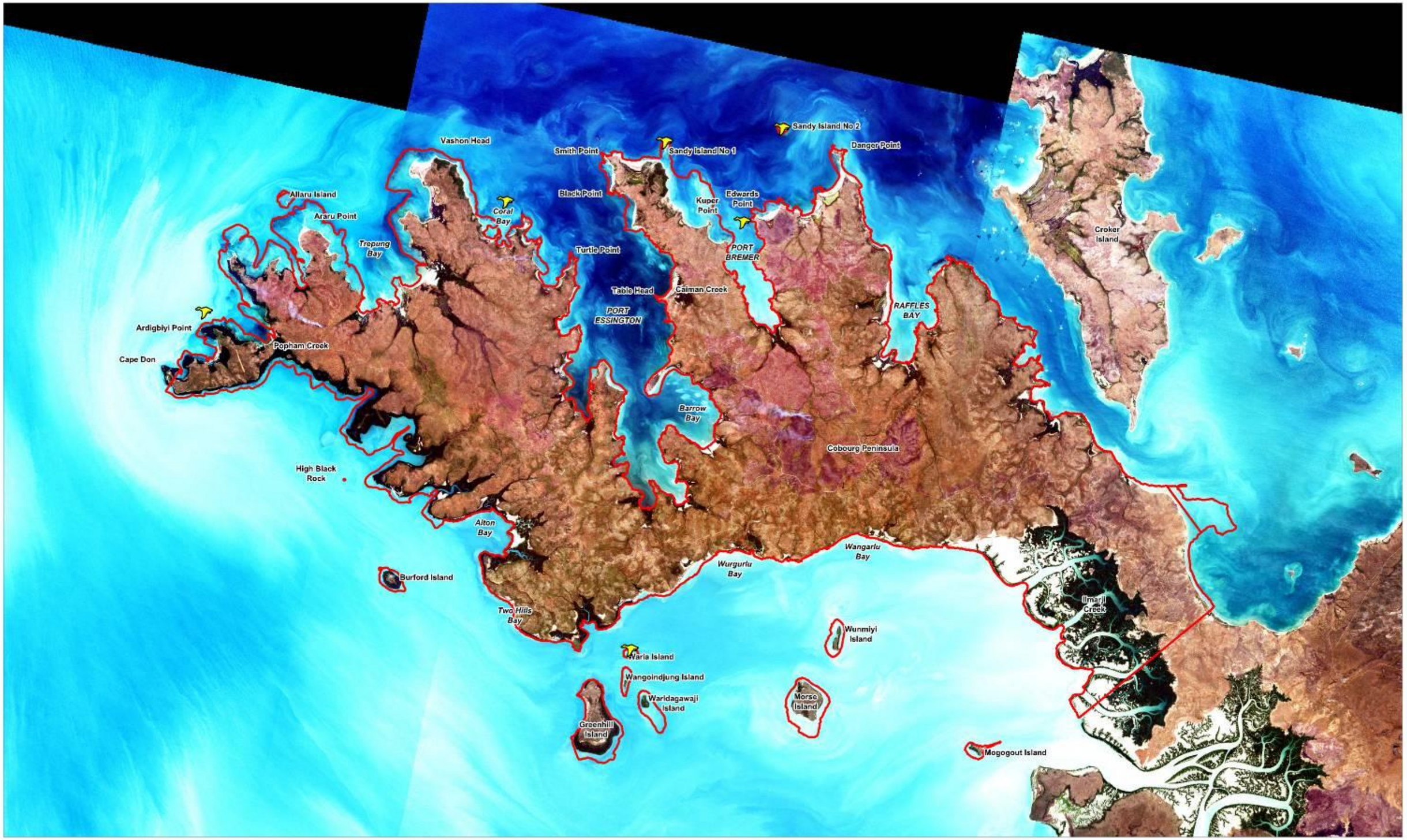
Notes: *significance rating from Chatto (2001): 'national' indicated a colony that exceeded one percent of the Australian population estimate (this is not the same as the Ramsar threshold which stipulates one percent of the global population), 'regionally high' indicated a large colony, 'low' indicated a small colony. Colony counts are as per Chatto (2001) unless otherwise noted. ^ indicates the count was likely to be considerably less than peak numbers as survey did not coincide with optimal breeding season or observer was unable to view all birds present.

Patterns in Variability

There are no available data to describe nesting densities and reproductive success, either before or after declaration of the Ramsar site. Variations in waterbird colony counts summarised in Table 3-5 are considered reflective of differing survey times, rather than large variations in abundance over time. Notwithstanding, key controls on waterbird breeding use of the site would include:

- diversity of disturbance-free roosts and breeding sites that are spatially proximate to suitable feeding grounds (shorebirds, and terns mainly)
- availability/quality of feeding sources such as the diversity and abundance of aquatic flora and invertebrate fauna (waterbirds generally)
- densely vegetated permanent wetlands supporting submerged and emergent aquatic macrophytes, and fringing littoral vegetation (waterbird breeding habitat primarily, though also a key attribute for particular waterbirds as feeding habitat).

Chatto (2001) provides general observations on seasonality for breeding colonies of these seabird species across the Northern Territory. Breeding times are strongly influenced by seasonal factors (which influence the key controls noted above), with all the seabird colonies avoiding the wet season. Timing differs between species. The numerically dominant (at Cobourg) crested tern has a well-defined breeding season of March to July, with most birds either roosting or moving away from colonies by the end of July. Caspian terns have been recorded breeding around May and October as two distinct seasons; it is suggested they are influenced by the breeding peaks of other species that use the same colony sites. The majority of roseate terns breed later in the year, between September and early January, though a second distinct season, probably a separate population, is recognised between April and June. Black-naped terns breed between September and December, while little terns have been recorded breeding during most months of the year with the lowest counts in March followed by a peak in May. Little terns probably have a continuous breeding period from April through to early January. Silver gull breeding colonies differ across the Northern Territory coastline, but generally all within the period of March to August.



LEGEND

Cobourg Peninsula Ramsar Site

Significant Seabird Breeding Site

Title:

Cobourg Peninsula Seabird Breeding Sites

Figure: 3-5

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

3.7 Supporting Processes

3.7.1 Climate

3.7.1.1 Seasonal Cycles

Cobourg Peninsula lies within the East Alligator River basin (Figure 2-2). The Peninsula, however, contributes little to the catchment, with surface water flow restricted to short drainage channels that flow directly into the Arafura Sea or Van Dieman Gulf. The climate conditions experienced across the Peninsula reflect those described throughout the Alligator Rivers Region by Saynor et al. (2000 and references therein). In general, the climate can be defined as wet-dry tropical with a wet season duration of four-and-a-half to seven months. Humidity is generally highest between January and March with mean relative humidity (at 9 am) greater than 80 percent. Temperatures at Black Point are high throughout the year (Figure 3-6). Annual mean minimum and maximum temperatures were 24.0 degrees Celsius and 31.3 degrees Celsius, respectively. The highest temperatures are generally recorded from October to December while lowest temperatures usually occur from June to August (Figure 3-6), however seasonal differences are small.

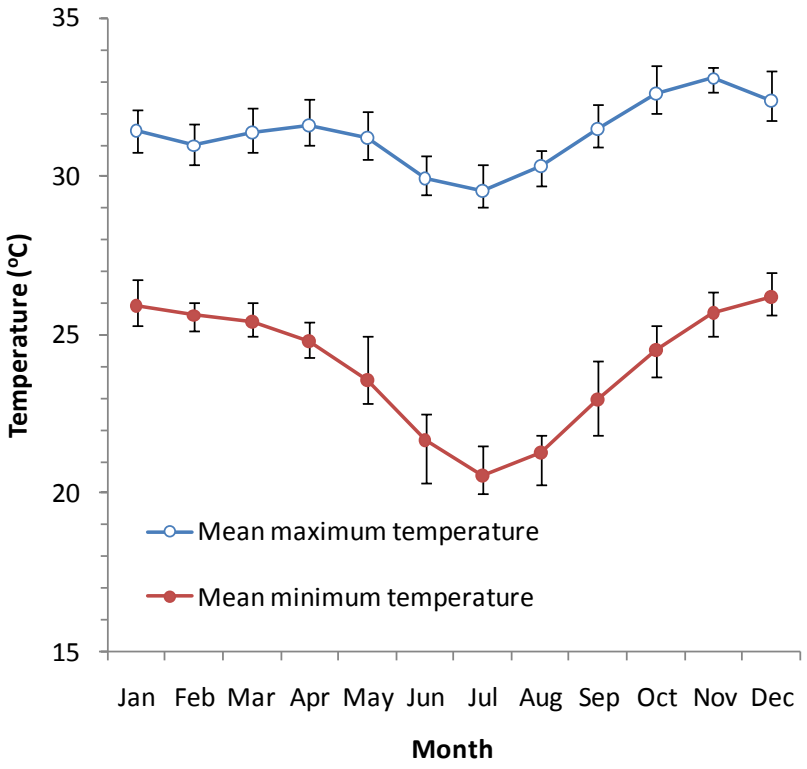


Figure 3-6 Mean maximum and minimum temperature at Black Point between 1991 and 2009. Upper and lower error bars denote the 90th and 10th percentiles (source: Bureau of Meteorology unpublished data)

Average annual maximum temperatures in the Northern Territory have increased by about 0.12 degrees Celsius per decade since 1950 together with an increase in frequency of extremely warm days and nights and a concurrent decrease of extremely cool days and nights (Hennessy et al. 2004). Greater warming was observed in May to October compared to November to April.

The warm wet season is marked by monsoonal depressions bringing heavy rain and occasional tropical cyclones to the area. Over 90 percent of the average rainfall occurs during the wet season between November and March (Figure 3-7) with mean annual rainfall of approximately 1300 millimetres. Little or no rain occurs during the cooler dry season extending from June to September (Figure 3-7). Potential evaporation (2400 to 2700 millimetres per year) exceeds rainfall in most years (Saynor et al. 2000).

The Northern Territory has become wetter between 1950 and 2002 with average rainfall rising 35.7 millimetres per decade for November to April and falling 0.4 millimetres per decade for April-October (Hennessy et al. 2004). Particularly strong rainfall periods are associated with cyclonic events, with the highest rainfall recorded at Black Point ranger station in 1974, 1984 and 1995 (Bureau of Meteorology unpublished data).

Winds are predominantly from the south-east and east between April and October, whereas winds are more variable with an often strong westerly and northerly component from November to March. Winds in excess of 25 knots occur on average 13 days per year (CPSB 1987).

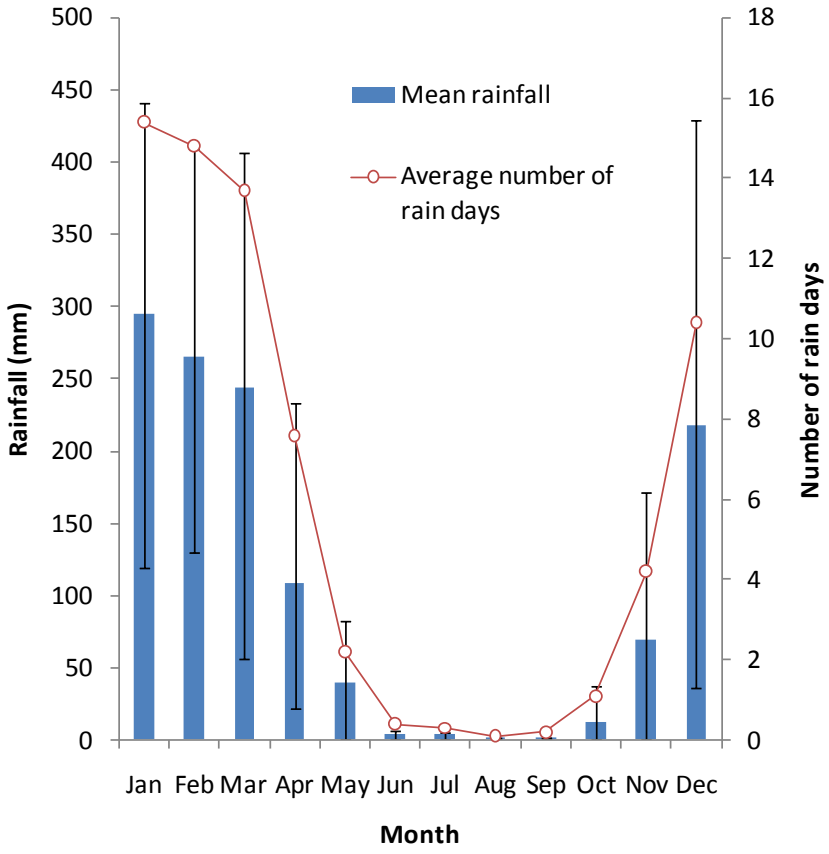


Figure 3-7 Mean monthly rainfall and average number of rain days at Black Point between 1967 and 2009. Upper and lower error bars denote the 90th and 10th percentiles (source: Bureau of Meteorology unpublished data)

3.7.1.2 Long-term Cycles

The El Niño Southern Oscillation (ENSO) modulates the behaviour of the monsoon and frequency of cyclones experienced (Hennessy et al. 2004, Wasson and Bayliss 2009). The El Niño phase tends to suppress monsoon and cyclone activity over the Northern Territory, while the La Niña phase tends to enhance this activity. Hence, dry periods tend to be El Niño years, whereas the wet periods are usually La Niña years.

However, further climate variability on longer, decadal time scales was suggested by Power et al. (1999). In particular, the Inter-decadal Pacific Oscillation (IPO) has been shown to be associated with decadal climate variability over parts of the Pacific Basin, and to modulate interannual ENSO-related climate variability over Australia (Salinger et al. 2001). Accordingly, Wasson et al. (in prep.) noted an approximate 20-year decadal variation in rainfall and flow for nearby Magela Creek (18 years) and Katherine River (22 years) catchments. The decadal variations in rainfall and flow were essentially in-phase. Bayliss et al. (2008) also noted that other major rivers across the "Top End" of the Northern Territory exhibit 20-25 year periodicities in flow volume. The Indian Ocean Dipole is another long term climate phenomenon associated with warming and cooling phases in the Indian Ocean. Recent research suggests it has played a large part in influencing long term droughts across Australia (Ummenhoffer et al. 2009), though its influence upon the Australia tropics is currently poorly understood.

Such long term decadal periodicities in rainfall and flow may have important implications for the biology in the area. This was demonstrated by Bayliss et al. (2006, 2008) who showed that magpie geese *Anseranas semipalmata* across Northern Territory exhibited approximately 20 year population cycles that were coupled to similar and generally coherent periodicities in flow of the Katherine River, Daly River and Magela Creek (refer Figure 3-8). The authors noted an average response time lag of three to five years between river flow and magpie goose numbers. Similar impacts on biological cycles on Cobourg Peninsula are expected.

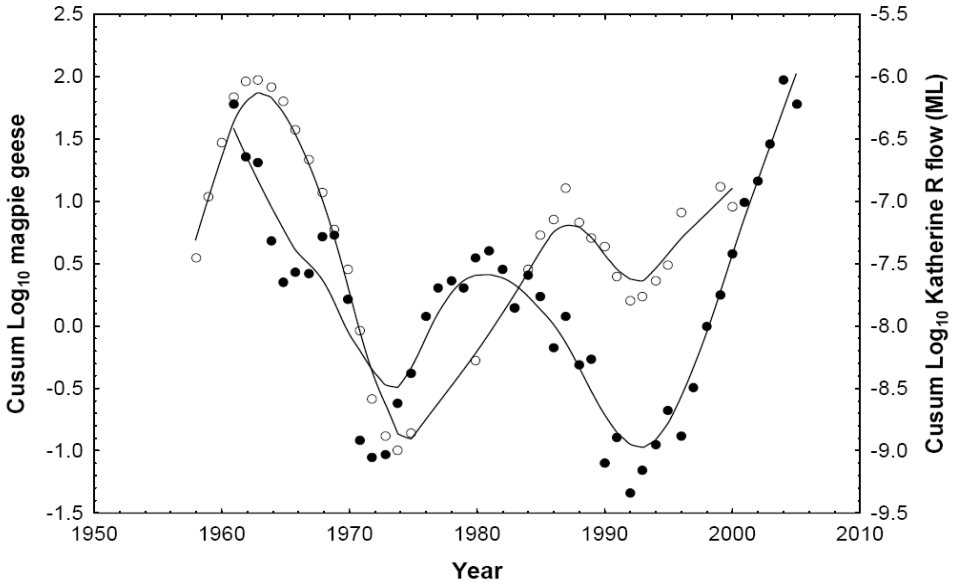


Figure 3-8 Cusum plots (cumulative sum of mean deviations) of magpie goose numbers (white symbols) in the Northern Territory, and Katherine River flow (black symbols) Figure reproduced from Bayliss et al. (2008)

3.7.1.3 Cyclones and High-Intensity Storms

Within the Northern Region of Australia, cyclones exist on average 7.7 days per year. The Arafura and Timor Seas, adjacent to Cobourg Peninsula, average one cyclone per year, while the northwestern Gulf of Carpentaria averages two per year. The majority of cyclones that form in the Northern Region move south-west or south-east, with those forming in the Arafura and Timor Seas more regularly following a south-westerly route (Bureau of Meteorology 2010).

During the last century (1906 – 2006), 47 cyclones were recorded within 200km of the centre of Cobourg Peninsula. Across the entire Northern Region of Australia, the highest number of cyclones per month has been experienced in March (for data between Jan 1960 and Jan 2007). Only 30 percent of all cyclones recorded in the Northern Region from 1963 to 2006 were severe (that is, category 3, 4 or 5 cyclones) (Bureau of Meteorology 2011).

AECOM (2011) reported evidence of modification of most freshwater wetlands on Cobourg Peninsula due to extreme weather events. Evidence included tree fall resulting from strong winds and tree mortality resulting from the influx of saline water, possibly from storm surge or increased permeability of wetlands. AECOM also reported on indicators of responses of biota to cyclonic disturbances including a negative correlation between macro invertebrate species richness and salinity of waterbodies, and the absence of fish in waterbodies with high salinity. With wetlands on Cobourg Peninsula experiencing occasional extreme weather events, it is expected that these systems and the flora and fauna occurring within them, are in a state of flux. Following an extreme event, the wetlands undergo a transition to pre-cyclone conditions. The rate of this transition is likely to depend on rainfall and resultant flushing of the wetlands (AECOM 2011).

3.7.2 Geology and Geomorphology

3.7.2.1 Geology

Landscape features within Cobourg Peninsula are the result of a relatively consistent but young geological history. The Cobourg Ramsar site is situated in the northern part of a major geological structure known as the Pine Creek Geosyncline which is the main geological structure of the region (Hughes 1978). The region is favourable to the deposition of minerals to some degree though these are not necessarily of economical significance (Hughes and Senior 1973).

The Cobourg Peninsula consists of three physiographic units (Figure 3-9). The southern part of the peninsula is dominated by sand plains with intermingled smooth, undulating lateric rises in western and central parts of the peninsula. The northern peninsula consists of gently dissected plateaux (Hughes and Senior 1973). The centre of the Peninsula is dominated by the Bathurst Island Formation, a thick Quaternary layer of sands, gravel and alluvium draped over laterised Cretaceous siltstones, sandstones and mudstones (Geoscience 2008).

Along the coastline adjacent to Mountnorris Bay are bitumen deposits, the only hydrocarbons in the area. More regular but poor quality bauxite is found in a number of outcrops across the peninsula. These include Danger Point, Smith Point, Turtle Point, Vashon Head and Araru Point. Similarly, Cobourg Peninsula also has small deposits of limestone, formed in linear bodies adjacent to the present day coastline. Uranium, phosphate and heavy mineral deposits have also been found on the

peninsula (Cobourg Peninsula Sanctuary Board 1987), but are not found in sufficient quantities for commercial extraction (Hughes and Senior 1973, Hughes, 1978).

The entirety of the area together with nearby Bathurst, Croker and Melville Islands are located on the Bathurst Terrace. This terrace has remained relatively stable throughout geological time with very little tectonic activity or faulting occurring (Hughes and Senior 1973, Hughes 1978). On the Cobourg Peninsula two minor faulting zones have been located at Grant Island and along the southern coast of Mountnorris Bay exposing underlying laterite to erosion. North-west tilting has also occurred in this area, exposing other profiles and promoting the formation of limited bauxite ores (Hughes 1978).

The peninsula, including coastal and riverine alluvial plains, is of very recent origin comparative to the surrounding geological basins (Hughes and Senior 1973). Following initial Precambrian laying of metamorphic basement rocks, erosion began to occur creating the island formations of the bays and the deposition of sedimentary rocks in the Cretaceous. As the Bathurst Terrace tilted, sedimentary rocks were exposed, leading to chemical weathering which created the extensive layer of laterite across the peninsula by the early Tertiary. As this eroded in the Quaternary it produced a thin layer of red sands and gravel across the island (Hughes and Senior 1973, Hughes 1978). Stabilising sea levels also promoted the formation of drowned river valleys and allowed for stable weathering to produce brackish organic-rich, acidic soils to support the wetlands of the Cobourg Peninsula Ramsar site (Hughes 1973).

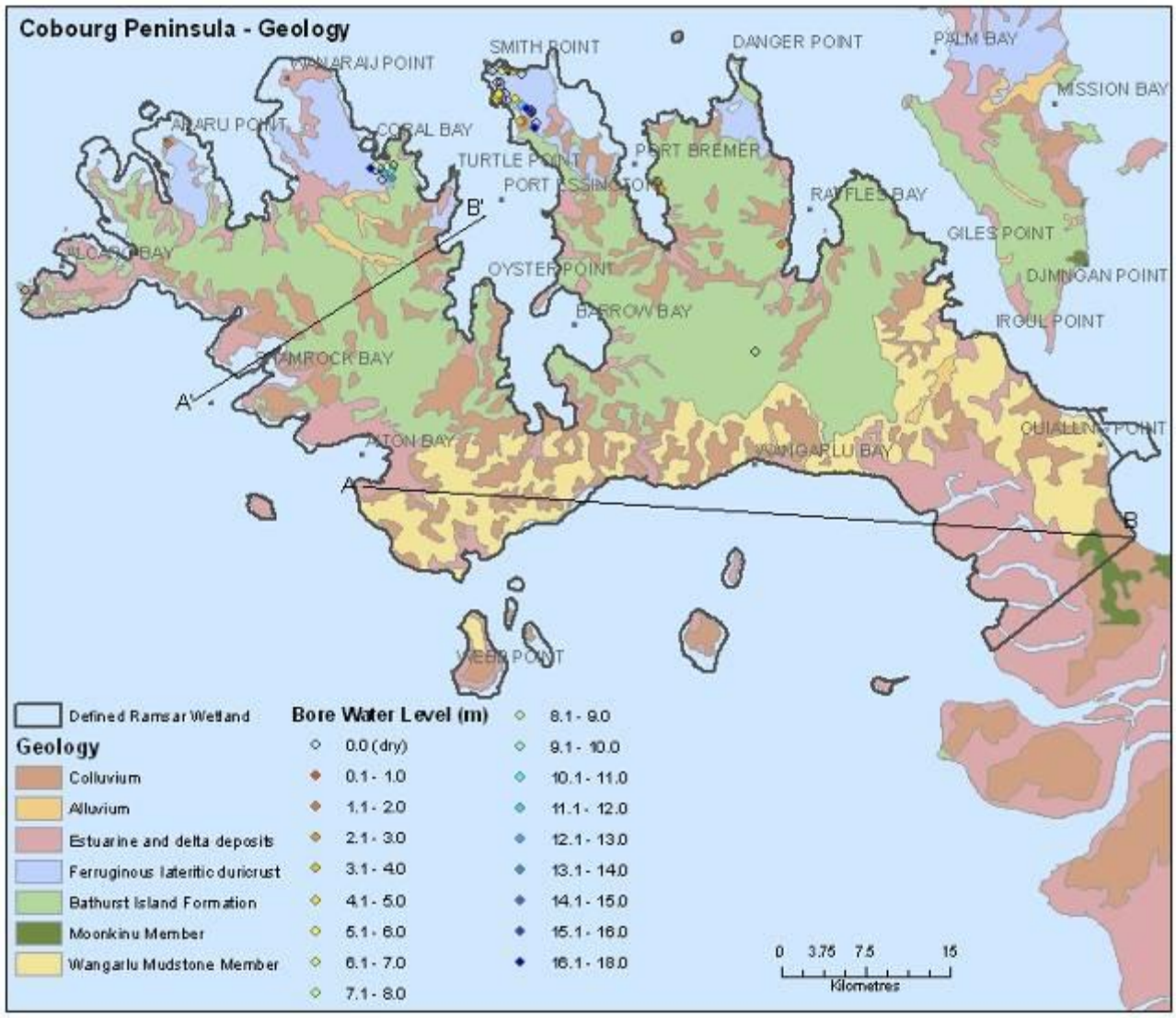


Figure 3-9 Geology, borehole distribution and watertable depth on Cobourg Peninsula (Geoscience Australia 2008). Cross-sections are depicted in Figure 3-10

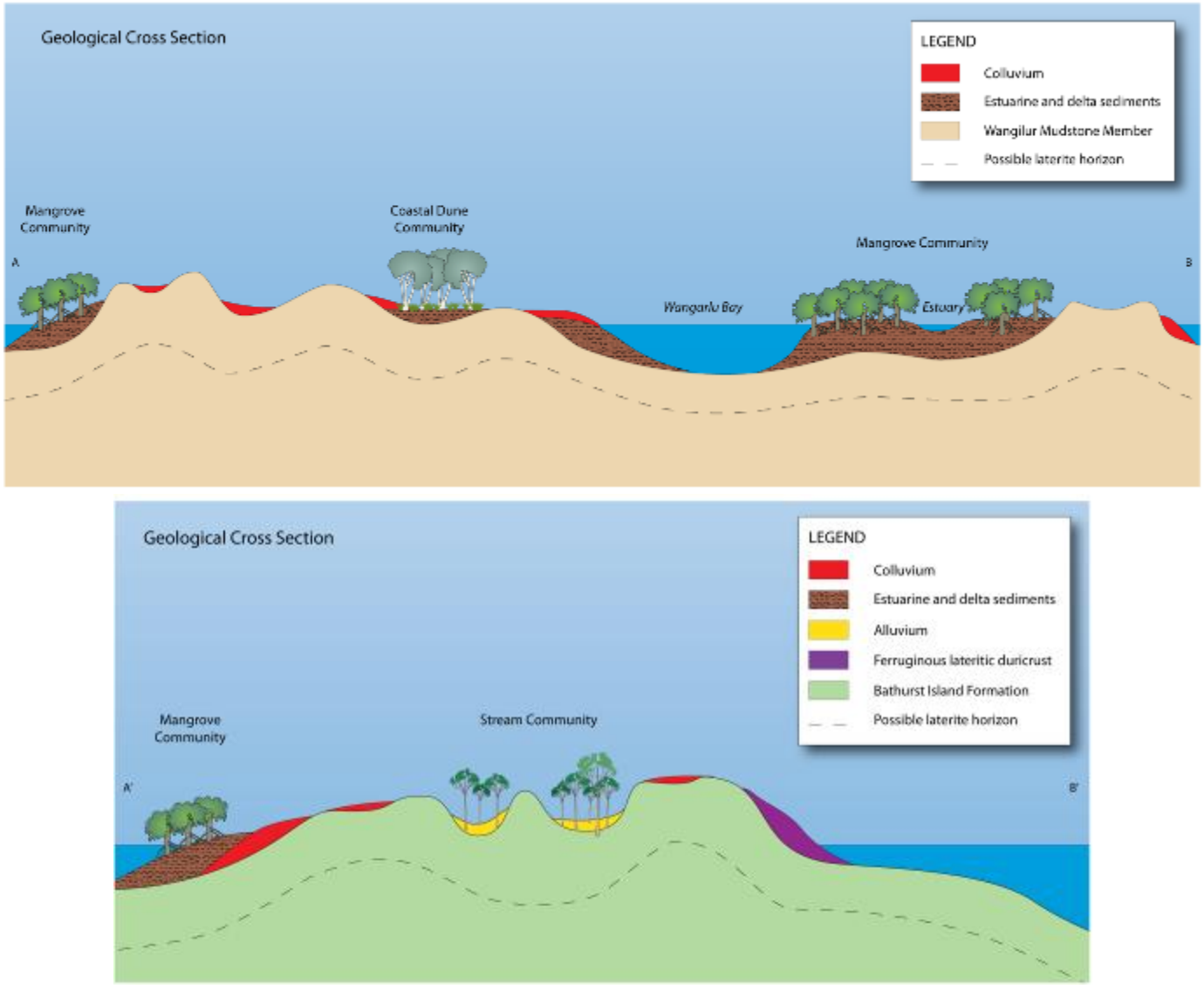


Figure 3-10 Schematic geological cross-sections through the Cobourg Peninsula region (Geoscience Australia 2008). Cross-sections locations indicated in Figure 3-9

3.7.2.2 Geomorphology

Cobourg Peninsula is connected to the mainland via a narrow isthmus (approximately 11 kilometres wide) adjacent to Mountnorris Bay. The majority of the peninsula is flat, undulating land with only two minor peaks at Mount Roe and Mount Bedwell (147 metres and 160 metres respectively). The northern coastline of the Peninsula has isolated bays, rocky headlands and beaches. The intertidal and coastal areas consist of extensive dunes, fringing coral and rocky reefs, sand and mudflats, with few areas of mangroves and seagrass communities. In contrast, the southern coastline and islands are dominated by mangrove communities associated with large mudflats.

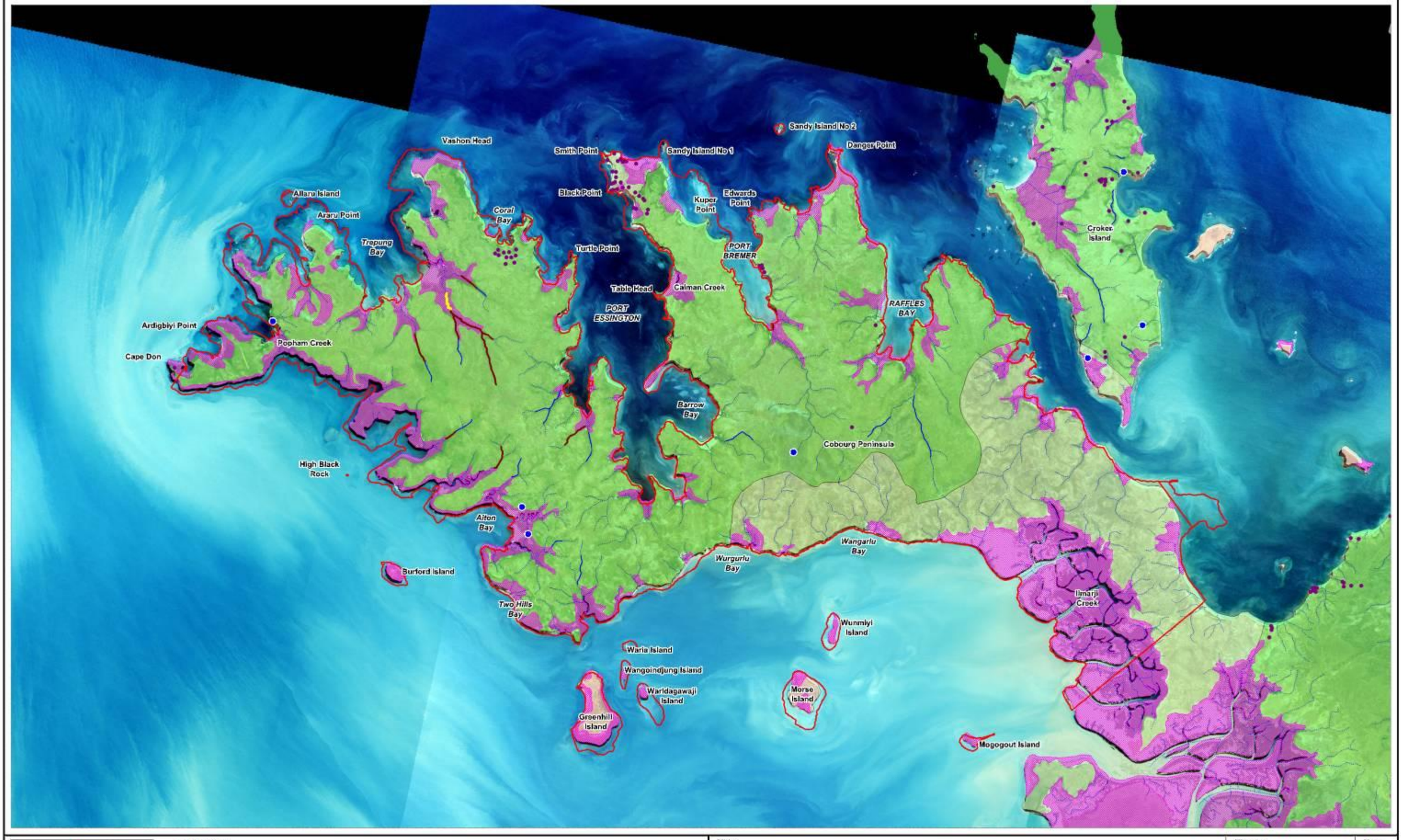
Most of the land in the Cobourg Peninsula lies 30 to 40 metres above sea level and is covered with associations of earthy soils containing ironstone gravels, with block laterite occurring at shallow depths (CPSB 1987). Areas of grey saline estuarine-clays are found in the low-lying coastal plains, while dune sands are widespread around the coastline. The soils of the peninsula are mostly unstructured and unsuited for agricultural or pastoral use. They are highly erodible if disturbed. Soils of the peninsula can be grouped based on parent material and geomorphology. These soil associations are presented in Table 3-6.

Table 3-6 Soils of Cobourg Peninsula grouped into associations based on parent material and geomorphology (CPSB 1987)

Soils Association	Description
Soils of laterized surface	Red and yellow earths of the gently undulating plains and the siliceous sands and humic gleys of the drainage areas. In general the earth soils are well drained, with the lateritic earths containing significant quantities of ferruginous and bauxitic gravels, with laterite at shallow depths.
Soils of hills, breakaways and low scarps	Skeletal soils occur wherever slopes are high. They are shallow, stony soils occurring throughout the upland areas of the Peninsula.
Soils of undulating low plains	This association includes yellow earths, podzolics, clays and earthy sands. Yellow earths and podzolics are by far the most extensive soils. Areas of non-cracking clays and earthy sands are restricted to the eastern lowlands and western lowlands respectively.
Soils of coastal margins	Includes the saline clays and saline muds of the estuarine areas and calcareous sands of beach dunes and sand plains. Cemented shell grit is present at depth in these soils.

3.7.3 Hydrology

The water resources of Western Arnhem Land have been the subject of broad-scale hydrological survey (Zaar 2003); Figure 3-11), but there is little detail from within the Ramsar site, itself. Fresh water available from streams, lagoons and shallow hand-dug wells provided sufficient supply for Arrarrkbi prior to 1970 (CPSB 1987).The visitor facilities, pearling stations and ranger station are serviced by a series of groundwater bores. Outstations are also serviced by shallow groundwater bores.



LEGEND

Cobourg Peninsula Ramsar Site

Waterways at the end of the dry season

- River which is dry
- River with permanent waterholes and flows <= 10 l/s
- River with a flows between 10 and 100 l/s
- River with a flows >100 l/s

- Spring
- Bore

Groundwater Resources

- Homeland supply
- Small homeland supply
- Little chance of water
- Saline groundwater

Title:

Water Resources of Cobourg Peninsula (source: Zaar 2003)

Figure: 3-11

Rev: A

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

In the dry season, there is a distinct absence of substantial, permanent fresh water. Wetlands are considered to be reliant upon a combination of tidal influences and groundwater (Geoscience Australia 2008). There is a steep salinity gradient between the estuaries and the inland extents of coastal wetlands.

3.7.3.1 Surface Water

Description and Patterns in Variability

Variations in the spatial extent of surface waters on the Cobourg Peninsula are strongly correlated with consistent seasonal monsoon rainfall. Influences from groundwater and saltwater intrusion are key drivers to the degree of permanence and conductivity of recognised waterbodies (that is, wetland types). Cobourg Peninsula is comprised of typically low-lying land, with little potential for extensive watercourses. With the exception of numerous perennial creeks and freshwater springs, other inland waterbodies are located within close proximity to the coastline. These coastal waterbodies vary considerably in terms of their permanence and salinity (both spatially and seasonally).

The majority of watercourses across the peninsula are dry by the end of the dry season (Zaar 2003). However 48 permanent brackish and freshwater lakes, lagoons, pools and springs representing a total of 1257 hectares have been identified from broad-scale mapping of inland wetlands (AECOM 2011 refer Appendix A). These areas would provide dry season refuge for aquatic fauna species occurring on the Cobourg Peninsula. Fauna species would include a diversity of freshwater and estuarine fish, a large number of waterbirds, and a number of traditional food species (for example, file snakes, freshwater turtles).

Perennial creeks and streams (type N) represent the most common surface water type within the Ramsar site (estimated total cover of 7,776 hectares). Most creeks are less than ten kilometres long with the exception of Mawuwu Creek (entering Port Bremer), Alaru Creek (entering Trepang Bay) and an unnamed creek (entering Raffles Bay) which range up to fourteen kilometres to the headwaters. These streams generally flow for short periods during the wet season, and more commonly consist of isolated temporary and semi-permanent pools connect by dry creek bed. The degree of subterranean connectivity is unknown.

There are several freshwater springs across the peninsula, particularly in the western half. These springs are generally located in the upper reaches of perennial creeks. Semi-permanent or permanent waterholes existing on Alaru Creek and adjacent minor tributaries are likely to also be sustained by groundwaters from a fresh (that is, less than 50 milligrams per litre of total dissolved solids) sandstone aquifer (Zaar 2003, refer to Section 3.7.3.3). Freshwater springs or shallow groundwater lenses may also contribute to maintaining permanent coastal freshwater lagoons (type K) and permanent freshwater marshes (type Ts), predominately identified within the central north and north-west of the site with an estimated 364 hectares of cover. The largest of these systems is Mariah Swamp adjoining Raffles Bay.

Seasonal freshwater lakes and floodplains (type P, with an estimated overall area 359 hectares), seasonal freshwater marshes and pools (type Ts with an estimated area of 110 hectares) and freshwater tree-dominated wetlands (type Xf with an area of 770 hectares) are

dependent on freshwater inputs from high seasonal rainfall. During the dry season, as fresh water inflow reduces, these systems will reduce in size and most likely increase in salinity. Given the proximity to the coastline, both permanent and seasonal freshwater bodies are susceptible to saline intrusion through storm surges induced by cyclonic winds.

Coastal brackish / saline lagoons (type J) are common along the northern coastline with an overall estimated cover of 1314 hectares within the site. AECOM (2011) suggest that these systems are attributed with at least one connection to the ocean to allow some degree of tidal flushing. Electrical conductivity within and amongst these systems is highly variable; some have been recorded as consistently hypersaline, others increase in salinity during the dry season. The variation in salinity occurring within these wetlands would be dependent on the amount of seasonal freshwater input, frequency of saltwater intrusion (tidal and saline aquifers), and evaporation rates.

Permanent and seasonal saline / brackish lakes, marshes and pools are also present, though relatively uncommon (a total of 816 hectares cover). Permanent saline lakes (type Q) are situated behind intertidal forests of Trepang Bay and Raffles Bay and behind a dunal system on Smith Point. Consistent with coastal brackish / saline lagoons, these wetland systems would show seasonal ranges in salinity.

There are no empirical data describing natural variability of inland wetlands over time. Parameters contributing to the dynamic nature of palustrine wetlands may include rainfall, fire and waterbird foraging. The degree of wetland seasonal flooding has important implications for flushing and the amount of isolated aquatic habitat during the dry season, where the extent of seasonal wetlands to dry out during the dry season determines the survival of both terrestrial and aquatic species that depend on them.

Seasonal variation in moisture context has been described by AECOM (2011) for each Ramsar inland wetland type. For inland habitats, seasonal wetlands display the greatest variation in moisture content. Smaller freshwater pools retain moisture longer than freshwater lakes due to reduced evaporation rates. Freshwater, tree-dominated wetlands (that is, *Melaleuca* forest) do not undergo large fluctuations in moisture content (AECOM 2011).

3.7.3.2 Tidal Hydraulics

Description and Patterns in Variability

Tides occur twice a day at Cobourg Peninsula. The northern coastline experiences meso-tides, with a range of two to three metres. The southern coastline, which falls within Van Diemen Gulf, experiences macro-tides with a range of four to six metres. The majority of water courses are tidal for much of their length.

The two kilometre channel known as Popham Creek[7], which separates Cape Don from the mainland, has a complex tidal regime due to the following (from Billyard 1995):

[7] The unusually close association of coral and mangrove species within this channel are discussed in Section 2.4.1 and underpin critical component 1.

- the system being open to the Arafura Sea via Popham Bay at its northern entrance, and to the Van Diemen Gulf at the southern opening
- the variation in tidal heights and times experienced at the northern and southern entrances
- the complexity of the dendritic channel network and intervening mangrove forest.

Tidal water movement in Popham Creek is dominated by the northern entrance. Tides at the northern entrance are generally 0.2 to 0.3 metres greater in maximum height (due to the funnelling of Popham Bay) and precede the southern entrance by approximates 1.5 hours, producing a north-south flow. On flood tides, inflows occur from both entrances (though again the southern entrance lags) creating a null point in the central portion of the system. As tides recede in the north, the system flows from south to north. Once the tidal level drops at the southern end, the tide ebbs from the centre of the system, draining to both entrances (Billyard 1995).

3.7.3.3 Groundwater

Description and Patterns in Variability

Saline to brackish water is believed to exist beneath the entire peninsula at a depth of about 10 metres and below (Britten and Chin 1989 in Geoscience Australia 2008). However, numerous shallow bore holes encounter fresh groundwater. Production bores servicing the Smith Point area drawdown from fresh groundwater lenses located within coastal dune systems and laterised sediments (Britten and Chin 1989 in Geoscience Australia 2008). Identified aquifers include superficial Quaternary sandstones, Cretaceous laterites, and a number of units within the Cretaceous Bathurst Island Formation (Marlingur Member, Darwin Member, Wangarlu Mudstone Member, and Moonkinu Member). Most of the Quaternary aquifers are unconfined, from which groundwater supplies diminish during the dry season (Hughes 1977). An aquifer identified by Zaar (2003) in the western half of the peninsula is of high quality, freshwater and probably contributes to the freshwater wetlands inland of Trepang Bay.

The Marligur Member, identified as a very high yielding aquifer (Prowse et al. 1999), extends across much of the southern part of the Cobourg Peninsula (Hughes 1978; Senior and Smart 1976). Two bore holes tapping this aquifer (southeast of the Ramsar site) have measured flows of 12 and 22 litres per second; pH of 7.0, salinity between 26 and 30 milligrams per litre, and total dissolved solids of 40.2 to 40.5 milligrams per litre (Hughes 1973). A total of 67 bore holes are recorded in the Cobourg Peninsula Ramsar site, 16 of which are production wells (Geoscience Australia 2008). The majority of these bores service the Black Point – Smith Point area and the resort in Coral Bay (Figure 3-11) and are associated with a shallow watertable within perched Quaternary aquifers, presumably recharged during the wet season.

Preliminary evidence suggests that many of the wetlands are strongly groundwater influenced/dependant (Geoscience Australia 2008). Mangrove and salt flats develop a tolerance to saline or brackish water and are likely to be drawing water primarily from estuarine/tidal sources; however, there may also be a groundwater component. Water available for the coastal dune communities is more likely to be stored in shallow perched,

unconfined Quaternary aquifers. Open forest communities are likely to be tapping deeper groundwater predominantly during the dry season, while stream and swamp communities are associated with relatively shallow groundwater and potentially discharge conditions.

Figure 3-12 Classification of groundwater influences on wetland hydrology. Red corresponds to high levels of influence, orange is moderate and yellow is low (source: Geoscience Australia 2008)

Groundwater influence on the (terrestrial) wetlands and other vegetation communities of Cobourg Peninsula was assessed by Geoscience Australia (2008) using remotely sensed data (Figure 3-12). Areas that recorded persistently high soil moisture during the dry season are assumed to have a high reliance on groundwater, given the lack of surface water on the peninsula outside the wet season. This typically includes coastal dune and some swamp communities. A moderate level of influence is assigned to stream and open forest communities that demonstrated relatively high soil moisture, and in the case of the Eucalypts, assumed phreatophytic vegetation. Finally, low levels of influence are typically assigned to the mangrove communities that rely much more heavily on tidal activities (Geoscience Australia 2008).

3.7.4 Water Quality

Only limited water quality data are available for the Cobourg Ramsar site, with most of the data being collected by AECOM (2011) on two occasions during the early and late dry season

within 2010. This data predominately focuses on centrally located wetlands systems within and adjoining Port Essington and, to a lesser extent, Port Bremer. There has been little to no water quality data collected in: the Ilmaryi estuarine system in the South, inland and coastal wetlands adjoining Raffles bay in the North-east, and Trepang Bay in the North-west. This is considered to be an important information gap.

Table 3-8 and Table 3-9 compare the range and median values of *in-situ* and nutrient concentrations derived for wetland types occurring on the Cobourg Peninsula (from AECOM 2011 raw data). The following description is based on the results of AECOM (2011).

Inland Waters

Of the inland wetland types identified on the Cobourg Peninsula, no data exists for seasonal freshwater lakes (type P), seasonal freshwater marshes (type Ts), permanent freshwater marshes (type Tp), and permanent saline / brackish lakes (type Sp).

Recorded electrical conductivity concentrations of inland wetlands show considerable range with respect to wetland type and seasonal changes within wetland types. Consistent readings of freshwater (that is, less than 0.8 millisiemens per centimetre) were recorded exclusively within freshwater springs (0.0125 to 0.0626 millisiemens per centimetre) and seasonal creeks (0.047 to 0.169 millisiemens per centimetre) during the mid and late dry season, with no variation in concentrations between periods. These systems were also slightly acidic, opposed to other wetland types that recorded slight to moderate alkalinity.

A coastal freshwater lagoon (Mariah Swamp) displayed a decrease in electrical conductivity over the dry season, ranging from brackish in July (2.6 to 2.7 millisiemens per centimetre) to fresh in October (0.159 to 0.167 millisiemens per centimetre). This result is inconsistent with the hypothesis that electrical conductivity increases during the course of the dry season due to evaporation, suggesting significant freshwater input.

In terms of nutrients, bioavailable forms of nitrogen (ammonia and nitrogen oxides) were a minor constituent of total nitrogen concentration. Wide ranges of total nitrogen concentrations were recorded, with a considerable increase between mid dry season and late dry season for all inland wetland types and coastal brackish and freshwater lagoons. Turbidity ranged considerably between inland wetlands, though was generally higher in the late dry season. Elevated turbidity can be indicative of increased suspended sediments, through direct disturbance of bed material, and/or high concentrations of suspended algae.

Marine / Coastal Waters

Inshore waters of the northern coastline have been used for pearl oyster farming since before 1979 (NRETAS 2007). The nature of the pearling industry requires marine waters of high quality, with minimal (or no) pollution (McGladdery 2007).

The water quality in the vicinity of Popham Creek was documented in Billyard (1995). This system is particularly vulnerable to changes in water quality, as the corals are already substantially light-limited due to the overhanging mangrove canopy. Water quality was reportedly uniformly high, largely due to the dominance of clearer northern water when tidally

inundated, diurnal tidal flushing leading to low residency times for water, and the regular flushing of leaf litter from the system (Billyard 1995). The following general observations were made in Billyard (1995) based upon the recordings summarised in Table 3-7:

- nutrient concentrations were consistent within the system and considered typical of coastal waters with limited onshore development
- turbidity was lower than that recorded in tidal estuaries, due to greater tidal flushing and the lower proportion of silty sediments found within the channel
- salinity was consistent within the system, though it was noted this was a single assessment undertaken during the dry season and freshwater input during the wet season may produce different results.

Table 3-7 Water quality of Popham Creek (source: Billyard 1995)

Parameter		Northern mouth	Central section	Southern mouth
Nutrients (milligrams per litre)	PO_4	less than 0.04	less than 0.04	less than 0.04
	NH_3	0.17	0.17	0.08
	NO_2	less than 0.03	less than 0.03	less than 0.03
	NO_3	0.08	0.11	0.08
	SO_4	2515	2610	2515
	TOC	2	2.2	1.5
Water temperature (^dC)		26.86 - 28.76	26.42 - 28.33	26.24 - 28.02
Salinity (ppt)		36.27 - 36.86	36.65 - 36.91	36.39 - 36.56
Dissolved oxygen (percent)		60.07 - 57.72	39.95 - 49.31	56.92 - 43.72
Turbidity (NTU)		2.14 - 2.74	2.72 - 3.44	3.11 - 4.06

Water quality results obtained by AECOM (2011) for marine / coastal wetland types (excluding coastal lagoons discussed previously) suggest the following:

- concentrations in ammonia and nitrogen oxides were generally consistent with Billyard (1995)
- median total nitrogen concentrations were relatively consistent amongst marine habitat types ranging from 400 to 700 micrograms per litre. The range of data obtained was generally consistent for coral reef, rocky and sandy shorelines with concentrations up to 1500 micrograms per litre. Data recorded at intertidal mudflats and intertidal forest wetlands ranged up to 2200 micrograms per litre and 2600 micrograms per litre respectively. Within estuaries total nitrogen concentrations were recorded up to 4800 micrograms per litre. Higher concentration across all wetland types were generally recorded in the late dry season
- median turbidity values were consistently low across wetland types ranging from 1.8 to 9.4 nephelometric turbidity units. Within estuarine waters and intertidal forested wetlands, turbidity ranged up to 93.2 nephelometric turbidity units and 38.7 nephelometric turbidity units respectively, and is considered generally typical of these wetland types.

Table 3-8 *In-situ* physiochemical water quality parameters (adapted from AECOM 2011 raw data)

Wetland Type	Code	*N*	Conductivity (ms/cm)	pH	Turbidity (NTU)	Dissolved Oxygen (ppm)	Temperature (ºC)
Coastal / Marine Wetland types							
Coral reefs	C	17	49.0 (34.4-55.6)	8.1 (7.5-9.2)	3.9 (0-10.5)	8.7 (7.0-10.3)	27.5 (26.4-35.6)
Rocky marine shores	D	16	52.0 (32.8-55.2)	7.9 (7.0-8.1)	1.8 (0-5.8)	7.9 (7.1-9.1)	27.9 (26.1-31.4)
Sand, shingle or pebble shores	E	17	50.8 (48.2-57.0)	7.9 (7.1-8.1)	2.0 (0.1-4.3)	8.4 (8.0-9.6)	26.7 (26.2-31.0)
Estuarine waters	F	17	56.8 (37.4-60.4)	7.4 (5.8-8.2)	6.7 (0.7-93.2)	5.4 (3.9-7.0)	30.5 (26.6-33.3)
Intertidal mud, sand or salt flats	G	10	50.7 (36.9-53.3)	7.9 (7.8-8.0)	5.4 (2.2-9.0)	6.7 (6.3-6.9)	26.5 (25.9-30.9)
Intertidal forested wetlands	I	25	50.9 (32.6-55.1)	8.2 (7.8-8.9)	9.4 (0-38.7)	6.8 (3.1-9.0)	29.4 (26.6-32.1)
Coastal brackish/saline lagoons	J	19	65.5 (19.4-77.0)	9.3 (7.4-9.5)	7.6 (0-15.1)	8.2 (5.9-8.8)	30.2 (27.7-41.6)
Coastal freshwater lagoon	K	6	0.036 (0.016-2.694)	7.5 (7.0-8.0)	11.3 (1.5-80)	-	33.7 (24.9-44.5)
Inland Wetland types							
Seasonal river / stream / creek	N	6	0.073 (0.047-0.169)	6.0 (5.7-6.5)	10.5 (0.1-297)	-	25.8 (25.6-27.1)
Permanent saline/brackish lake	Q	6	29.3 (21.6-44.8)	8.5 (7.8-9.0)	3.8 (0-341)	-	34.0 (30.6-38.8)
Seasonal saline/brackish lake	R	7	8.1 (7.7-27.3)	7.8 (7.2-9.9)	3.1 (0-622)	-	24.0 (17.6-32.0)
Seasonal saline pool	Ss	3	11.2 (11.0-11.7)	9.8 (9.8-9.8)	8.2 (1-99)	6.4 (5.3-7.1)	40.5 (38.4-41.1)
Permanent freshwater pool	Tp	-	-	-	-	-	-
Freshwater tree-dominated wetland	Xf	3	2.328 (2.297-2.381)	7.5 (7.3-7.8)	569 (386-2664)	-	30.3 (28.6-30.8)
Freshwater springs	Y	15	0.026 (0.0125-0.0626)	5.4 (4.4-6.2)	7.3 (1.5-1700)	4.7 (0.4-60.2)	28.7 (25.1-35.1)

Table 3-9 Nutrient concentration (adapted from AECOM 2011 raw data)

Wetland type	Code	*N*	Ammonia (micrograms per litre)	Nitrogen Oxides (micrograms per litre)	Total Nitrogen (micrograms per litre)
Coastal / Marine Wetland types					
Coral reefs	C	9	50 (10-160)	40 (<10-70)	600 (<500-1200)
Rocky marine shores	D	9	50 (30-120)	45 (<10-100)	400 (100-1200)
Sand, shingle or pebble shores	E	9	80 (20-120)	40 (<10-60)	450 (200-1500)
Estuarine waters	F	12	70 (<10-1560)	50 (<10-100)	600 (200-4800)
Intertidal mud, sand or salt flats	G	9	70 (<10-950)	30 (10-80)	600 (200-2200)
Intertidal forested wetlands	I	14	40 (<10-120)	40 (<10-80)	700 (200-2600)
Coastal brackish/saline lagoons	J	11	430 (260-1230)	30 (20-80)	1200 (600-1800)
Coastal freshwater lagoon	K	6	70 (<10-140)	55 (40-80)	1000 (400-1800)
Inland Wetland types					
Seasonal river / stream / creek	N	4	60 (<10-230)	20 (<10-70)	500 (200-1400)
Permanent saline/brackish lake	Q	6	190 (30-1800)	30 (20-50)	1750 (800-3400)
Seasonal saline/brackish lake	R	6	180 (<10-1680)	30 (<10-40)	3500 (1300-21800)
Seasonal saline pool	Ss	3	20 (<10-20)	20 (<10-20)	4000 (3900-4200)
Permanent freshwater pool	Tp	3	40 (30-60)	45 (<10-50)	2600 (600-7400)
Freshwater tree-dominated wetland	Xf	3	700 (520-1480)	30 (<10-30)	2900 (1600-2900)
Freshwater springs	Y	15	70 (<10-520)	50 (<10-90)	300 (100-1400)

3.7.5 Fire Regime

Fire is one of the major forces that influences dynamics of the landscape, particularly with regard to regeneration processes of vegetation. As such, fire can have significant impacts on the landscape and is important for maintaining species and habitat diversity (Russell-Smith 1995a).

Description and Patterns in Variability

Fire has been a part of the northern Australian landscape for more than 50 000 years, since before the arrival of people in Australia (see Section 3.8.1). The use of fire by Arrarrkbi was associated with hunting and gathering, to protect certain productive species and to make walking through country easier. Fire regimes have been modified since the arrival of Europeans, and occurrences of intense late dry season fires are thought to have increased (Andersen et al. 1998; Vigilante and Bowman 2004). Fires experienced at inappropriate (too high or too low) frequencies, intensities or seasonality may lead to substantial changes in vegetation community composition and/or structure.

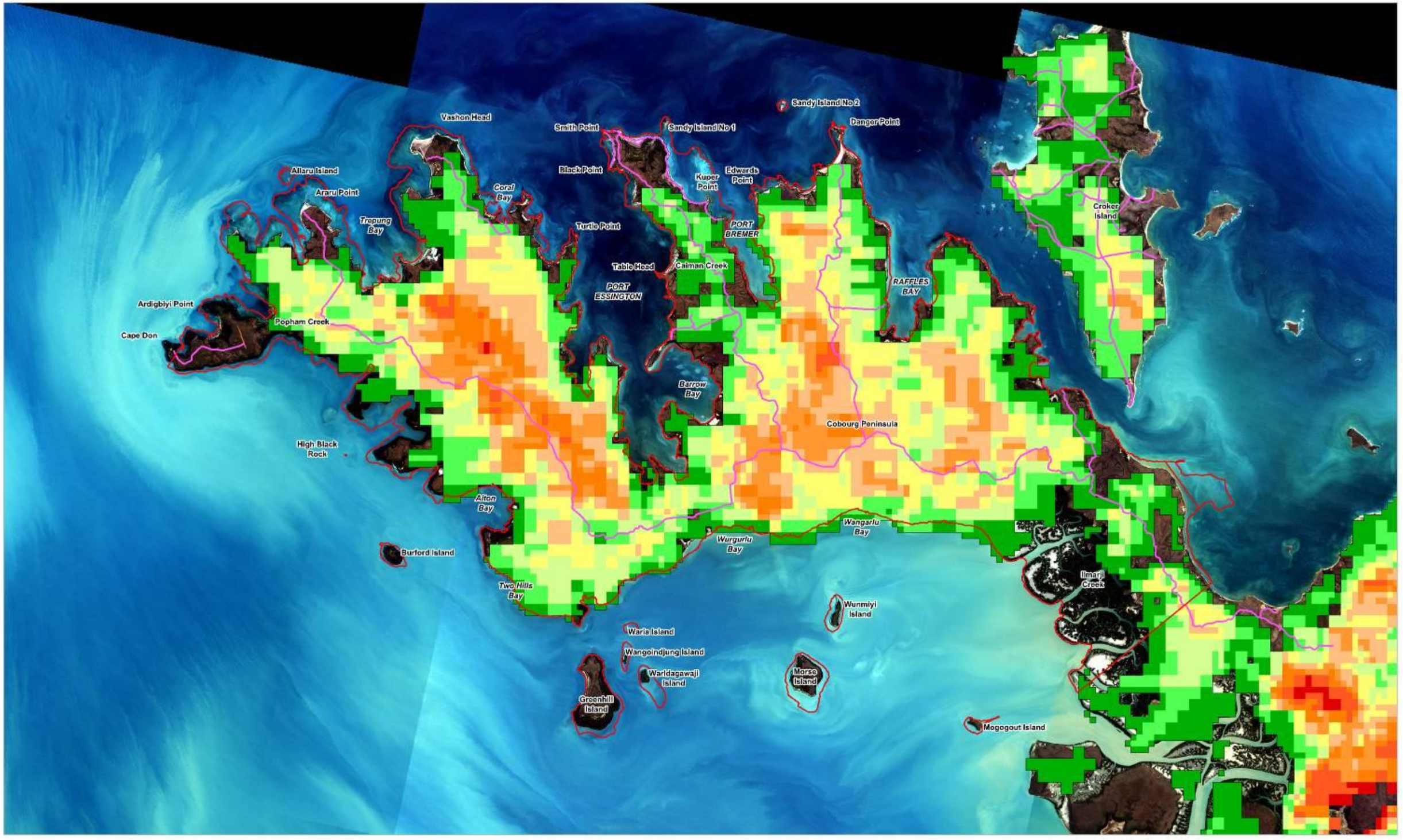
Fire histories for the region are an important resource for determining the success of prescribed burning practices. The Cobourg Peninsula is part of the Northern Coastal Humid rainclass (Russell-Smith 2007) which experiences the highest level of lightning strikes of all rainclass areas in Australia. This results in a high prevalence of natural fires (Woinarski and Baker 2002; Baker et al. 2005; Russel-Smith 2007). Spatial and temporal patterns of fires have been assessed for the period 1997 to 2008 (Figure 3-13) with the following general observations:

- The most frequently burnt areas of the peninsula are the tropical woodlands in close proximity to the road network, reflecting a shift from traditional burnings where people moved by foot or canoe (refer Figure 3-13)
- Many of the coastal wetland areas have not been burnt in the past 14 years[8] (NAFI 2010)
- Many *Melaleuca* forests and monsoon rainforest patches have experienced relatively frequent fires, which may have had negative impacts (Russel-Smith and Bowman 1992)
- The incidence of late-season burns, when fires are started later in the dry season sometimes resulting in fires of too high intensity, is relatively low but similarly more common along the road network (NAFI 2010).

There is little quantitative information on fire practices between 1974 (time of Ramsar listing) and 1997. Active aerial burning was practised by Parks and Wildlife staff across Cobourg Peninsula and nearby Murganella during this period. Burns were conducted during the early dry season, however there are no data on the coverage of these fires (P. Fitzgerald pers. comm. 2010).

Throughout the 1970s, there were practically no traditional owner residents on Cobourg Peninsula, and the park was staffed by a single ranger. Between 1963 and at least 1982, burning of the coastal grasslands was actively discouraged, a phenomenon that appeared to encourage growth of monsoon rainforest clumps (Bowman et al. 1990).

[8] Data earlier than 14 years ago is not available.



LEGEND

Fire frequency 1997-2008
Number of times burnt

1 2 3 4 5 6 7 8 9

Cobourg Peninsula Ramsar Site

Roads

Title:
Cobourg Peninsula Fire History 1997-2008 (source: NAFI 2010)

Figure: 3-13

Rev: A

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

The existence of fire in the area, however erratic, still effects major changes in the viability and biodiversity due to the long history of traditional owner mosaic burning. This includes impacts on the succession of plant species (Bowman et al. 1990; Bowman and Panton 1995), the extent of grasslands (Bowman et al. 2007), and the habitat suitability for native and feral animals (Woinarski and Baker 2002). The lack of a strict fire regime until recently has caused an increase in grassland and a decrease in shrubs, decreasing native fauna habitat suitability while increasing feeding opportunities for feral animals (Woinarski and Baker 2002).

Parts of Cobourg Peninsula have been subject to renewed attempts to return to an intricate fire regime to minimise late dry season fires (Williams et al. 2002; Woinarski and Baker 2002). This has been established through the development a Fire Working Group involving traditional owners, Park rangers and community rangers (see Section 3.8.1).

3.7.6 Other Notable Biological Processes

Biological processes describe any process occurring within, or by, an organism. As such, these processes can operate at the genetic, cellular, individual, population, community or ecosystem levels. There is a vast range of biological processes that, together with physical (abiotic) processes described above, contribute to the maintenance of wetland ecosystem functioning. The following is a brief overview of some of the key biological processes operating at a whole-of-site scale for the Cobourg Peninsula Ramsar site.

3.7.6.1 Nutrient Cycling

Information on nutrient cycling processes specific to Cobourg Peninsula is not available. In one study addressing nutrient cycling in the broader region, Cook (1994) investigated the effect of fires on nutrient fluxes in the tropical savannah at Kapalga, Kakadu National Park, an area analogous to the tropical woodlands of Cobourg Peninsula. The magnitude of nutrient fluxes due to fires was greatest in forest communities, where grassy fuel loads were high. Up to 94 percent of measured nutrients were transferred to the atmosphere during the fires. While nutrients transferred to the atmosphere as entrained ash settled within several kilometres of the fires, nutrients transferred in gaseous forms, such as nitrogen, are lost from the system. Furthermore, nitrogen fixation was found to be of insufficient magnitude to replace the lost nitrogen, indicating that annual burning may deplete nitrogen reserves in savannas.

As vegetative and animal matter begins to senesce and die, microbes invade the tissues and transform the organic material into more bio-available forms of carbon and other nutrients. While microalgae, mangroves and seagrasses are mainly responsible for primary productivity within estuarine and marine waters of the site, microbial breakdown is a key pathway for plant material entering the food-web in these ecosystems (Alongi 1990). This is especially true for marine, estuarine and freshwater macrophytes (seagrass, mangroves, saltmarshes, freshwater marshes), which with few notable exceptions (e.g. some invertebrates, fish and birds), are generally not directly grazed, but instead enter food-webs following microbial conversion of organic matter (Day et al. 1989). Carbon flows in freshwater wetlands are not well known and require further investigation, although freshwater marshes and peat swamps are recognised as important sinks for carbon as they actively accumulate organic matter.

3.7.6.2 Aquatic Foodwebs

Similar to other areas throughout Australia's wet-dry tropics, aquatic food webs on Cobourg Peninsula are closely linked with seasonal hydrology. Douglas et al. (2005) provided a review and conceptual model of river and wetland food webs in Australia's wet-dry tropics. Based on this review, the aquatic food webs and associated ecosystem processes in Cobourg Peninsula Ramsar site are assumed to be underpinned by five general principles, as outlined below. Refer to Douglas et al. (2005) for further information.

1. Seasonal hydrology is a strong driver of ecosystem processes and food web structure.
2. Hydrological connectivity is largely intact and supports important terrestrial-aquatic food web subsidies.
3. River and wetland food webs are strongly dependent on algal production. Relative to other aquatic plants and terrestrial inputs, benthic (and epiphytic) algae are typically the major source of organic carbon supporting consumers and sustaining the food webs.
4. A few common macro-consumer species have a strong influence on benthic food webs.
5. Omnivory is widespread and food chains are short.

Trophic levels (ten levels: aquatic insectivore, herbivore, carnivore; ground foraging herbivore, insectivore, carnivore; flying insectivore, frugivore, herbivore, carnivore, nectivore) for vertebrate fauna have been identified for one marine/coastal wetland type (K), and six inland wetland types (N, Q, R, Ts, Xf, Y: AECOM 2011). Each wetland type supported quite different combinations of trophic levels, illustrating the variety of foodwebs that can occur at the site. For example, seventeen vertebrate species were identified at a seasonal creek wetland. This wetland supported the greatest number of ground foraging insectivores (mostly amphibians and lizards), though few waterbirds due to the small size of the waterbody. The majority of species were birds foraging in the trees associated with the wetland type (AECOM 2011).

3.8 Critical Services/Benefits

The present study identifies two critical services/benefits for the Cobourg Peninsula Ramsar site (Table 3-1). In the context of the nomenclature outlined by the Millennium Ecosystem Assessment (2003), critical services/benefits for the site are classified as follows:

- S1 – Contemporary Living Culture, which can be considered to represent a cultural service.
- S2 – Maintenance of Global Biodiversity, which is considered to represent a supporting service.

3.8.1 Contemporary Living Culture

Reasons for Selection as 'Critical'

Contemporary living culture was selected as a critical service as it is an important determinant of the site's unique character. In particular, it is noteworthy that the Cobourg Peninsula Ramsar site meets all four of the Ramsar cultural characteristics as outlined by Resolutions VIII.19 and IX.21(cultural characteristics 'a', 'c' and 'd' described below; refer Section 3.9.4 for cultural characteristic 'b').

Description

The indigenous culture of Australia is considered to be the world's oldest living culture (DEWHA 2008). Arrarrkbi (traditional indigenous owners of Cobourg Peninsula) have lived on and used the Cobourg Peninsula for between 40 000 and 60 000 years (CPSB 1987; Brockwell et al. 1995). In many Dreamtime stories across the Top End of the Northern Territory, it is considered that the Creation Ancestors first entered Australia via Malay Bay near the Cobourg Peninsula before travelling across the rest of the country creating people and places. This may reflect knowledge of the origin of the first humans to enter Australia (Chaloupka 1993).

At present, some Arrarrkbi live on the Cobourg Peninsula and continue many of the cultural practices which have been handed down over many generations. Traditional ownership of Cobourg Peninsula is shared between five Arrarrkbi clans: the Algalda, Ngaynjaharr, Muran, Madjunbalmi clan and the Minaga clan (Northern Land Council 2003). Figure 3-14 demonstrates a general interpretation of clan estates. The core traditional owner group consists of approximately 50-60 people (Ian White *pers. comm*. 4th May 2010), with many more people having connections and cultural obligations associated with Cobourg Peninsula. The right of Arrarrkbi to occupy and use the land is secured through the *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act 1996* (NT) (see Section 1.3). This land is vested in perpetuity in the Cobourg Peninsula Sanctuary Land Trust in trust for the traditional owners. Approximately 24 Arrarrkbi live on Cobourg Peninsula, whilst the remaining Arrarrkbi live on Croker Island, Darwin, Jabiru and further afield. Those who do not live on Cobourg Peninsula are still able to visit 'their country' and undertake cultural practices.

Cobourg Peninsula's contemporary 'living culture' is described under three of the Ramsar cultural characteristics below.

Cultural characteristic 'c': Sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples

The ability of Arrarrkbi to live on, and use, the land, sea and resources of Cobourg Peninsula Ramsar site allows them to maintain their culture. Likewise, the Arrarrkbi presence and continuation of customary beliefs and practices sustained over thousands of years assists to maintain the ecological character of the wetlands. Cobourg Peninsula has been described as a "humanised landscape" containing a pattern of ecosystems that has been created by thousands of years of "calculated management" (CPSB 1987). The present environment of Cobourg Peninsula has been so influenced by humans that the continuation of these beliefs and practices is necessary in order to maintain the existing ecosystems. These beliefs and practices include cultural responsibilities, traditional ecological knowledge, language, joint management, land, sea and fire management.

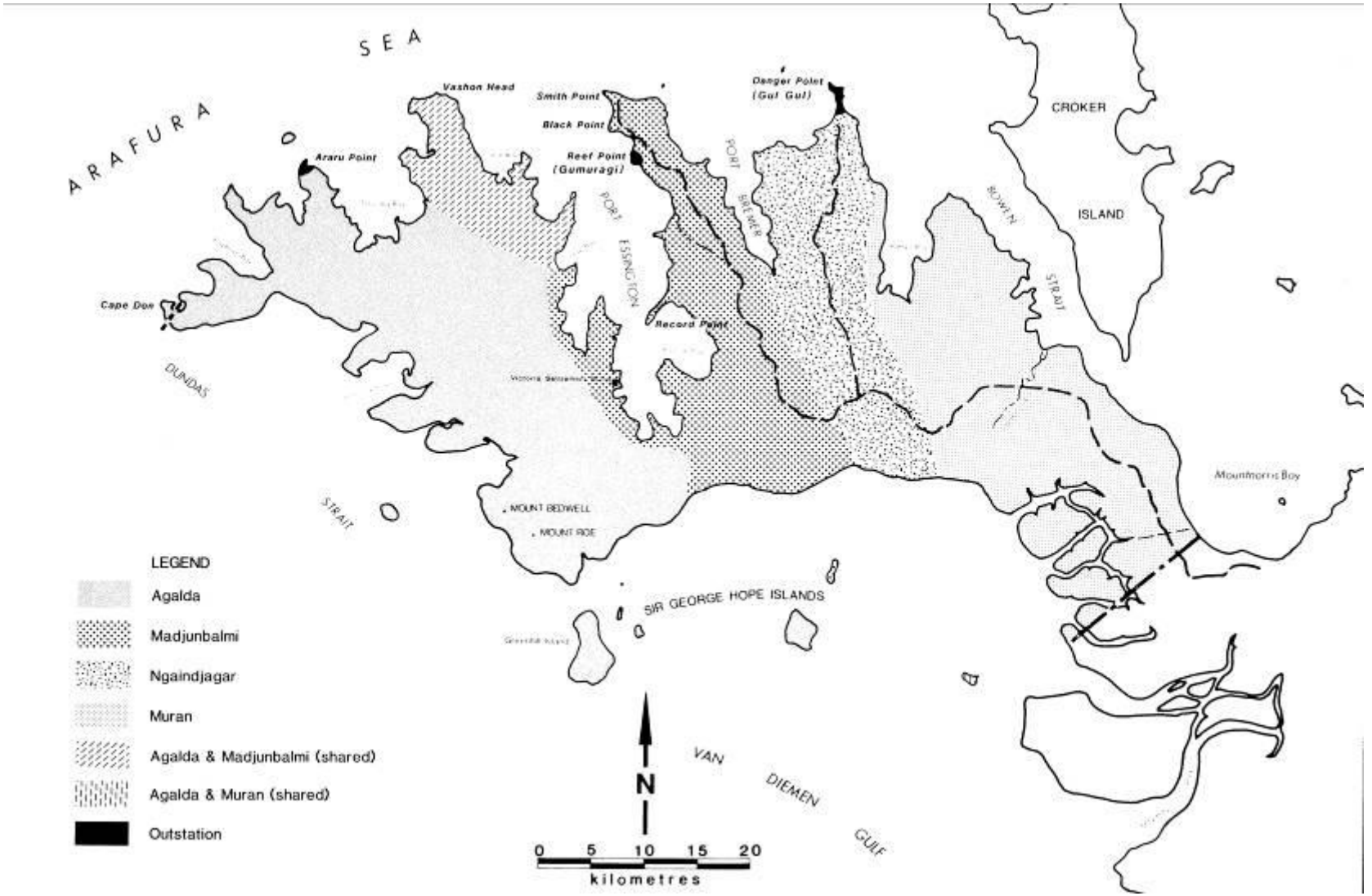


Figure 3-14 Arrarrkbi traditional land owner clan estates (© Copyright, Cobourg Peninsula Sanctuary Board 1987)

Cultural responsibility

As traditional owners of Cobourg Peninsula, Arrarrkbi have responsibilities to 'look after country' to ensure that the flora, fauna, and terrestrial and marine landscapes are conserved. This responsibility is executed through land and resource management as well as spiritual practices.

Traditional Ecological Knowledge

Arrarrkbi hold a substantial body of traditional ecological knowledge which is defined as a "cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 1993 in Berkes et al. 1995). Traditional ecological knowledge includes knowledge on fire management, knowledge of flora, fauna and ecosystems, ecological processes, landscape change, weather and seasons. As coastal people, Arrarrkbi also have intimate knowledge of currents, sandbanks, local conditions, safe boating routes, breeding localities, water depths, good hunting localities and where to find fresh water (Peterson and Tonkinson 1979). Through this intimate knowledge of the environment, Arrarrkbi are able to closely monitor the health of the ecosystems and landscapes found within the Ramsar site.

Language

"Language is the key to the continuation of cultural information and maintaining the lores and traditions that enable the people and the land to flourish" (PWCNT 2010). The main indigenous language spoken on Cobourg Peninsula is Iwaidja; a number of other languages (such as Wurrugu and Garig) which were once spoken on the Peninsula have now died out (traditional owner consultations, September 2010). The Iwaidja language names and traditional uses (including food, medicine, timber, fibre, dye and many others) for 269 plants have been recorded (Blake et al. 1998). Over 400 Arrarrkbi place names were recorded on the Cobourg Peninsula prior to 1979 (Figure 3-15). A cultural mapping project undertaken in 2009 recorded Iwaidja names for more than 400 places on Cobourg Peninsula, and in some cases the stories associated with those places (R. Ledgar pers. comm. 2009). A comprehensive knowledge of the interaction between plants, animals, the environment and the seasons is carried in stories held by senior knowledge holders (PWCNT 2010). Songs sung in Iwaidja, such as the frigate bird, fish fry and beach hibiscus song sets (Barwick et al. 2007), connect people to these animals and hold knowledge of their ecology. The Iwaidja language is maintained through its everyday use by Arrarrkbi, through documentation, oral history and song, and by using the Iwaidja names for places in the park. The maintenance of language is recognised as an important component of protecting the cultural heritage and reservoir of traditional ecological knowledge for Cobourg Peninsula. The extent to which the Iwaidja language is used by Arrarrkbi within the park can be used as an indicator for the condition of 'living culture' (West 1998).

Figure 3-15 Aboriginal place names, Smith Point Peninsula (© Copyright, Cobourg Peninsula Sanctuary Board 1987)

Joint Management

Cobourg Peninsula is Arrarrkbi-owned land which is managed as a national park (the Garig Gunak Barlu National Park) under a joint management arrangement between Arrarrkbi and the Parks and Wildlife Commission of the Northern Territory (PWCNT). This allows Arrarrkbi to live on and use the land whilst being a decision-making partner in the management of the national park through the Board of Management. There are three outstations and one ranger station located within Garig Gunak Barlu National Park, some of which are occupied by Arrarrkbi. There is also some opportunity for employment of Arrarrkbi by PWCNT through permanent, contract and flexible work arrangements. Through the application of land, marine, fire, visitor, weeds, feral animal and cultural management, the joint management partners maintain the ecological character of the Ramsar site.

Land and Sea Management

Arrarrkbi engage in land and sea management through employment as rangers through PWCNT or the Warramunburr ranger group, or through independent traditional land and sea management practices. Approximately 25 percent of the staff employed through Garig Gunak Barlu National Park are Arrarrkbi people (R. Ledgar pers. comm. 2009). The Warramunburr ranger group, established in 2010, employs five full time Arrarrkbi to undertake land and sea management activities in Garig Gunak Barlu National Park. Both groups undertake fire, weed and feral animal management and coastal surveillance whilst the Warramunburr ranger group also undertakes ghost net management and monitoring of fauna, weeds, ghost nets, fire and illegal fishing vessels (A. Kerr pers. comm. 2010; A. Wood pers. comm. 2010). Arrarrkbi who live in outstations on Garig Gunak Barlu National Park, as well as those who visit the park on occasion, also undertake land and sea management practices such as burning, monitoring the populations of species and monitoring the environmental impacts of activities such as tourism on the land. These activities are fundamental in maintaining the ecological character of the Ramsar site.

Fire management

Fire has been a part of the northern Australian landscape for more than 50 000 years, since before the arrival of people in Australia (Brockwell et al. 1995; Russell-Smith 1995). Prior to non-indigenous colonisation, fires were lit as Arrarrkbi travelled across the land on foot or as they went ashore whilst travelling by canoe along the coast. Fire was an important tool for managing and expressing ownership of country, and it was used to manage food resources, as a hunting strategy, for clearing grasses and undergrowth to make travel easier, for communication, for defence and for specific spiritual and cultural obligations. Section 3.7.5 provides information on the importance of fire management within the Cobourg Peninsula Ramsar site.

Cultural characteristic 'a': Sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland

All of the components listed under cultural characteristic 'c' above demonstrate the application of traditional knowledge and contribute to the wise management of the Ramsar site. In addition to these, the sustainable use of resources and regulated use of the site for tourism and other business enterprises provides a model of wise use of the Ramsar site.

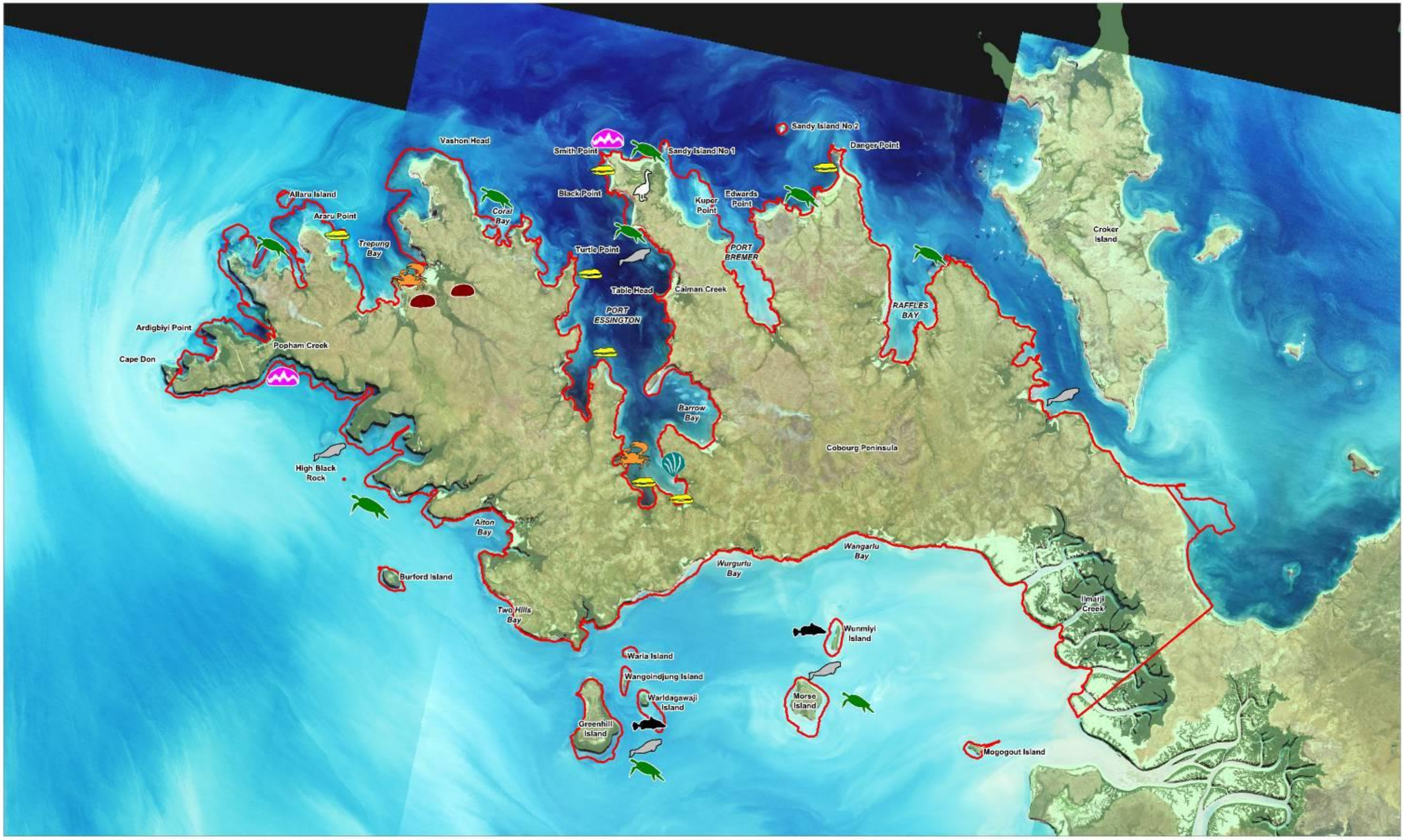
Sustainable Use

Cobourg Peninsula Ramsar site provides a rich variety of flora and fauna which have been traditionally used for food, medicine, timber, fibre, dye, tools and many other uses (Blake et al. 1998). Blake et al. (1998) list 269 plant species with traditional use within Garig Gunak Barlu National Park, and many important species of flora and fauna were identified by Arrarrkbi during consultation (Table 3-10). Figure 3-16 shows some of the major locations where bush tucker is harvested, including crabs, turtles, dugongs, barramundi, oysters and cockleshells.

Table 3-10 Important plants and animals for traditional use by Arrarrkbi (identified through consultation during September 2010)

Common name	Scientific name	Use
dugong	*Dugong dugon*	Food
green turtle	*Chelonia mydas*	Food
salt water crocodile	*Crocodylus porosus*	Food
duck (various species)	Various species	Food
oyster	*Saccostrea spp.*	Food
banteng	*Bos javanicus*	Food
stingray	*Dasyatus spp.*	Food
magpie goose	*Anseranas semipalmata*	Food
long necked turtle	*Chelodina rugosa*	Food
mud crab	*Scylla serrata*	Food
cabbage palm	*Livistona humilis, Gronophyllum ramsayi*	Food, basket material
long yam	*Dioscorea bulbifera*	Food
cheeky yam	*Dioscorea transversa*	Food
kangaroo	*Macropus antilopinus*	Food
wallaby	*Macropus agilus*	Food
possum	*Trichosurus arnhemensis*	Food
bandicoot	*Isoodon macrourus*	Food
eucalyptus species	*Eucalyptus* spp.	Spears, medicine, sugar bag
hibiscus	*Hibiscus* spp.	Spears
fish	various species	Food
sugar bag (native honey)	*Austroplebeia* and *Trigona spp.*	Food
ant bed	*Mastotermes darwiniensis*	Medicine
billy goat plum	*Terminalia ferdinandiana*	Food
long bum	*Telescopium telescopium*	Food
mussel	Various species	Food
cycad	*Cycas armstrongii*	Food
capok	*Bombax ceiba*	Timber used for dugout canoe
deer	*Cervus unicolor*	Food
buffalo	*Bubalus bubalis*	Food
mangrove jack	*Lutjanus argentimaculus*	Food
hawksbill turtle	*Eretmochelys imbricata*	Food
seagull egg	*Chroicocephalus novaehollandiae* and *Sterna spp.*	Food

Common name	Scientific name	Use
bailer shell	*Melo amphora*	Food
clam	*Tridacna squamosa*	Food
pig	*Sus scrofa*	Food
mangrove worm	various species	Food, medicine
wild apple	*Syzygium* spp.	Food
green plum	*Buchanania obovata*	Food
olive python	*Liasis olivaceus*	Food
emu	*Dromaius novaehollandiae*	Food
echidna	*Tachyglossus aculeatus*	Food
pigeon	various species, including *Ducula spilorrhoa*	Food
tamarind	*Tamarindus indica*	Food
cheese fruit	*Morinda citrifolia*	Medicine
cocky apple	*Planchonia careya*	Medicine
iron wood	*Erythrophleum chlorostachys*	Medicine, ceremony tree



LEGEND

- Cobourg Peninsula Ramsar Site
- Dugongs
- Barramundi
- Turtles
- Oysters
- Clams
- Cockleshells
- Crabs
- Yams
- Geese

Title:

Major Localities from which Resources are Harvested (adapted from CPSB 1987)

Figure: 3-16

Rev: A

N

0 7.5 15km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath :

It is estimated that subsistence fishing provides up to 70 percent of the daily food intake of indigenous people in coastal Arnhem Land (Meehan 1977 in Ganter 1996). During consultation with Arrarrkbi, it was stated by a traditional owner living at Araru outstation that "all our food comes from the sea and bush". Many of the traditional methods for processing plant material and manipulating the environment continue to be used in Cobourg Peninsula and a complex set of cultural rules applies to the hunting of animals and distribution of food (CPSB 1987). The knowledge required to collect plants and animals is extensive, which can be demonstrated through the use of the Iwaidja seasonal calendar. Many species, such as dugong and turtle have spiritual, ritual and mythological significance in Arrarrkbi traditions in addition to providing food for Arrarrkbi (NRETAS 2007).

By harvesting resources following traditional customs developed over thousands of years, Arrarrkbi are able to maintain a sustainable harvest, maintain traditional ecological knowledge and help to monitor the success of habitat management programs and the status of important species through their use.

Importance of wetland types

Whilst Arrarrkbi use and harvest resources from terrestrial, aquatic and marine ecosystems, Arrarrkbi generally consider themselves to be 'salt water people'. During consultation, one traditional owner commented that 'salt water is the source of most of our food'. Culturally significant and occupation sites also occur in these areas. For this reason, coastal wetlands are considered to be very important to Arrarrkbi. The important coastal wetland types listed by Arrarrkbi during consultation included beaches and coastal dunes (type E), the intertidal zone (types G and H), coral reefs (type C), lagoons and lakes (types J and K), seagrass meadows (type B), mangroves (type I), estuaries (type F) and rocky shores and headlands (type D),

Inland wetlands are generally not attributed the same significance as coastal wetlands by Arrarrkbi. However, some inland wetlands provide vital sources of food and fresh water throughout the various seasons, and some are associated with culturally significant sites and occupation sites. Important inland wetland types listed by Arrarrkbi during consultation include billabongs, waterholes and swamps (represented by Ramsar wetland types Xf, Tp and Ts), springs, wells and soaks (represented by Ramsar wetland type Y), creeks (represented by Ramsar wetland type N) and lakes (represented by Ramsar wetland types P, Q and R).

Changes in the importance of wetland types over time was not mentioned by Arrarrkbi during consultation.

Cultural characteristic 'd': Sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland

The Cobourg Peninsula landscape is overlain by a complex spiritual and social system sustained by Arrarrkbi. All land and sea is valuable under this spiritual perspective and some sites are viewed as particularly sacred or significant (Chaloupka 1993). Coastal indigenous groups generally do not differentiate between the land and sea, and both areas are treated similarly in terms of ownership and spirituality (Russell 2004). Sites of particular cultural significance can be referred to as dreaming tracks and places (*djang*). *Djang* can occur on land, or in and under the sea (NRETAS 2007), and

they relate to the activities that took place during the creation era and the travels of the first people such as *Warramurra-ngundji*. *Djang* are associated with natural features such as plants, animals, landscape features, climate features and habitats. Knowledge related to, and access to, *djang* varies according to a person's status in Arrarrkbi society (Blake et al. 1998).

Twenty-six *djang* have been described for Cobourg Peninsula (Peterson and Tonkinson 1979) whilst maps of some of the *djang* can be found in the Gurig National Park Plan of Management (CPSB 1987). Many *djang* have also been recorded through the cultural mapping project undertaken by PWCNT with senior traditional owners during 2009, but this information had not been published at the time that this study was undertaken. During consultation with Arrarrkbi for this study, numerous *djang* were identified including: crab dreaming, dog dreaming, frill necked lizard dreaming, bat dreaming, turtle dreaming, lightning dreaming, sugar glider dreaming, rainbow serpent dreaming, and men's site.

Locations of *djang* identified by Arrarrkbi include (but are not limited to): Danger Point, D'urville Point, Giles Point, the strait between High Point and Giles Point, Ardbinae, Araru, Vashon Head, Lingi Point, Araru Creek, Black Point, and Two Hills Bay.

Ceremony is an important part of Arrarrkbi spiritual life. Ceremonies are still performed on Cobourg Peninsula, especially those associated with the death of a senior traditional owner. Following the death of a person, a prohibition is placed on food, materials and sometimes even money derived from the person's clan estate until the *malar* rite is performed. Peterson and Tonkinson (1979) listed several ceremonies which were actively performed, including the *mardyin, kunapipi, lorkun, guwar* and *djamalag* ceremonies. The grounds (including those at Uwiri, Wagali, Duwalbi and Wulumu) where these ceremonies were performed are important places to Arrarrkbi (Peterson and Tonkinson 1979).

Arrarrkbi also have a connection to the land through conception. The area where a person is born has spiritual significance and their father is thought to find their spirit on his clan estate (Peterson and Tonkinson 1979). During consultation for this project, the birth places of several people were mentioned. This provides further imperative for Arrarrkbi to look after their clan estate.

All of the land must be respected through Arrarrkbi culture while *djang* command particular reverence. Through the protection of landscape features, plants and animals associated with *djang* and the overriding obligation to leave the land undisturbed, the spiritual aspects of Arrarrkbi culture are key drivers in maintaining the ecological character of the Cobourg Peninsula Ramsar site.

3.8.2 Maintenance of Global Biodiversity

Reasons for Selection as 'Critical'

Biological diversity, or biodiversity, is the variety of all life forms, the genes they contain and the ecosystem processes of which they form a part. The term biodiversity can therefore incorporate most of the critical and supporting components outlined in the previous sections. However, Cobourg Peninsula provides a role in maintaining global biodiversity through supporting habitat for globally and nationally threatened wetland-dependent species.

In addition to the values of these species in terms of maintaining global biodiversity, some species are of great scientific research value (see Section 3.9.3), provide a cultural resource (for example, green turtle and dugong, see Section 3.8.1) and/or play a role in maintaining wetland ecosystems and foodwebs.

This service underpins Criteria 2 and 3.

Description

Seven globally or nationally threatened species are considered to have important habitat within Cobourg Peninsula (see Table 3-11 and discussion in Section 2.5.4 and 3.6.1). Several other wetland-dependant threatened species are also known or likely to occur in the site, however the site is not considered to represent critical habitats for these species due to their low occupancy and reliance on Cobourg Peninsula in the context of the bioregion. This includes the fish: speartooth shark *Glyphis glyphis*, dwarf sawfish *Pristis clavata*, freshwater sawfish *P. microdon*, green sawfish *P. zijsron* (note these species have not been recorded from Cobourg but is noted as likely to occur here by AECOM 2011), giant groper *Epinephelus laceolatus*, lemon shark *Nagaprion acutidens*; birds: eastern curlew *Numenius magagascariensis*, great knot *Calidris tenuirostris*, yellow chat *Epthianura crocea*; mammals: water mouse *Xeromys myoides*

The role of the wetlands within Cobourg Peninsula in maintaining these species, together with patterns in variability, are described in other sections relating to critical components and processes.

Table 3-11 Threatened wetland species that have critical habitat within the Ramsar site

Species	Reproduction	Population	Feeding	Critical Element
Flatback turtle	Yes – Black Point to Smith Point, Danger Point, Vashon Head	The islands and waters of Cobourg Peninsula are considered among the most important nesting sites in the NT (NRETAS 2007)	No	C1, P1
Green turtle	Yes – Black Point to Smith Point, Danger Point, Vashon Head	Important nesting areas for a (potentially) distinct genetic stock, the site also supports feeding areas (intertidal seagrass)	Yes – important feeding habitats near Greenhill Island, Cape Don and Araru Point	C1, P1
Leatherback turtle	Yes – Danger Point	Possibly the only currently active nesting site in Australia, and one of only a few sites ever recorded in Australia	Yes	C1
Hawksbill turtle	Probable	Low density nesting recorded within the site	Yes	C1
Olive Ridley turtle	Yes – Danger Point	Low density nesting recorded within the site	Yes	C1
Loggerhead turtle	No	Occasional foraging grounds	Possibly	C1
Dugong	Possibly, dugongs calve in shallow waters of tidal sandbanks and estuaries and while not specifically recorded within Cobourg Peninsula, it is considered highly likely to be occurring.	The waters within and adjacent the Ramsar site are regarded as one of the most significant areas for dugong in Australia with population estimates of greater than 1000 animals (Parks and Wildlife Service of the Northern Territory 2003)	Yes - this population is heavily reliant upon intertidal seagrass beds that lie within the Ramsar site.	C1

3.9 Supporting Services/Benefits

3.9.1 Fisheries Resource Values

Cobourg Peninsula supports important fisheries resources in the form of fisheries habitats. Fisheries values are important determinants of the site's character, and support other services/benefits including recreation and tourism (supporting service) and contemporary living culture (critical service 1). This service/benefit is based on fisheries habitat and fish abundance, and excludes fishing activities.

Description

The wetland habitats within the site support a diverse community of fish and invertebrates, many of which move between areas within the Ramsar boundary (that is, creeks, coastal lagoons, intertidal areas, inshore waters of rocky and coral reefs) and the broader Garig Gunak Barlu National Park boundary (formerly the Cobourg Marine Park). Approximately 600 species of fish have been recorded in the Park (Appendix D). Notable invertebrates that support this service are the rock oyster *Sacrostrea cucucculata amasa* and mud crab *Scylla serrata.* Rock oyster beds are common on exposed hard rock surfaces in the intertidal zone (Gomelyuk 2000), and harvested extensively by traditional owners (see Section 3.8.1). Estimates of mud crab abundance in the Cobourg Peninsula region, which included the Mini-mini system (data were not available to exclude this area) range from 200 000 to 400 000 crabs (Hay et al. 2005).

Most commercially important species use a wide range of habitats (and habitat patches) as part of their life-cycle. It is therefore appropriate to consider fisheries habitat values in the context of:

1. the range of habitat types supporting different life-history functions of different fisheries species (and their prey, for example, bony bream, mullet, rainbowfish etc.)
2. hydraulic (flow regimes) and bio-physical habitat conditions, which ultimately control patterns in fish community structure across a range of spatial and temporal scales
3. connectivity/linkages between different habitat types and patches, which vary seasonally
4. specific environmental conditions and stresses within particular habitat patches (for example, water quality conditions)
5. biological interactions (particularly predation, prey availability) within particular habitat types and patches.

The diversity and connectivity of the wide variety of wetland habitats occurring at Cobourg Peninsula is documented as a critical component of the site (see Section 3.4.1). The extent and location of each wetland is described in Section 2.4 and Appendix A.

All wetland types together support the ecosystems and constituent habitats, populations and food webs that support fisheries resource values within and adjacent to the site. Positive relationships between habitat types and fisheries resources have been well documented (Manson et al. 2005, Nagelkerken et al. 2008). Commercial fishing of relatively low intensity (primarily mud crabs and barramundi) occurs under licence (see Section 2.5.10). Due to the wide home range of many estuarine and marine species, the site would support habitats and other fisheries resources that

contribute to fisheries productivity outside the site. Notable fisheries include trepang harvesting and pearling.

3.9.2 Recreation and Tourism

Garig Gunak Barlu National Park was established 'as a national park for the benefit and enjoyment of all people' (Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Park Act s. 12). The main visitor attractions include recreational boating and fishing, wilderness, beautiful beaches, scenery and bird life (A. Wood pers. comm. 2010). Other potential activities include beach and bush walking, bird watching, photography, camping, general sightseeing, wildlife observation, visiting historic ruins, relaxing, socialising, safari hunting, cultural tours and scuba diving (CPSB 1987).

Figure 3-17 Camp site and facilities at Smith Point campground (source: Melaleuca Enterprises) © Copyright, Michelle McKemey

The main areas of the park visited by tourists are the campgrounds at Smith Point (Figure 3-17), various areas in the marine park for fishing and Victoria Settlement at Port Essington. Public access via motor vehicle is limited to the main road leading from the entrance of Garig Gunak Barlu National Park to Black Point and Smith Point. This means that public access to a large proportion of the national park is prohibited (Figure 3-18). Access is also available via sea or air. Boats may anchor in the waters of the park, subject to the management zones provided in the Cobourg Marine Park Plan of Management (NRETAS 2007; see Appendix E).

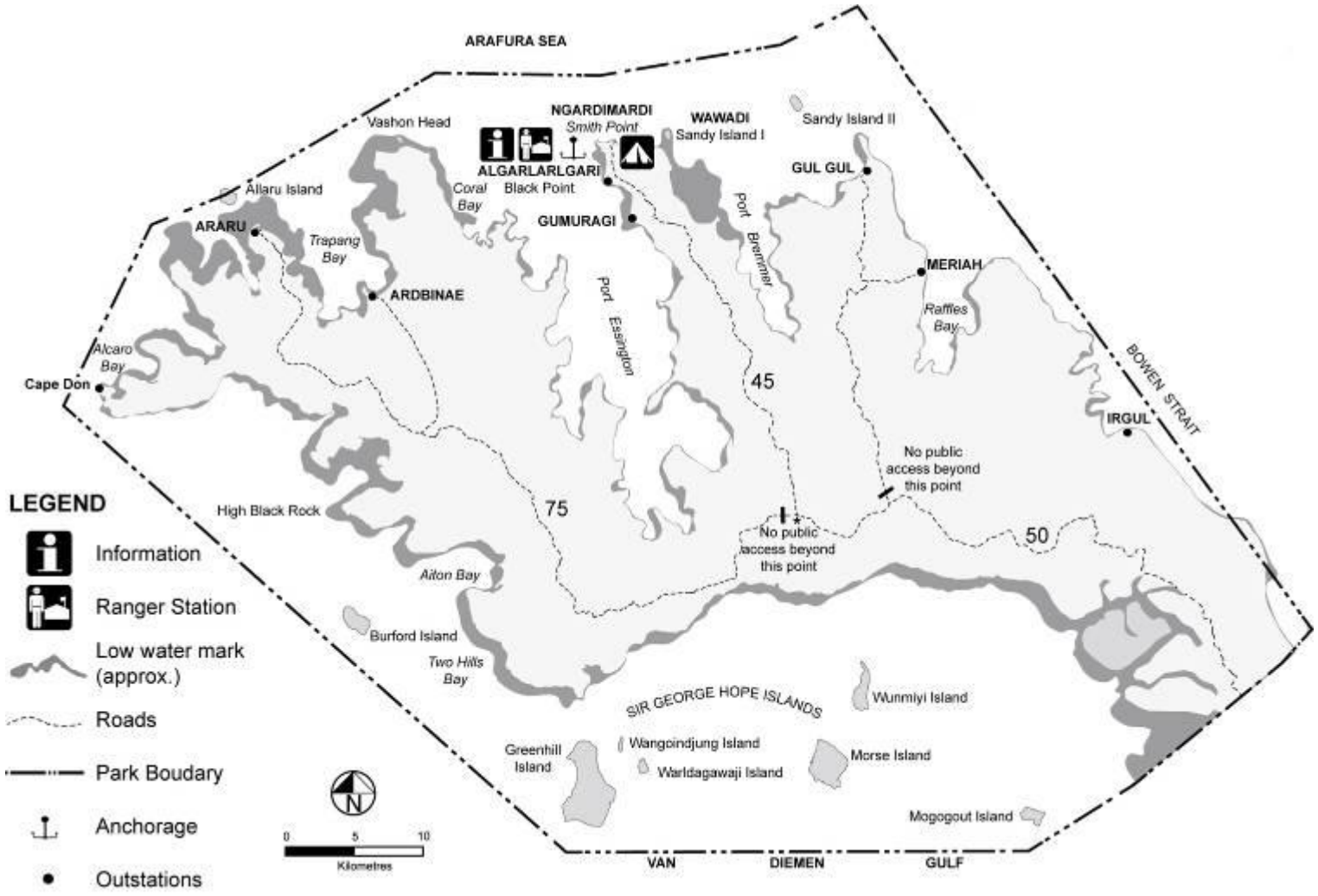


Figure 3-18 Public access areas of Garig Gunak Barlu National Park
(© Copyright, Parks and Wildlife Commission of the Northern Territory 2010)

A permit system regulates the number of visitors who use the park each year. This system has been in place since 1964. A maximum of 15 visitor vehicles may use the park at one time (CPSB 1987). The Park is only open to tourists from 1 May to 31 October. Visitors may come independently or with commercial tour operators. Self-guided visitor numbers have fluctuated over the years, from a low of 317 in 1978 to a high of 1347 visitors per year in 1986. From 2005 to 2009, visitor numbers remained reasonably stable (Figure 3-19), averaging 808 visitors and 312 vehicles per year. Data is not available over this time period on the number of visitors who entered the park with commercial tour groups, however in 2008-2009, 79 people visited the park with commercial operators (Cobourg Peninsula Sanctuary and Marine Park Board 2009).

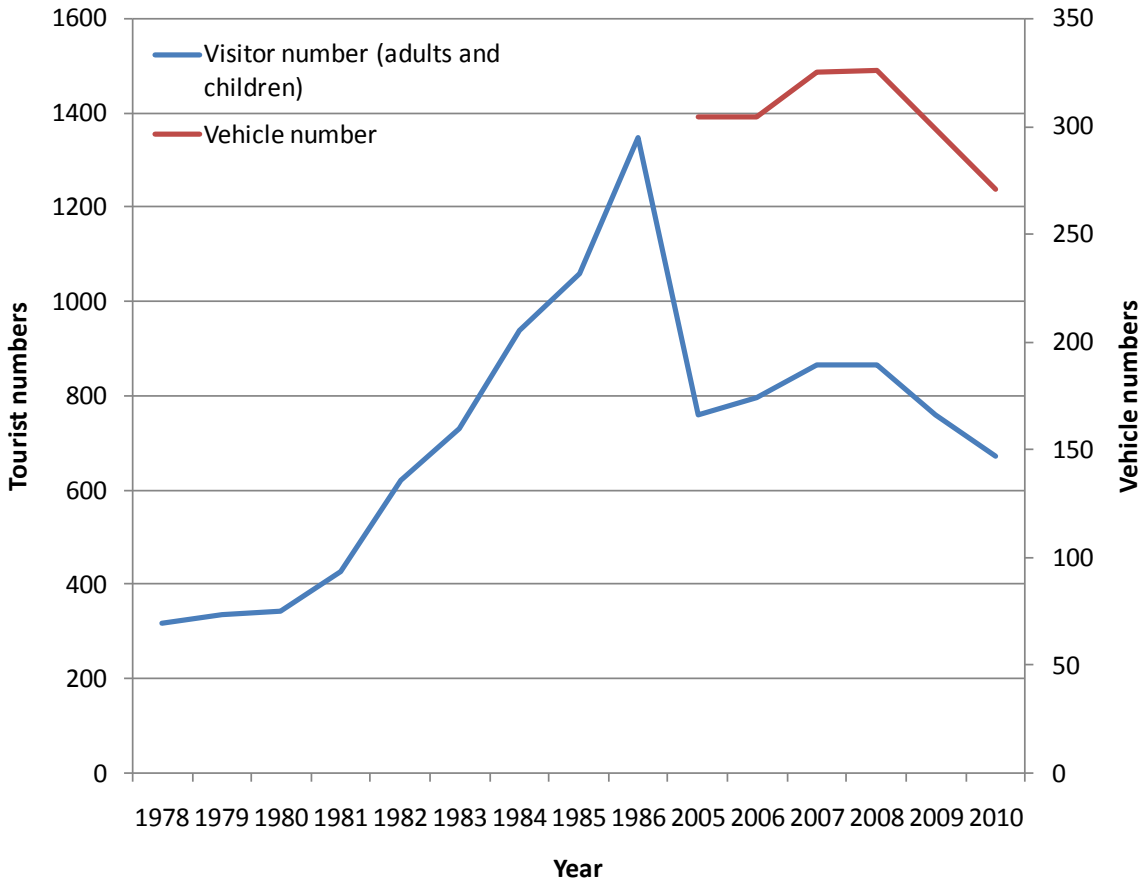


Figure 3-19 Tourist visitation data to 25 August 2010
(© Copyright, Cobourg Peninsula Sanctuary and Marine Park Board 2009)

Tourism businesses operating within Garig Gunak Barlu National Park include a luxury wilderness resort and tourist operations, sport fishing camp, fishing and eco tours, tag-along guided vehicle tours and trophy banteng hunting safaris. A store and four beach huts exist in the park but these were not operational at the time of writing (Figure 3-20).

Figure 3-20 Beach hut at Smith Point (source: Melaleuca Enterprises)
© Copyright, Michelle McKemey

3.9.3 Scientific Research and Education

The natural and cultural values of Cobourg Peninsula are largely undisturbed from developmental influence, providing good opportunities for scientific, archaeological, historical and cultural research. The intact nature of the wetlands within the Ramsar site makes it an ideal 'reference' or 'benchmark' location for scientific research. The site includes many type localities for Australia's tropical reptiles, mammals, birds, other animals and plants due in large part to the early European settlement of Port Essington in the 1840s (Frith and Calaby 1974).

Scientific research potential within the Ramsar site is extensive. Several expeditions have categorised predominantly terrestrial species including the 1948 American-Australian Arnhem Land Expedition (Specht 1964), and the first joint CSIRO and Northern Territory surveys in the late 1960s (Frith and Calaby 1974). The coastlines have been surveyed, primarily by air, for waterbird, shorebird and marine turtles (Chatto 2001, 2003, 2006, Chatto and Baker 2008), and there has been some research into the impacts of the wild population of feral (but globally endangered) banteng (Bowman and Panton 1991, Choquenot 1993, Bradshaw et al. 2007b). Only floristic inventories have been undertaken of terrestrial habitats, with some localised studies on vegetation dynamics (Bowman et al. 1990, Russell-Smith 1991, Brocklehurst and Lynch 2009, Brocklehurst 2010;). The wetland habitats and surrounding marine waters, like much of the Northern Territory, have been very rarely investigated with only specific studies on Popham Creek and coral communities and fishes (Billyard 1995, Gomelyuk 2007, 2009). Of note is that the waters within and surrounding the Ramsar site are one of only twenty four sites (and five in Australia) remotely monitored by the National Ocean and Atmospheric Administration's (USA) Coral Reef Watch Satellite Bleaching Alert system (NOAA 2010).

Archaeologically, Cobourg Peninsula is unique in that nowhere else in Australia are there so many different indigenous, early European and Macassan sites in one region including the evidence of the interaction of these 'three cultures'. The area is both culturally rich and diverse and comprises a significant chapter of the prehistory and history of the Australian continent (Tacon 1988). For example, the Victoria Settlement was the subject of the first research-based historical and contact archaeology project in Australia. The surviving integrity of Arrarrkbi ('living culture') is also a valuable continuing resource for cultural researchers. During consultation with Arrarrkbi, some traditional owners stressed the importance of continuing research and educating key stakeholders and the public about Cobourg Peninsula.

A number of knowledge gaps that require further scientific research have been identified for each of the critical components, processes and services/benefits (refer Section 7.1). As such, the Ramsar site is seen as a critically important for expanding scientific knowledge. Furthermore, baseline monitoring studies are an important component of future scientific research in order to ensure that the values of the Ramsar site do not become degraded over time.

This supporting service also underpins one of the original justifications for listing this site under the nomination criteria proposed at the time (see Section 2.5.1 for further discussion).

3.9.4 Historic Indigenous and Non-Indigenous Cultural Heritage

In addition to the cultural features listed in 3.8.1, the Cobourg Peninsula Ramsar site has significant historical indigenous and non-indigenous cultural heritage. Arrarrkbi have lived on Cobourg Peninsula for up to 60 000 years (Brockwell et al. 1995). Macassan trepang traders visited the Cobourg Peninsula from 1720 until 1907 (Mitchell 1996; Russell 2004). Europeans attempted to establish settlements on Cobourg Peninsula from 1827 until 1849 (NRETAS 2007). For this reason, Cobourg Peninsula is sometimes known as the land of 'three cultures'. The archaeological resources for this area are rich and unique (Tacon 1988).

Cultural characteristic 'b': Sites which have exceptional cultural traditions or records of former civilisations that have influenced the ecological character of the wetland

There are approximately 100 sites on Cobourg Peninsula which are prescribed archaeological places or objects, relating to Aboriginal and Macassan occupation of the Peninsula, protected under the Northern Territory's *Heritage Conservation Act 1991*. Four sites are declared heritage places under the Heritage Conservation Act: Victoria Settlement Historical Reserve, Fort Wellington, Smith Point Beacon and Cape Don Lighthouse Complex. Two sites are listed under the historic class on the Register of the National Estate: the Cobourg Peninsula Historic Sites Precinct and Cape Don Lighthouse Complex. Individual archaeological sites may contain the material culture of Arrarrkbi, Macassan and European heritages. Tacon (1988) found a total 1497 individual artefacts in his survey of 48 archaeological sites on Cobourg Peninsula. All of these sites are an important record of cultural interactions through time on the Cobourg Peninsula, and demonstrate the types of interactions and impacts the 'three cultures' may have had on the ecological character of the landscape over thousands (for Arrarrkbi) and hundreds (for Macassans and Europeans) of years. Items and places of significance are outlined in Appendix F, and briefly described as follows:

- Arrarrkbi heritage – The interaction with, and custodianship of the land and sea, has been described in Section 3.8.1. Arrarrkbi archaeological resources occurring within the Cobourg

Peninsula Ramsar site include grinding tools, hollows and grooves, stone tools, harpoons, middens, freshwater wells, occupation sites and burial sites.

- Maccassan heritage - Macassan trepang fisherman (from the city of Ujung Pandang in southern Sulawesi) visited Cobourg Peninsula over a period of approximately 200 years (between 1720 and 1907). They arrived around December and left around June each year. During their annual visit to Cobourg Peninsula, they would camp along the coastline and collect and process trepang to sell to China (Mitchell 1996). Eighteen sites related to Macassan use have been recorded on the Cobourg Peninsula. Archaeological resources related to Macassan culture include fireplaces, smoke house pits, boiling cauldrons, stone lines, tamarind trees, graves, bottle glass and pottery (Tacon 1988). The Macassans influenced Arrarrkbi culture through trade, the introduction of new materials (e.g. metal, dug-out canoes, glass, tobacco, smoking pipes, liquor, beads and cloth; Mitchell 1996), and cultural interactions in feasts, ceremonies and liaisons. Macassan contact was reflected in the evolution of a mixed language in some places (Russell 2004), Arrarrkbi music, art forms and ceremonial life (Mitchell 1996), and the fact that Macassans fathered children in Australia. Like Arrarrkbi, Macassans respected the sea and attributed spiritual qualities to it (Russell 2004). Macassans may have influenced the ecological character of the wetland through their occupation, influence on Arrarrkbi culture, harvesting of trepang, use of springs and wells, and the introduction of plants such as the tamarind tree.

- European heritage - The earliest known Europeans to explore the waters around Cobourg Peninsula were the Dutch voyagers Pieter Pieterszoon in 1636, Abel Tasman in 1644 and Maaren Van Delft in 1705. The British officer, Lieutenant King, explored the area in 1818 and recommended the establishment of a settlement (CPSB Territory 1987). Cobourg Peninsula was the site of the first two European mainland settlements in the Northern Territory (Peterson and Tonkinson 1979); Fort Wellington at Raffles Bay (1827-1829) and Victoria Settlement at Port Essington (1838-1849). In 1845, Ludwig Leichardt completed his overland journey from Moreton Bay in Queensland at Port Essington (CPSB 1987). From 1870 onwards, a pastoral industry was established through the Cobourg Cattle Company. A catholic mission was established on Greenhill Island in the late 1800s, but was abandoned some time later. Only minimal archaeological remains are evident on site (Tacon 1988). The pearling industry, first established by the Macassans, began in the 19th century and continues to the present day. The timber industry was also established by the Macassans and continued by European and Chinese settlers (CPSB 1987). The British stopped the Macassans using the Cobourg Peninsula in 1906 by prohibiting trepangers from visiting Australian shores. Cape Don Lighthouse was built in 1916 to serve ships passing through Dundas Strait between Melville Island and Cobourg Peninsula (refer to Section 1.3 for discussion on protection of these heritage sites). Europeans may have influenced the ecological character of the Ramsar site through their occupation, impact on the reef, influence on Arrarrkbi and Macassan culture, timber logging, pastoralism, pearling, introduction of exotic plant and animal species and later, the establishment and management of a national park.

There are also up to eighteen shipwrecks in the marine park around Cobourg Peninsula (NRETAS 2007). The precise location of the wrecks is unknown, though at least some are expected to lie within the Ramsar site as they grounded in shallow water. Sixteen of these are declared under the *Historic*

Shipwrecks Act 1976 (Table 3-12). These shipwrecks provide an insight into the maritime history and culture of the area.

Table 3-12 Declared shipwrecks around Cobourg Peninsula (source: DSEWPaC 2010)

Shipwreck	Location	Year
Australia	Vashon Head	1906
Bengal	Vashon Head	1874
Bertie	Off Port Bremer	1886
Calcutta	Vashon Head	1894
Cape Don Perahu	Near Cape Don	1960
Ena	Smith Point	1937
Evangel (Greenhill Island wreck)	Greenhill Island	1903
Lizard Bay Wreckage	Lizard Bay, Port Bremer	n.d
Orontes	Port Vashon	1838
Port Essington Perahu 1	Outside Port Essington	1847
Port Essington Perahu 2	Outside Port Essington	1847
Port Essington Perahu 3	Outside Port Essington	1847
Port Essington Perahu 4	Outside Port Essington	1847
Red Gauntlet	7 miles WSW of Vashon Head/Allaru Island	1887
Sandy Island Perahu 1	SE of Sandy Island	n.d
Willie	Cape Don	1916

3.9.5 Biological Products

Arrarrkbi communities have a strong relationship with the ecosystems of Cobourg Peninsula. Ecosystems are important with respect to provision of biological products including traditional foods (termed 'bush tucker') as well as materials that are useful for various purposes. While the diet and customs of Arrarrkbi communities may have changed since European colonisation, many traditional biological products are still sourced from ecosystems.

Cobourg Peninsula provides a rich variety of biological products, such as plant and animal materials, which have been traditionally used by Arrarrkbi for food, medicine, timber, fibre, dye, tools and many other uses (Blake et al. 1998). These biological products are discussed in greater detail in Section 3.7.1. Species that are known to be included in the traditional diet are listed in Table 3-10. As indicated in the table, a large proportion of the bush tucker species originate from the coastal region being either marine/estuarine species or foods such as yams that are found in the monsoon rainforest.

Oyster pearls have been harvested from the northern embayments of Cobourg Peninsula since Macassan times (see Section 3.9.4). Commercial operators hold leases to grow and harvest oyster pearls in Port Essington, Port Bremer and Raffles Bay that are excised from the National Park, but within the Ramsar boundary. Licensed operations to harvest crocodile eggs, under quotas set by the Northern Territory Government, have been operating since 2007.

3.10 Conceptual Models

Several conceptual models have been prepared to support this ECD, in particular to illustrate the interaction of critical components and processes to produce ecosystem services/benefits.

In seeking to logically characterise the broad range of wetland habitats present at Cobourg Peninsula, the models reflect: the coastal and estuarine areas that are characteristic of the northern coastline of the site around the embayments; the southern coastline with extensive mangrove forests and the tidal channel known as Popham Creek; and the islands.

Figure 3-21 depicts the coastline, estuarine waters, associated creeks and islands characteristic of the embayment known as Port Essington, and typical of other areas of the northern coastline. The wetland environments are particularly diverse in this area, with freshwater springs providing some permanent inland water, steep rocky headlands above sandy beaches and areas of extensive seagrass beds supporting marine turtles, fish and dugongs.

Figure 3-22 depicts the extensive mangrove fringe of the southern coastline, often backed by large saltpans and saltmarsh. The notable coral and mangrove association found within the tidal channel known as Popham Creek is also illustrated, demonstrating the connectivity between the diversity of wetlands.

Figure 3-23 depicts the island habitats of the Ramsar site, supporting important marine turtle nesting grounds and waterbird breeding colonies. As outlined in the critical services section, these areas also contain important traditional hunting grounds.

Figure 3-21 Northern coastline conceptual model

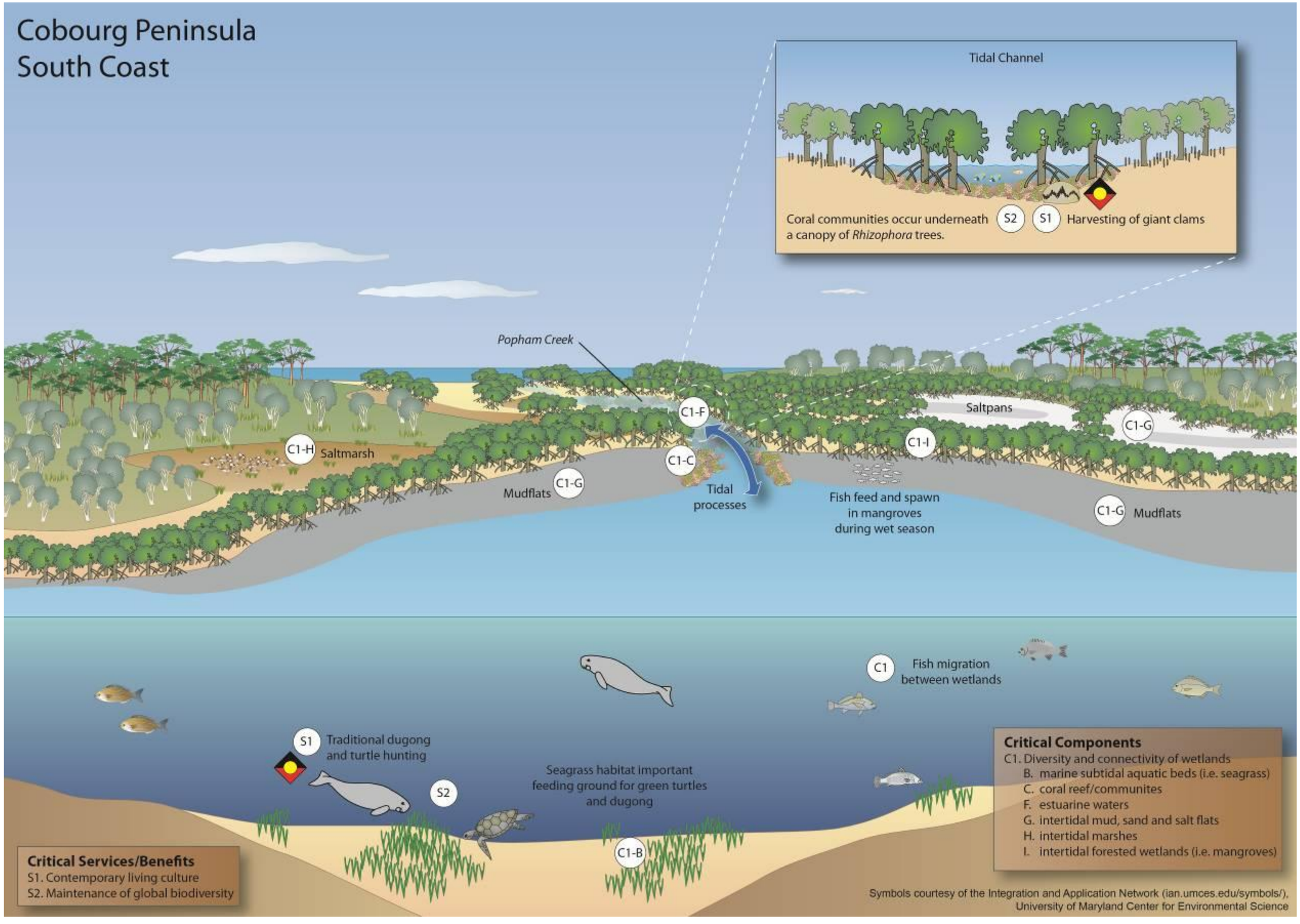


Figure 3-22 Southern coastline conceptual model

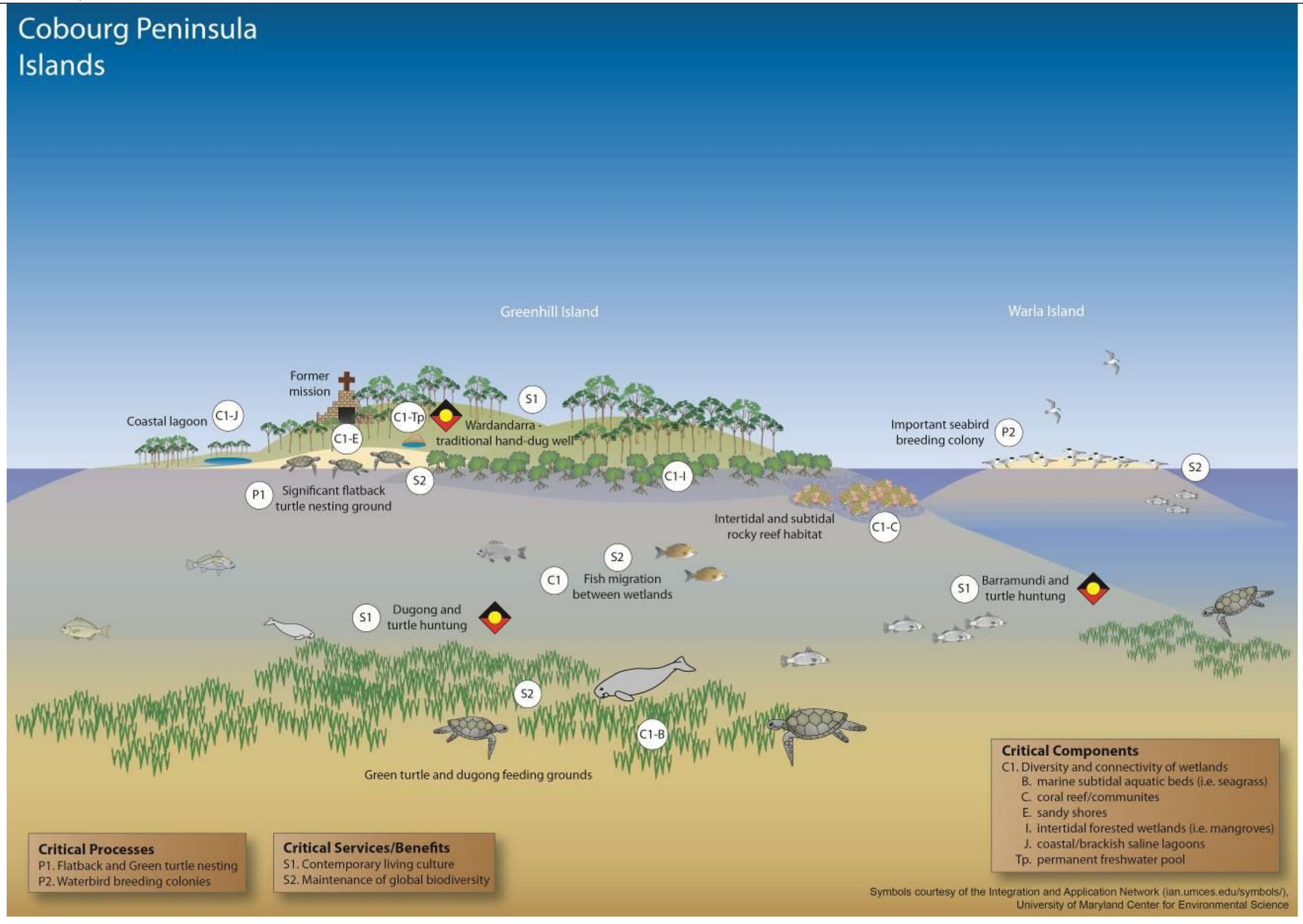


Figure 3-23 Islands conceptual model

4 LIMITS OF ACCEPTABLE CHANGE

4.1 Background

A key requirement of the ECD is to define the limits of acceptable change (LAC) for the critical components, processes and services/benefits of the wetland. LAC are defined as 'the variation that is considered acceptable in a particular measure of feature of the ecological character of the wetland' (DEWHA 2008). The LAC may equal the natural variability or may be set at some other value. LAC are based on quantitative information from relevant monitoring programs, scientific papers, technical reports, or other publications and information about the wetland or input from wetland scientists and experts.

Consistent with the above, the approach taken for the identification of LAC for the Cobourg Peninsula Ramsar site has been the following:

- to assess natural variability and provide limits of acceptable change for each of the critical services/benefits and to identify, where relevant, particular aspects of the service for which LAC have been derived
- to assess natural variability and provide LAC for critical wetland ecosystem components and processes specifically in the context of those wetland species (for example, species of conservation significance), populations (for example, waterbirds, fish) and habitat types (for example, seagrass, coral) that underpin the critical services/benefits.

It should be noted that in deriving the LAC as part of the current study, there are significant data and knowledge gaps and as a result, there are high levels of uncertainty associated with deriving the limits. As such, the LAC should be regarded by the site manager and other users of the document as being based on current knowledge and best professional judgement at the time of preparation of this ECD document, but need to be subject to further expert review over time and evaluated as knowledge about the site and its ecological character improves.

Regarding wetland type areas, two datasets were available from AECOM (2011): 1973 mapping using historical satellite imagery and 2010 mapping using higher resolution satellite imagery. Some differences in these datasets are discussed in Section 2.5.3. However, given the wider variety of wetland identified in 2010, this dataset is considered most useful for establishing LAC. Using a mixture of the two datasets was considered, however due to potential overlaps this was deemed inappropriate. For example, intertidal forested wetlands mapped in 1973 probably largely overlap many coastal wetland types giving an exaggerated total area.

A change to ecological character will generally be deemed to have occurred where an LAC has been exceeded. Monitoring of the extent and condition of key wetland parameters (refer Section 7.2), generally over a period of time, will be needed in most cases to confirm that the change was not due to natural variation. As a consequence, many LAC set criteria that require successive counts or observations exceeding a given threshold over a stated period of time.

It should also be noted that there may be a range of processes occurring outside of the site that could affect the breach of a particular LAC; for example, the populations of migratory species that use the site. As such, in the future evaluation of LAC it is important to determine if the underlying reason for

the breach of a LAC is attributable to natural variability, related to anthropogenic impacts on or near the site or alternatively a result of anthropogenic impacts off the site (for example, lack of available breeding habitat for migratory birds in the northern hemisphere).

4.2 Derivation of Limits of Acceptable Change

In developing LAC as part of this ECD, a number of approaches were adopted; use of existing data sets and information as well as national, state and local guidelines (see also Appendix C.2).

4.2.1 Natural Variability and Probability Based LAC

Defining Baseline Conditions

As outlined in the National Framework for ECDs, it is preferable for LAC to be based on the known natural variability (over time) of a parameter. The LAC can then be set at the upper and lower bounds of that natural variability profile in the time period leading up to Ramsar site declaration. However, in most cases such data are unavailable or incomplete for Cobourg Peninsula.

Recognising these information gaps, particularly with respect to natural variability prior to listing, we have adopted the following hierarchy (in order of preference) for establishing baseline conditions and natural variability:

1. empirical data (pre-listing) data describing natural variability prior to site declaration
2. empirical data (post-listing) for parameters that are unlikely to have substantially changed since listing
3. empirical data/qualitative data for parameters that may have changed since listing, but represent the only available data for establishing 'baseline conditions'.

Where there are no data (or very few data), this has been identified as an information gap and a recommended LAC has been provided that could be used, should data become available as result of future studies.

Defining Baseline Data Quality

In characterising the baseline information used in deriving LAC, the following typology has been used:

- Level A – This LAC has been developed from data and/or information (such as bird count data, fisheries catch data or similar) that has been reviewed by the authors and deemed to be sufficient for setting an LAC. This type of LAC is typically derived from long-term monitoring data.
- Level B – This type of LAC is derived from empirical data, but is unlikely to describe the range of natural variability in time. This can include two sub-types:
  - repeated measurements but over a limited temporal context
  - single measurement (no temporal context) of the extent of a particular habitat type, abundance of a species or diversity of an assemblage.
- Level C – This type of LAC is not based on empirical data describing patterns in natural variability. This can include two sub-types:

- Based on a published or other acceptable source of information, such as personal communication with relevant scientists and researchers, or is taken from referenced studies as part of management plans, journal articles or similar documents
- Where there are no or limited data sets and a lack of published information about the parameter, and the LAC has been derived based on the best professional judgement of the authors.

The LAC tables below provide a LAC quality rating incorporating both the baseline data characteristics (see Defining Baseline Conditions above) and data quality (Level A, B or C).

Measures Used to Describe LAC

Depending on the LAC parameter under consideration, several types of measures may be used to describe natural variability:

- Percentile values. The use of percentile values allows for some change in the measured parameter, but still within the range of natural variability. Common examples of this type of LAC include water quality and biological indicator guideline values derived from statistical analysis of reference datasets. This approach is conceptually similar to the approach used for assessing water quality guideline values (for example, ANZECC/ARMCANZ 2000); in this instance a variation beyond a given nominated percentile value may indicate a potential change in ecological character.
- An allowable proportional change relative to a baseline value. While the use of percentile values to describe natural variability (and therefore LAC) is typically preferred, this is not always possible due to data limitations (such as insufficient baseline data to derive percentile values), and/or in some cases it is not meaningful to use percentiles due to the pattern in variability of the measured parameter (for example, the extent of some habitat types which show low natural variability).
- Broad ecosystem state and function. This type of LAC is based on a broad change in an ecosystem from one state to another or on the basis of the wetland continuing to provide a particular function (such as provision of breeding habitat). An example of this type of LAC is a change in the recorded number of a particular wetland type, such as a freshwater spring or coastal freshwater lake. This is relevant in the context of this site given that the areal extent of these types of wetlands is likely to fluctuate widely with annual rainfall and meaningful percentage changes cannot be described. This type of LAC has the advantage of encompassing a variety of indicators, and specifically addresses ecosystem end-points that can be directly linked to high level critical components and services.

Many of the LAC are based on a timescale of ten years. This period is based upon the frequency of large-scale climatic phenomena that impact the site, such as ENSO events which occur over an approximate twenty year cycle (see Section 3.7.1.2), and is therefore ecologically meaningful in climatic processes impacting upon the site. However, the twenty year period is deemed too long term to enable management intervention, if required. Sampling events are often described as requiring a minimum of three events separated by at least two year intervals. The intention of this is to ensure the range of natural variability can be accounted for, and is to be applied such that sampling may occur at year zero, year ten, and somewhere in between (from years two to eight).

4.3 Summary of Limits of Acceptable Change

For each LAC indicator outlined in Table 4-1, the following information is provided: (i) the relative timescale of the measure (refer to Appendix C for details); (ii) LAC values describing the degree of allowable change (relative to baseline conditions – see Appendix C) in the short-term (within 20 years timeframe) or the long-term (greater than 20 year timeframe); (iii) the spatial and temporal scale at which measurements must be undertaken to assess the LAC; (iv) data quality rating for baseline data and (v) secondary critical component, process and service/benefits addressed by the LAC.

As shown in Table 4-1, in most cases, the LAC in the current study have been subjectively derived (level 3) based on the best scientific judgement of the authors. This is due to:

1. a largely incomplete data set for key parameters such as wetland condition and extent, waterbird usage, fish usage and environment condition (both geographically and temporally) since listing, and
2. the general lack of scientific knowledge about the response of particular species and habitats to multiple stressors (for instance a combination of water flows, salinity and habitat availability).

Further discussion on these information gaps is provided in Section 7.1 of this document.

Additional LAC explanatory notes

6. Limits of Acceptable Change are a tool by which ecological change can be measured. However, Ecological Character Descriptions are not management plans and Limits of Acceptable Change do not constitute a management regime for the Ramsar site.
7. Exceeding or not meeting Limits of Acceptable Change does not necessarily indicate that there has been a change in ecological character within the meaning of the Ramsar Convention. However, exceeding or not meeting Limits of Acceptable Change may require investigation to determine whether there has been a change in ecological character.
8. While the best available information has been used to prepare this Ecological Character Description and define Limits of Acceptable Change for the site, a comprehensive understanding of site character may not be possible as in many cases only limited information and data is available for these purposes. The Limits of Acceptable Change may not accurately represent the variability of the critical components, processes, benefits or services under the management regime and natural conditions that prevailed at the time the site was listed as a Ramsar wetland.
9. Users should exercise their own skill and care with respect to their use of the information in this Ecological Character Description and carefully evaluate the suitability of the information for their own purposes.
10. Limits of Acceptable Change can be updated as new information becomes available to ensure they more accurately reflect the natural variability (or normal range for artificial sites) of critical components, processes, benefits or services of the Ramsar wetland.

Table 4-1 Limits of acceptable change (LAC)

Number	Indicator for critical component / process/service for the LAC	Relative timescale[9]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
C1: Critical Component – Diversity of wetlands						
1	Reduction in extent of any one of the following marine/coastal habitat types: • marine subtidal aquatic beds (seagrass) • intertidal mud, sand and saltflats • intertidal marshes (saltmarsh) • intertidal forested wetlands (mangroves) • sand, shingle or pebble shores • estuarine waters	Long term	Extent of each habitat type will not decline by more than 20 percent of the following baseline values^: • intertidal mud, sand and saltflats = 6212 ha • intertidal marshes (saltmarsh) = 2734 ha • intertidal forested wetlands (mangroves) = 26 207 ha • sand, shingle or pebble shores = 2070 ha • estuarine waters = 7592 ha Marine subtidal aquatic beds (seagrass) have not been mapped and represent an information gap, a baseline value cannot be set at this time. Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	• Minimum three sample events separated by at least two year intervals[#]. • Measured over any 10 year period.	2B (Appendix A) except marine subtidal aquatic beds where no empirical data currently exists therefore has a data rating of 2C.	S1, S2
2	Reduction in extent of any one of the following marine/coastal habitat types: • rocky marine shores (rocky cliffs)	Long term	Extent of each habitat type will not decline by more than 10 percent of the following baseline values^: • rocky marine shores (rocky cliffs) = 36.5 km Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	• Minimum three sample events separated by at least two year intervals[#]. • Shores and estuarine water measurements to be undertaken over a consistent tidal period, such as mean low water springs. • Measured over any 10 year period.	2B (Appendix A)	P1, P2, S1, S2
3	Reduction in the number of any one of the following	Short and Long term	A 25 percent loss in the number of mapped waterbodies (see Appendix A) or identified	• Loss is defined as feature not being present or in a substantially modified condition for a	2B for the lagoons (Appendix A)	S1, S2

[9] Short Term – measured in years; Long term – 10+ year intervals.

Number	Indicator for critical component / process/service for the LAC	Relative timescale[9]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
	marine/coastal habitat types: • coastal brackish/saline lagoons (with sea connection) • coastal freshwater lagoons • coral reef		reef sites, based upon the following baseline values^: • coastal brackish/saline lagoons (with sea connection) = 28 lagoons • coastal freshwater lagoons = 4 lagoons • coral reef = 12 sites Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.	period of greater than 5 years	2C (coral reef) with identified sites including: Popham Creek, Kuper Point, Sandy Island No. 1 and Sandy Island No. 2, Table Head, Turtle Point, Coral Bay, adjacent Vashon Head, Danger Point, Smith Point, Black Point and Caiman Creek	
4	Reduction in the number of any one of the following inland wetland habitat types: • seasonal freshwater lakes • seasonal saline/brackish lakes • permanent saline/brackish lakes • freshwater springs	Short and Long Term	A 25 percent loss in the number of mapped waterbodies (see Appendix A), based upon the following baseline values^: • seasonal freshwater lakes = 14 lakes • seasonal saline/brackish lakes = 7 lakes • permanent saline/brackish lakes = 8 lakes • freshwater springs = 22 springs Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.	• Loss is defined as feature not being present or in a substantially modified condition for a period of greater than 5 years	2B (Appendix A)	S1, S2
5	Reduction in the extent of freshwater, tree-dominated wetlands (*Melaleuca*)	Long term	No decline in the extent of *Melaleuca* forests by more than 10 percent of the following baseline value^: 770 ha Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected	• Minimum three sample events separated by at least two year intervals. • Measured over any 10 year period.	2B (Appendix A)	S1, S2
P1: Critical Process – Marine turtle nesting						
6	Marine turtle nesting	Short term	The average number of nesting attempts at core turtle nesting areas on Black Point, Smith Point, Danger Point and Greenhill Island does not decline by more than 20 percent. Note no baseline data exists at present.	• Recommended baseline monitoring program should follow survey protocols of Schäuble et al. 2006 for Field Island. The programme should include annual sampling over a ten year period, with sampling events timed to meet peak nesting periods (i.e. dry	2C	S1, S2

Number	Indicator for critical component / process/service for the LAC	Relative timescale[9]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
				season for flatback turtles, wet season for green turtles). • LAC based over a 10 year period from date of ECD preparation.		
P2: Critical Process – Waterbird breeding colony						
7	Waterbird breeding (i.e. seabirds, excluding migratory shorebirds)	Short term	Identified sites continue to support breeding colonies of a similar waterbird assemblage. Insufficient current, systematically collected baseline data to enable a quantitative LAC to be described. Long-term LAC to be confirmed on completion of data collection as part of a recommended baseline monitoring program.	• Recommended baseline monitoring program should be based on aerial survey protocols of Morton et al. (1991) and Chatto (2001) The survey should be systematic and involve repeat sampling over corresponding time periods. Based on a ten year cycle, the recommended program should comprise a minimum three sampling events, each separated by at least one year. Each sampling event is comprised of one late dry season and one wet season survey over the course of one year. • LAC based on sampling in at least three years within a 10 year period from date of ECD preparation.	2B with identified sites including Sandy Island No. 1 and Sandy Island No. 2, Edwards Point, Wurrurrlarnbi, sand island in Coral Bay, Warla Island.	S1, S2
S1: Critical Service – Contemporary living culture						
8	Contemporary Arrarrkbi 'living culture' (including the body of Traditional Ecological Knowledge, Arrarrkbi languages, traditional fire and land management practices, traditional resource use) (Service 1)	N/A	Due to the lack of quantitative data regarding 'living culture' attributes, the limits of acceptable change are unable to be defined quantitatively. However a change in the ability of Arrarrkbi to own, occupy, access and use the land and resources of Garig Gunak Barlu National Park could impact on 'living culture'. A change in the ability of Arrarrkbi to use and transmit cultural practices, knowledge and spirituality could also impact on 'living culture'*	N/A	N/A	C1
S2: Critical Service – Maintenance of global biodiversity						
9	Threatened species	N/A	An unacceptable change would have occurred if the site no longer supported at least one of the following species of reptile (flatback turtle, green turtle, leatherback turtle, hawksbill turtle, Olive Ridley turtle,	Based on multiple targeted surveys at appropriate levels of spatial and temporal replication (at least four annual surveys in preferred habitats) over a 10 year period.	2B for reptiles and fish. 2C for mammals and birds.	C1, P1, P2, S1

LIMITS OF ACCEPTABLE CHANGE

Number	Indicator for critical component / process/service for the LAC	Relative timescale[9]	Limit of Acceptable Change	Spatial scale/temporal scale of measurements	Underpinning baseline data	Secondary critical C, P, S addressed through LAC
			loggerhead turtle), and mammal (dugong)			

Note that where particular areas have been quantified, these are based on the best available data/mapping and should be revised if a more appropriate baseline dataset is derived.

^ This baseline data is reliant on data collected post-declaration of the site (that is, in 2010) and may not be representative of conditions when the Ramsar site was declared. Some habitat types, such as seagrass, can be highly variable over time.

This is to be interpreted to mean a minimum sampling protocol of three events, the first at year 0, the last at year 10, the middle event to be anywhere between year 2 and 8.

* These cultural elements could be monitored by Arrarrkbi and reported through cultural heritage workshops to discuss indicators of 'living culture', including: use and transmission of languages, cultural practices, cultural knowledge; access to land and resources; and the ability to undertake spirituality practices

N/A = no available data

5 OVERVIEW OF CURRENT AND FUTURE THREATS

The threats to the ecological character of the Cobourg Peninsula Ramsar site vary greatly across multiple spatial and temporal scales and in terms of their potential severity. Major threats are summarised in Table 5-1 and are discussed below. In characterising the key threats outlined in Table 5-1, the consequence of individual threats were assessed based on categories presented in Table 5-2.

Table 5-1 Summary of major threats to the Cobourg Peninsula Ramsar site

Threat	Potential impacts to wetlands	Consequence	Timing*
Proliferation/ introduction of exotic flora	Impacts from introduction and proliferation of key wetland weed species such as mimosa, salvinia, para grass and olive hymenachne. Note these species have not yet been recorded within the site but are present within the broader region.	Medium	Short- to long-term
Proliferation/ introduction of exotic fauna	Continuing impacts from pigs, banteng, buffalo, cane toads and other invasive species into wetland habitats and negative impacts on the populations of wetland-dependant species.	High	Short- to long-term
Climate change – coral bleaching	Alteration to, or mass mortality of, coral reef communities due to increased incidence and intensity of coral bleaching events.	Medium	Medium- to long-term
Climate change – Increased saltwater intrusion from sea level rise	Reduction in extent of freshwater wetland areas; associated loss of species diversity and habitat and associated ecological and cultural values associated with these areas.	Medium to high	Medium- to long-term
Climate change – Changes to mangrove distribution from sea level rise	Increase in mangrove extent at the expense of saltpan and *Melaleuca* communities; possible loss of existing mangrove communities in foreshore and lower estuary zones due to increased sea level rise and water-logging; associated loss of species diversity and habitat and associated ecological and cultural values associated with these areas.	Medium to high	Medium- to long-term
Climate change – Changes to fire regime	Changes to rates of evaporation and increased drought conditions leading to change in wetland inundation regimes and increased risks of wetland damage from more intense fires.	Medium to high	Medium- to long-term
Climate change – high-intensity storms and cyclones	Increase in damage to vegetation and habitats through more frequent events of extreme wind speed.	Medium to high	Medium- to long-term
Tourism and recreational activities	Disturbance to flora and fauna particularly turtle and seabird breeding colonies, litter and waste production, water pollution, increased strain on limited groundwater resources, impacts to habitats by boats, boat-strike on sea turtles and marine mammals.	Low	Short- to medium-term
Marine debris	A 'key threatening process' that has potential to injure or kill aquatic fauna, particularly listed marine species and impact on critical processes of marine turtle breeding and seabird breeding colonies.	Low	Medium- to long-term
Impacts on 'living culture'	Decline in traditional knowledge, loss of language, loss of knowledge such as land and sea management, traditional burning, cultural heritage management and joint management.	Medium	Short- to medium-term
Damage to archaeological resources	Specifically human induced impacts including theft, vandalism and inappropriate development and tourism. Weathering, vegetation growth and feral animal, termite and fire damage.	Low to medium	Medium- to long-term
Living resource extraction	Impact on fish populations, loss of bush tucker resources, loss of application of traditional cultural practices; impact of poaching/ inappropriate hunting on wildlife and plant populations.	Low to medium	Medium- to long-term

*Timing: short term: about 1-2 years; medium term: about 5 – 10 years; long term: more than 10 years.

Table 5-2 Threat Consequence Categories

Consequence	Interpretation
High	• Irreversible impacts at the broad scale or regional scale • Medium-term impact at the broad scale
Medium	• Irreversible impact at a local scale • Medium-term impacts at the regional scale • Short-term impact at a broad scale
Low	• Irreversible impact at the individual scale • Medium-term impact at a local scale • Short-term impact at a regional scale

5.1 Exotic Flora

Many parts of the northern Australia have infestations of non-native plants that impact on the vegetation structure, fire regimes and ecosystem functioning. To date, Cobourg Peninsula has maintained relatively low densities of introduced plants, and many of the more invasive species found elsewhere, such as gamba grass *Andropogon gayanus,* are absent (Woinarski and Baker 2002). Ten declared weeds (*Cenchrus echinatus, Cryptostegia madagascariensis var. indeterminate, Hyptis suaveolens, Opuntia inermis, Senna obtusifolia, Sida acuta, S. cordifolia, S. rhombifolia, Stachytarpheta cayennensis, and Tribulus cistoides*) and one undeclared but problematic environmental weed (*Delonix regia*) have been recorded from the site but do not currently pose a serious threat (Harrison et al. 2009). No major wetland weed species (for example mimosa or salvinia) are believed to be threatening the site (A. Wood pers. comm. 2010).

Weed species can significantly change the volume of fuel in the understorey and due to their ability to retain moisture longer than native species they do not burn until much later in the dry season. This results in hotter fires with significantly increased flame heights.

The primary cause of weed introduction is dispersal via tourist vehicles. While most tourists are required to remain on designated roads, there is some off road activity conducted by safari operators and Arrarrkbi. It is important therefore that areas of known infestation of invasive plants, such as mission grass, are located and isolated so that seeds are not carried by vehicles within the Park.

The weeds present that have the potential to impact the values of the Ramsar site are:

- rubbervine *Cryptostegia madagascariensis* at Cape Don
- snakeweed *Stachytarpheta* spp. at Cape Don
- infestation of perennial mission *grass Pennisetum polystachion* at various locations
- infestations of annual mission grass *P. pedicillatum* at various locations
- *Hyptis suaveolens* at old camp-sites.

5.2 Exotic Fauna

Cobourg Peninsula maintains a collection of large, exotic ungulates (hooved mammals: see Section 6.1.2 for discussion on each species). Described as being managed in some respects as a "large open air menagerie", the exotic species are some of the most conspicuous wildlife features of the park (Woinarski and Baker 2002). Feral animal control by rangers is focussed upon the Smith Point peninsula area and the access road to Danger Point (A. Wood pers. comm. 2010). Concerted efforts to reduce large non-indigenous herbivore numbers have not been utilised on Cobourg Peninsula to date, with annual cull numbers relatively low (Table 5-3). The brucellosis and tuberculosis eradication campaign, that dramatically reduced water buffalo and other ungulate numbers across northern Australia, reportedly did not extend into Cobourg Peninsula (Bradshaw et al. 2007). Fencing across the isthmus connecting the Peninsula to western Arnhem Land aims to restrict the exotics to the peninsula (Woinarski and Baker 2002), but there are recent reports of banteng off the peninsula in the Murganella region (S. Ward pers. comm. 2010). A Commonwealth-funded program to control pigs and banteng within Cobourg Peninsula, through baiting, shooting and trapping, began in late 2010[10].

Table 5-3 Summary of feral animal control 2009-2010

Species	2009	2010	Total cull
Banteng	29	30	59
Buffalo	7	4	11
Pigs	41	37	78
Total cull	77	71	148

The impact of introduced animals such as pigs, banteng and buffaloes on the native vegetation is poorly understood. Pigs cause significant disturbance around moist areas, banteng inhabit the monsoon rainforest and both banteng and buffalo disturb the wetlands (CPSB 1987). Further control efforts are complicated by competing cultural, ethical and economic interests (Brook et al. 2006). Trophy hunting is viewed as a significant economic input to the traditional owners (see Section 3.9.2).

In addition to large introduced animals there are a number of other feral species that have potential to impact on the values of the Ramsar site. The cane toad *Rhinella marina* is now well established despite early efforts to restrict its advancement (Young 2003). Likely impacts will reflect those seen in other reserves (see Section 6.1.2 for a more detailed discussion). Key concerns are linked to negative impacts arising from direct consumption, competition for resources, and toxic effects on toad predators (van Dam et al. 2002; Bradshaw et al. 2007).

Impacts of exotic fauna are further discussed in Section 6.1.2.

5.3 Climate Change

There have not been any studies undertaken to determine the implications of climate change for Cobourg Peninsula. Studies have been undertaken for the southern coast of Van Diemen Gulf (that is

[10] see http://www.nrm.gov.au/business-plan/funded/10/open/success-nt.html, accessed 5 May 2011.

Kakadu National Park; Bayliss et al. 1997; BMT WBM 2010), and a broad climate change risk assessment for the West Arnhem Shire (local adaptation pathways program[11]). The principal threats to the wetland values of the Cobourg Peninsula Ramsar site from climate change can be summarised as follows:

- increased incidence of coral bleaching due to rising sea temperatures
- increased rate and extent of saltwater inundation into freshwater coastal environments due to sea level rise and increased frequency and/or magnitude of storm surge events
- changes in intertidal vegetation communities in response to rising sea levels
- changed fire regimes resulting from hotter dry seasons, and subsequent damage to monsoon forest and coastal grasslands
- increase in number of high intensity storms and cyclones and the resulting damage to vegetation and susceptible species.

5.3.1 Coral Bleaching

The coral communities of Cobourg Peninsula live on the extreme edge of water temperature and turbidity limits for coral growth (Gomelyuk 2007). These communities are restricted to a very narrow photic zone, and therefore lack any deepwater corals that may serve as refugia for reef inhabitants as well as a resource to aid recovery via re-settling. These communities are considered highly vulnerable to coral bleaching events, triggered by higher-than-normal sea temperature. Coral bleaching is a condition in which corals lose the brown pigmentation of their dinoflagellate symbionts (Hoegh-Guldberg et al. 2007). Depending on the severity of the stress incurred by the corals, mass-coral mortality can occur. It is thought that, given the lack of deeper water corals, the recovery of coral communities at Cobourg Peninsula may be significantly hindered (Gomelyuk 2007).

Severe coral bleaching at Cobourg Peninsula is described by Gomelyuk (2007), following an apparently natural case of elevated sea surface temperatures between November 2002 and January 2003. Four months after the bleaching event, several reefs had lost between 42 percent and 90 percent of their live coral cover. It is not known whether these reefs have recovered since that time. Whilst this appears to have been a natural incident, current climate change predictions are that the frequency of such events will increase. The coral communities of Popham Creek are at a similar risk of bleaching as elsewhere within the site. As documented in Section 3.7.4, Billyard (1995) characterised the water quality within this tidal channel as comparable to adjacent coastal conditions, presumably as the system is so highly flushed. Turbidity and light intensity were exceptions, both generally lower due to the nature of the system. However, water temperature as the primary driver of coral bleaching was uniform throughout, such that elevated sea surface temperatures in the vicinity of Popham Creek are equally likely to impact upon the coral communities.

There are examples in the literature where coral communities have proven more adaptable to bleaching events, high turbidity and increased sediment stress (see Hoegh-Guldberg et al. 2007); all issues experienced by coral within the Ramsar site. The potential recovery ability of corals within the Cobourg Peninsula Ramsar site remains a significant knowledge gap.

[11] The results of this study are not publicly available as yet, see http://www.climatechange.gov.au/about/grants/2009-17.aspx

5.3.2 Saltwater Intrusion into Freshwater Areas

In an assessment targeting the Alligator Rivers region, Bayliss *et al*. (1997) indicated that all wetland areas below four metres in elevation are assessed as being vulnerable to climate-induced changes. This includes much of the southern shores of Van Dieman Gulf; a similar risk can be reasonably assumed for the shores of Cobourg Peninsula. The coastal wetlands of the site undergo substantial salinity changes during the dry season (see Section 3.7.3). Freshwater wetlands and floodplains are comparatively rare, and there is a general scarcity of freshwater across much of the site throughout the dry season.

Climate change impacts include an increased risk of saltwater intrusion from sea level rise on low-lying coastal wetlands. Sea level rise will increase tidal pressure up the creek systems of the site, and possibly intrude on coastal freshwater wetlands, particularly during the dry season.

Storm surge also plays a large role in increasing saltwater intrusion. The predicted increase in average cyclone intensity will increase storm surge levels and exacerbate saltwater intrusion into creeks and low-lying land. Increase in storm surge events from more frequent cyclones will also decrease the recovery time for coastal freshwater wetlands following inundation. The greatest impacts from saltwater intrusion from more frequent cyclones will occur when saltwater intrusion events are followed by a wet season with a lower than average rainfall, resulting in limited flushing of wetlands.

Increases in sea level are likely to be greater than increases in storm surge. That is, the mean sea level may increase by several times the increases in storm surge water levels. However, individual storm surge events, although infrequent, will continue to give higher extreme water levels overall (in the order of many metres) than sea level rise induced by climate change.

5.3.3 Mangrove Expansion

As outlined in Section 3.4.1, the southern coastline of Cobourg Peninsula is dominated by extensive mangrove forests and saltpans. The northern coastline includes less extensive areas of mangrove forest, areas of saltpan and *Melaleuca* communities along riparian zones. The variation of these communities over the past 30 plus years is discussed in Section 3.4.1 and Section 6. Under a sea level rise scenario, an expansion of mangrove communities is predicted, particularly in saltpan areas that are currently only receiving occasional tidal inflows (Figure 5-1). The impacts of this will be for mangroves to replace areas of saltpan and fringing *Melaleuca* communities, assuming that suitable habitat conditions exist (for example, bed levels are at a suitable height, creeks are adequately flushed etc.). Inversely, current mangrove communities along downstream tidal channels and in the lower reaches of the estuaries could be at risk from more permanent inundation and water logging if sea levels rise too quickly for the communities to naturally respond.

Figure 5-1 Mangrove and saltpan interface along the southern coastline (source: BMT WBM) © Copyright, Simon Drummond

5.3.4 Changes to Fire Regime

Fire management is an important cultural activity and the implementation of appropriate burning regimes was raised as an important issue during consultation with Arrarrkbi. The fire regime on Cobourg Peninsula has changed since European colonisation, with the traditional Arrarrkbi burning regime of frequent, fine-scale mosaic burns being replaced with less regular, more destructive fires. This has partially resulted from changes in the ways Arrarrkbi travel and the routes taken (that is, roads) across the land.

It is generally accepted that increased frequencies and intensities of fire associated with higher temperatures and longer dry seasons will threaten the values of Cobourg Peninsula. Higher temperature fires may affect the distribution of wetland habitat types, particularly seasonal wetlands and transitional habitats such as freshwater, tree-dominated wetlands (Ramsar type Xf) and other riparian habitats (Petty et al. 2008). Longer dry seasons threaten the extent and natural variability in seasonal wetland habitats. In turn, pressure will be placed upon wetland dependent fauna, either to aggregate in fewer, smaller habitats and in greater concentrations or to relocate to habitats elsewhere. The scale and intensity of this potential change is poorly understood and remains a key knowledge gap for the Ramsar site.

5.3.5 High Intensity Storms and Cyclones

The frequency and occurrence of cyclones (including severe cyclones) is discussed in Section 3.7.1.3. While Harper et al. (2008) concluded that there is no *prima facie* evidence of a climate change-induced trend in tropical cyclone intensity in northwestern Australia over the last 30 years, an increase in high intensity storms and cyclones has significant potential to threaten the values of Cobourg Peninsula (Figure 5-2). Higher wind speeds can defoliate vegetation, topple trees, snap trunks and drop branches (Turner and Batianoff 2007). The resulting plant debris may dry out and increase the risk of hot fires. In wetland types like Melaleuca forests and monsoon rainforests, this

may produce long-term damage to the values of the habitat (Bowman and Panton 1994). Severe winds and cyclones will also impact on fauna, destroying nests and nesting opportunities, and reducing food availability.

Higher intensity cyclones also have the potential to cause significant landscape change. Dune systems may be moved through coastal processes or aeolian transport of sands, which may cause further changes including the extent or dynamics of the intertidal zone and the complete loss of coastal dune vegetation. The loss of coastal vegetation may allow salt-laden winds to reach further inland to impact on non-salt tolerant species. Mangrove communities may also be impacted through sand movement (that is, burial or being cut off from the sea) and extensive wave action. Heavy seas may also impact on reefs, resulting in the movement of bommies or damage to branching corals.

Figure 5-2 Vegetation damage to Cobourg Peninsula following Cyclone Ingrid (source http://www.bom.gov.au/announcements/sevwx/tc_ingrid/cobourg_leafless_image.shtml)

5.4 Tourism and Recreational Activities

Visitor numbers for Garig Gunak Barlu National Park are currently relatively low. This is due to restrictions such as the park only being open to tourists from 1 May to 31 October each year, a limit of 15 vehicles in the park at one time, a permit system being in place and a limit on areas accessible to visitors.

Yet there are some potential threats associated with tourism. These include inappropriate access to closed areas and non-compliance with park regulations. There is a potential for over-fishing of recreational fish species. Tourist vehicles can spread weeds (Lonsdale and Lane 1994), as can

commercial tour operators such as safari hunters who have access to otherwise closed areas of the park.

During consultation, Arrarrkbi raised a number of concerns related to tourism. The most highly used visitor area is Smith Point which could lead to concentrated impacts in this area. Issues such as damage to oysters (Gomelyuk 2000), damage to coral reefs through boat anchoring, litter and noise were observed by Arrarrkbi. Arrarrkbi were also concerned about the potential impacts of tourism on their culture, through loss of privacy and subsequent restriction on cultural activities.

Tourist facilities, including road maintenance, are reliant upon groundwater extraction for freshwater supply. As discussed in Section 3.7.3.3, groundwater resources in the coastal areas are largely restricted to unconfined, shallow aquifers that are prone to salinisation. Many of the coastal dune communities and other wetland types may also be highly reliant on these aquifers for persistence (see Section 3.7.3.3). Groundwater resources will need to be carefully managed to ensure over-extraction does not impact on the wetlands.

Commercial fishing within the site is licensed by NT Fisheries (see Section 1.3.3.2). The annual catch is very small (Table 5-4), and is restricted to mud crab and barramundi fishing within the site. In adjacent waters within the Garig Gunak Barlu National Park, commercial fishing also occurs under licence; the trepang fishery is the only operation that takes substantial catches from the area.

Table 5-4 Average annual fisheries catch between 2000 – 2009

Fishery	Number / weight
Aquarium	200 fish
Barramundi	less than 1000 kilograms
Coastal line	less than 100 kilograms
Mudcrab	less than 1000 kilograms
Trepang	less than 5000 kilograms
Fishing Tour Operators (recreational)	13 000 (11 500 released) fish

Source: NT Fisheries unpublished data (provided 1 September 2010)

Recreational angling is a key use of the site by tourists. The recreational fishery has two aspects: 1) based on Fishing Tour Operators that primarily operate in deeper waters outside the Ramsar site; and 2) campers that either bring their own boats or fish from the shore. The Fishing Tour Operators report annual catch and release to NT Fisheries. Shore fishing occurs within the site, and is largely restricted to the area around Caiman Creek (accessible by vehicle track). Boat strike on sea turtles and marine mammals is a risk, though comparatively low given the current level of boat traffic. Dolphins observed during research within the Park displayed evidence of scarring along their dorsal sides that may be the result of intermittent boat strike (A. Wood, *pers. comm.*, 2011).

5.5 Marine Debris

A key threatening process under EPBC Act is 'injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris' (DEWHA 2009c). This key threatening process presents an ongoing threat to endangered and vulnerable species that occur within the marine environment of the Cobourg Peninsula Ramsar site. Abatement of this threat relies on national and international coordination and management towards reduction in marine pollution.

Surveys for marine debris have been conducted along the coastline of Cobourg Peninsula: in early September 2010 by the Warramunburr Rangers, in July 2010 and 2008 by Conservation Volunteers Australia (CVA) and in 2003 and 2004 by the World Wildlife Foundation (WWF) (in conjunction with CVA):

- Surveys by the Warramunburr Rangers were conducted in the areas near Danger Point. A total of 405 items of marine debris were collected. The composition of the debris collected was predominantly plastic (48 percent), followed by glass (17 percent), foam (10 percent) and rubber (10 percent). Of the plastics, the dominant debris types were buoys (48 percent) and bottle caps (16 percent) (GhostNets Program 2010). In July 2010, approximately 230kg of ghost nets were collected between Smith Point, Black Point and Danger Point (raw data provided by A. Woods, 29 December 2010).
- Surveys conducted by CVA (in conjunction with Scout groups) were undertaken at Smith Point and Danger Point in June 2008. Plastic constituted 83 percent of debris items collected (40 percent by weight) at Smith Point, and 87 percent of debris items collected (21 percent by weight) at Danger Point. Six nets were collected during the survey at Smith Point and 26 at Danger Point. Results suggest net sources included Taiwan, Korea, Thailand, Indonesia, Japan and Australia.
- Surveys undertaken by WWF in conjunction with CVA were conducted along a northwest-facing 4.7 kilometre stretch of coastline at Araru Point. In 2003 a total of 1144 items of marine debris were collected, equating to 242.9 items per kilometre (White 2003). In 2004 this number had reduced to only 80.4 items per kilometre (White 2006). The composition of the marine debris found at Araru Point for both years was between 60 percent and 70 percent plastic while a further 20 percent of items collected were metal. Nets constituted 2.8 percent while rubber, glass, paper and cloth constituted the remainder of items collected. The largest net recorded across all IMCRA zones during the 2004 surveys was a trawl net measuring 78 x 30 m and weighing 181 kilograms found on Araru Point (White 2006).

Other surveys have been conducted in the region and data have been compiled by NRETAS.[12]

WWF (White, 2006) reported that, of the sites surveyed in the Northern Territory, sites within the Gulf of Carpentaria received substantially greater quantities of marine debris than sites outside the Gulf, with Cobourg Peninsula recording the least items per kilometre of all sites surveyed in 2004. Further, Cobourg Peninsula differed from the majority of other sites surveyed by WWF because 60 to 80 percent of marine debris recorded at the site was from an Australian source (e.g. urban litter or Australian vessel waste) whereas between 50 percent and 70 percent of marine debris at other sites

[12] http://wwf.org.au/ourwork/oceans/debrismap/, accessed 2 March 2011.

was from Asian nations (White 2003, 2006). Of the sites surveyed by WWF in 2004, Cobourg had the lowest number per kilometre but the highest weight per kilometre of nets recorded (White 2006).

5.5.1 Endangered or Vulnerable Species

Marine debris has been identified as a threat to 20 species currently listed as threatened under the EPBC Act, including the six species of marine turtle which frequent the waters and beaches of Cobourg Peninsula; loggerhead turtle (*Caretta caretta*), leatherback turtle (*Dermochelys coriacea*), Olive Ridley (*Lepidochelys olivacea*), hawksbill turtle (*Eretmochelys imbricata*), flatback turtle (*Natator depressus*) and green turtle (*Chelonia mydas*).

Mortality of marine turtles due to ingestion and entanglement represents a threat to these already vulnerable and endangered species. Between 1989 and 2009, across Australia, 1122 marine turtles were impacted by ingestion of or entanglement in marine plastic debris resulting in over 400 fatalities. Recorded events of ingestion or entanglement in marine debris reached a peak in 2005 and subsequently decreased[13] (Ceccarelli 2009, DEWHA 2009c). It is unknown whether this decrease represents a reduction in marine debris impacts or decreases in marine turtle populations.

5.5.2 Other Listed Species

Other species identified as threatened by marine debris include the dugong (*Dugong dugon*) (EPA 2003) and the pelican (*Pelecanus conspicillatus*) (Sloan et al. 1998), both of which have been recorded in the waters of Cobourg Peninsula. These species are both listed marine species under the EPBC Act. Similar to marine turtles, these species are threatened due to ingestion of or entanglement in marine debris within the waters of the Northern Territory (Sloan et al. 1998, EPA 2003, DEWHA 2009c).

5.6 Impacts on 'Living Culture'

Contemporary Arrarrkbi culture is under threat of decline. Two Arrarrkbi languages, Garig and Wurrugu, which were once spoken on Cobourg Peninsula are no longer known or used. Iwaidja, the only remaining Arrarrkbi language which is spoken on the Cobourg Peninsula, is considered to be a 'highly endangered language' (Barwick et al. 2007). Use and knowledge of indigenous language can be used as an indicator of cultural integrity, and the rapid decline of indigenous languages on Cobourg Peninsula indicates that living Arrarrkbi culture could also be under threat of being lost.

There are many factors involved in the decline of living culture. The removal of Arrarrkbi from Cobourg Peninsula between 1950 and 1970, which led to a decrease in access to traditional clan estates on land and sea, and a reduced ability to undertake cultural practices, resulted in a decline in cultural knowledge and practice. Despite many Arrarrkbi moving back to Cobourg Peninsula after 1981, most have since relocated to major centres such as Darwin. A lack of education, health, communication and maintenance services on Cobourg Peninsula, together with a lack of supplies and general remoteness of the location are the primary reasons for relocation. A summary of Arrarrkbi inhabitation of Cobourg Peninsula is provided in Figure 5-3. Diseases such as smallpox also had a devastating effect on the Arrarrkbi population during the early years of European settlement (Peterson and Tonkinson 1979).

[13] Latest data available is from 2008

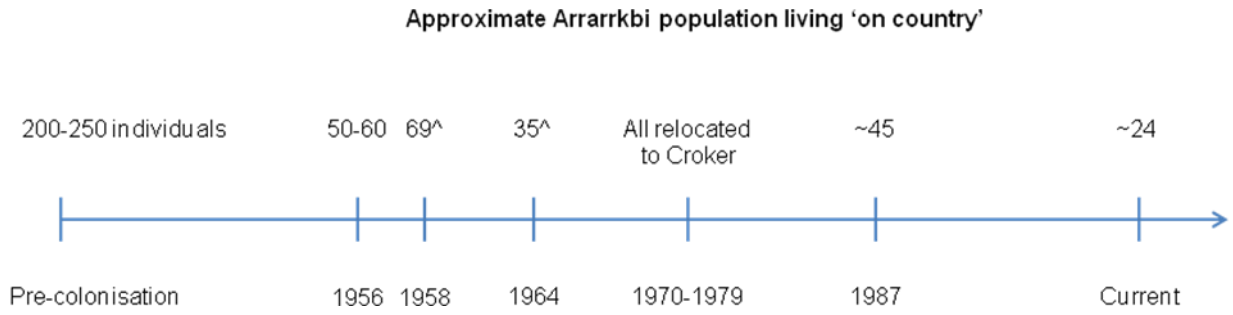


Figure 5-3 Approximate timeline of Arrarrkbi inhabitation of Cobourg Peninsula. ^ indicates population was based at Cape Don

5.7 Damage to Archaeological Resources and Sites of Cultural Significance

Physical damage to archaeological resources, sites of Arrarrkbi cultural significance (such as *djang* and *nyunyuk*) can be caused by the development of roads and airstrips. Vehicular traffic, both on and off roads, is considered by Tacon (1988) to be the most destructive threat to archaeological resources in Garig Gunak Barlu National Park. An example cited in Tacon (1988) is of a complex of Arrarrkbi campsites and middens near Smith Point which were in danger of being damaged by vehicular traffic if action such as relocation of the road was not undertaken. Collectors can pose a significant threat to archaeological resources through the removal of artefacts and disturbance of sites. Erosion, inclement weather and feral animal foraging can also damage archaeological resources such as graves.

5.8 Living Resource Extraction

Through the environmental impacts described in sections 5.1, 5.2, 5.3 and 5.4, biological products such as bush tucker plants and animals may face population decline. For example, Arrarrkbi mentioned during consultation that pigs were causing damage to habitat where yams grow. In addition to this, there may be a threat of decline in the number of some species due to unsustainable hunting, gathering and fishing. Whilst Arrarrkbi traditional culture requires that plants and animals are harvested sustainably according to certain protocols, a change in technology and potential disregard of these protocols may mean that some harvests may not be sustainable. Mitchell (1996) demonstrated that the introduction of Macassan metal harpoons and dugout canoes increased the intensity of hunting of marine animals by Arrarrkbi during early contact between Arrarrkbi and Macassans. The breeding seabirds on Sandy Islands No. 1 and No. 2 are very susceptible to disturbance. The mere presence of people in the area can cause adult birds to leave their nests, and as a consequence mortality rates for young birds are high and successful egg hatching rates are lowered (NRETAS 2007).

The sustainability of contemporary indigenous hunting of dugong in powerboats has been questioned, suggesting that perhaps traditional protocols no longer provide sufficient regulation to maintain healthy dugong populations (see Toyne and Johnson 1991, Anderson 1996, White and Meehan 1993 in Higgins 1999). Foods such as seagull eggs, marine turtle meat and eggs, dugong meat and fresh water turtle meat are vulnerable to over-exploitation due to the hunting technology available and ease of hunting or collection. During consultation with Arrarrkbi, some people

mentioned the importance of sustainable hunting and suggested avoiding hunting those foods that are vulnerable to over-exploitation and mentioned the need to inform and control the indigenous collection of plant and animal foods. Recreational fishing by tourists could also impact on fish populations if regulations are not enforced.

5.9 Interactions or Synergies Between Threats

There is broad potential for threats to interact, such that the impacts of one threat are magnified in the presence of another, which is a form of synergy. In many cases these will be quite unpredictable and it is important that as such effects become apparent they become incorporated into management planning. Possible examples include: grazing or disturbance by feral animals may slow recovery following damage by cyclones; changed fire regimes may have greater impacts in the presence of introduced weeds and an increase in the frequency of very hot days (a predicted consequence of climate change in northern Australia).

6 CHANGES TO ECOLOGICAL CHARACTER

'Ecological character' is defined as a combination of the wetland ecosystem services/benefits, components and processes that underpin wetland systems at any given point in time. In assessing changes to ecological character for Cobourg Peninsula Ramsar site, as required by the National Framework for ECDs (DEWHA 2008), the relevant timescales for the assessment of ecological character are taken to include 1974 (when the site was listed as a Wetland of International Importance) and 2010 (the time of preparation of this first ECD).

While there has been a considerable body of research in the Smith Point peninsula and several other areas within the site, scant information exists at a whole-of-site scale. As such, the analyses below attempt to characterise whole-of-site changes to ecological character but also rely on specific investigations and information about particular areas of the site where relevant.

6.1 Ecological Character Change Methods

Based on the National Framework for ECDs and similar approaches undertaken in other ECDs, a two-step approach has been employed to assess changes in ecological character for the Cobourg Peninsula Ramsar site as discussed in the sections below. These are:

1. based on the documentation reviewed, the original Nomination RIS and Ramsar criteria listed as part of the 1998 RIS, an assessment of whether these listing criteria continue to apply
2. based on the critical components, processes and services/benefits and LAC identified, whether there has been a measurable change to ecological character that is the likely result of anthropogenic activities in Cobourg Peninsula.

Figure 6-1 presents a timeline demonstrating some of the potential changes to wetland value of the site.

6.1.1 Assessment of Listing Criteria

Cobourg Peninsula continues to support the key values identified in the original nomination documentation (see Section 2.5.1 and Table 2-3. The 1998 RIS (PWCNT 1998) assessed the site against the formal Ramsar criteria current for that period. The analysis presented in Section 2.5.2 and summarised in Table 2-4 demonstrates that the site continues to meet three of the criterion listed in 1998, and is deemed to meet two additional Ramsar criteria. Cobourg Peninsula also continues to support two aspects that are not reflected in the current nomination criteria, that is its value as a scientific resource (due to the large number of type localities recorded on the site) and its ability to be effectively conserved (gazetted as a National Park).

One of the Ramsar criterion outlined in the 1998 RIS is not considered to be met by the site (that is, criterion 5 relating to waterbird use of the site). As discussed in Section 2.5.7, this is not considered to reflect an ecological character change, but is a consequence of a re-investigation of available data sources. It has also been highlighted that, with targeted and appropriate survey effort, it is possible this criterion may be considered to be met in the future.

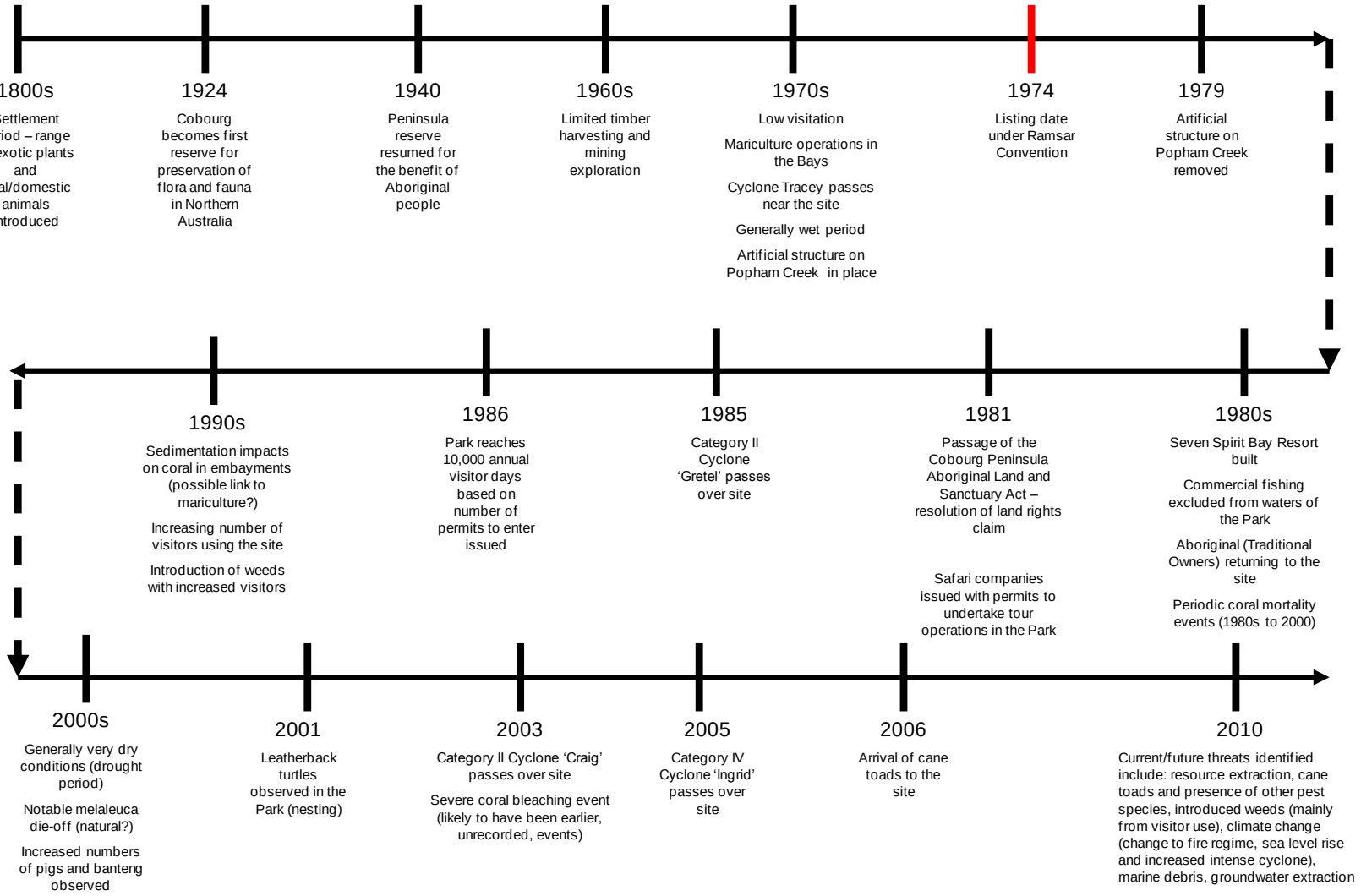


Figure 6-1 Historical dates of interest and potential changes to the wetland values of the Cobourg Peninsula Ramsar site (source: BMT WBM)

6.1.2 Potential Changes to Ecological Character Since Listing

When considering changes in ecological character of the site, the National Framework for ECDs requires the ECD to examine any changes to character that have occurred since the listing date. In order to do this, a baseline of ecological character at the time of listing must be established.

As documented in Section 2.5.1, the reports documented in Frith and Calaby (1974) were submitted as a reference supporting the site's Ramsar nomination. The report documented the results of a series of field surveys conducted during the 1960s that provided a relatively comprehensive inventory of the mammals, birds, amphibians, reptiles and marine molluscs that inhabited Cobourg Peninsula. A general description of vegetation was also given, though this was heavily based on herbarium specimens collected in the 19th century.

As a baseline inventory, the report by Frith and Calaby (1974) is useful in determining broad-scale ecological character change as judged by the presence and/or absence of fauna within the Ramsar site. However, it is only possible to make qualitative comparisons, as there is only limited anecdotal information available on relative abundance or density of any species (largely restricted to a few species of bird). Much of the effort documented in Frith and Calaby (1974) is directed at terrestrial species, many of which have very little reliance on wetlands (many birds, amphibians and reptiles are notable exceptions). Nonetheless, there are to date no reports or indications of subsequent loss of any of the wetland-dependant species documented in Frith and Calaby (1974).

At a local scale, changes to the waterbird fauna associated with Gul Gul (also referred to as Banteng Lagoon) at Danger Point are noted in AECOM (2011). In surveys conducted in the 1960s (reported in Frith and Calaby 1974), a relatively diverse waterbird assemblage was recorded (that is, pied heron, great egret, Australian white ibis, glossy ibis, magpie goose, green pygmy goose, wandering whistling duck, radjah shelduck, pacific black duck, brolga). In surveys conducted in 2010, birds more commonly associated with marine environments were dominant (that is, black-necked stork, lesser sand plover, silver gull, gull-billed tern and Caspian tern), and there was a marked absence of submerged or emergent wetland plants, and the fringing vegetation was dominated by numerous juvenile mangrove, and dead *Melaleuca* trees (AECOM 2011). These observations are reflective of a transition in state of this wetland, from a coastal freshwater lagoon to a brackish/saline lagoon. As discussed in Sections 3.7.1.3 and 5.3.5, it is hypothesised that cyclonic events drive these transitions.

Other notable changes to the extent and distribution of wetlands include a transition in coastal areas from mangrove to saltmarsh or saltpan and vice versa (see Section 3.4.1).

Notwithstanding, this information forms only a qualitative basis for assessing ecological character changes since listing and more recent studies, monitoring data as well as the expert views of the Knowledge Management Committee need also to be considered in assessing ecological character changes. Some of the key issues with regard to possible changes to ecological character are discussed below:

Exotic Flora

Of the declared weeds currently reported within the Ramsar site (see Section 5.1), only hyptis *Hyptis suaveolens* and prickly pear *Opuntia inermis* were noted in Frith and Calaby (1974). While the

introduction of additional exotic species has undoubtedly impacted on habitats at a local scale, they are not considered to have caused a change to the ecological character of the site.

Exotic Fauna

A wide variety of non-indigenous fauna species are known to occur within the site and include: pigs *Sus scrofa*, banteng *Bos javanicus,* Asian swamp buffalo *Bubalus bubalis*, horses *Equus caballus*, sambar deer *Cervus unicolour,* dogs *Canis lupus familiaris*, cane toads *Rhinella marina,* flower-pot blind snake *Rhamphotyphlops braminus*, and Asian house gecko *Hemidactylus frenatus* (Frith and Calaby 1974, CPSB 1987). These species, to varying extents, whether individually or collectively, are thought likely to add pressure to the maintenance of the site's values for biodiversity and threatened species, although the relative impact of these on native fauna is likely to vary considerably (Bradshaw et al. 2007).

Feral cats *Felis catus* are rarely seen, and non-native black rats *Rattus rattus* are yet to be recorded, though both species are increasingly invading areas of northern Australia.

Of the non-indigenous fauna recorded on the site, the greatest threats to fauna habitat values are linked to the presence of large, hard-hoofed herbivorous mammals (banteng, buffalo, horses, and pigs) and cane toads (CPSB 1987), Woinarski and Gambold 1992), as discussed in further detail below:

Large Herbivores

Cobourg Peninsula is thought to currently support densities of banteng comparable to an operating pastoral property (about 10 000 individuals across 2200 km^2; Woinarski and Baker 2002). Pigs are thought to also occur in large numbers (CPSB 1987), though actual estimates are not known. These two species are probably responsible for the most adverse environmental impacts within the site. Asian water buffalo, though first introduced to Australia at Cobourg Peninsula, are now considered to be in reasonably low numbers (Harrison et al. 2009).

Banteng, unlike the other herbivores, are restricted in range to Cobourg Peninsula and adjacent Murganella area. Bowman and Panton (1991) suggested this may be due to their habitat preference for coastal grasslands abutting monsoon rainforest. Genetic assays confirm that the species has not hybridized with other *Bos* spp., and is genetically consistent with wild banteng in Southeast Asia (Bradshaw et al. 2006). It is notable that banteng are considered endangered in their native range (Timmins et al. 2008). In the 1960s, the banteng population at Cobourg Peninsula was estimated at 1500 individuals (Letts 1964). Current population estimates range from 5000 to 10 000 individuals (Woinarski and Baker 2002, Bradshaw et al. 2007b). Bowman (1993) conducted exclusion experiments in open woodland and monsoon rainforest, while Panton (1993) ran similar experiments in coastal grassland habitats. Both demonstrated that, after three years protection, there was a far greater herb biomass in the exclosures.

Banteng are considered to have greater deleterious impacts in monsoon rainforest patches (primarily through trampling), their preferential habitat, where densities approach 70 individuals per square kilometre (Bowman and Panton 1991). It is thought their impact on monsoon rainforest may be twofold. The first is negative in that they trample saplings. The second is positive (to this habitat type) in that Bowman et al. (1990) describe forest clumps of *Pandanus spiralis*, *Acacia auriculiformis,*

Alstonia actinophylla, Timonius timon and *Casuarina equisetifolia* in coastal grasslands that are thought to be a succession towards monsoon rainforest clumps. The development of these clumps may be promoted by banteng grazing on the grasslands, reducing fire intensity and allowing woody vegetation to develop.

Tree rubbing within *Melaleuca* forests has also been considered a significant impact attributed to banteng. Within typically brackish coastal swamps, banteng have been observed puncturing the shelcrete layer to access freshwater that was presumably confined beneath (D. Lindner pers. comm. 2010). Anecdotal reports suggest that banteng may have also caused widespread damage to some habitats through browsing on all vegetation to head height, thereby removing much of the understorey and lower branches of trees (D. Lindner pers. comm. 2010). Banteng may also be responsible for trampling burrows of small mammals and reptiles on coastal grasslands, though the impacts of this behaviour are not quantified (Frith and Calaby 1974).

Pigs generate physical degradation of habitat, particularly around wetlands, and are implicated in the spread of some of significant weed species elsewhere (for example, mimosa *Mimosa pigra* and olive hymenachne *Hymenachne amplexicaulis*; Director of National Parks 2007). On Cobourg Peninsula, pigs are considered to "damage severely ... swamp communities" through rooting (Bowman and Panton 1991). They are also likely to have similar impacts on monsoon rainforests, as has been recorded on Bathurst Island (Fensham 1993 in Woinarski and Baker 2002). Pigs are considered a greater threat to monsoon rainforest than banteng (Bowman and Panton 1991; Bradshaw et al. 2007).

Water buffalo occur within the Ramsar site, but numbers are considered relatively low (Bowman and Panton 1991). In consequence, the damage often associated with buffalo elsewhere (for example Melville Island and Kakadu National Park; Skeat et al. 1996) is less pronounced on Cobourg Peninsula (CPSB 1987). Threats to wetland values from horses are minor, with a population estimate of 450 in the 1970s (Letts et al. 1979 in CPSB 1987). The abundance of sambar deer and their impacts are unquantified.

While the few studies documented here have addressed some questions regarding potential impacts of large herbivores, the actual extent of damage and impact on viability of different wetland types remains a key knowledge gap in the context of this ECD and broader management of Garig Gunak Barlu National Park.

Cane toad

Cane toads are recent invaders to Cobourg Peninsula, first recorded in 2006 (A. Wood pers. comm. 2010). No data exists to date on the extent of their invasion, or associated impacts to flora and fauna. However, the scale and degree of impact is likely to reflect that recently experienced in Kakadu National Park. The preliminary risk assessment of cane toads prepared by van Dam et al. (2002) outlined the potential effects of cane toads on Kakadu National Park's resources which included toxic effects on predators such as reptiles, birds and mammals, potential competition with native frogs, and cultural effects from the loss of important bush tucker species. That work assessed the susceptibility of 151 native species as potential cane toad predators and concluded that ten species were considered likely to be at risk of experiencing population level effects (northern quoll, mangrove monitor, Merten's water monitor, northern sand goanna, spotted tree monitor, northern death adder, king brown snake, dingo), with a further 12 species (or species groups) at possible risk of

experiencing population level effects (leeches, snails, ornate burrowing frog, northern dwarf treefrog, desert tree frog, blue-tongued lizard, carpet python, brown tree snake, slaty-grey snake, freshwater crocodile, black bittern, blue-winged kookaburra). A notable proportion of this higher risk group comprises wetland-dependent species (three snake species, four lizard species, all frog species). Most of these species are also known to occur on Cobourg Peninsula.

Many of the 'at risk' species also represent traditional food sources. Loss of traditional food sources can lead to decreased application and transmission of traditional ecological knowledge and other activities often associated with this, including decreased use of Iwaidja languages and decreased application of traditional land and fire management practices.

Some of these predicted impacts appear to have already occurred on Cobourg Peninsula, with anecdotal reports of fewer goannas since cane toads arrived (K. Wauchope pers. comm. 2010). There are no empirical estimates of the degree of impact of cane toads on native fauna populations within the site; hence firm conclusions on whether there has been a change in character can not be drawn. This represents a key information gap in the context of this ECD and broader management of Garig Gunak Barlu National Park.

There are presently no effective cane toad control measures. Consequently, no cane toad threat abatement plan has been developed to date.

Contemporary Living Culture

The ecosystems that existed at the time of declaration of Cobourg Peninsula as a Ramsar wetland (1974) were the result of thousands of years of land, fire and natural resource management by Arrarrkbi. However, at declaration all Arrarrkbi had been removed from Cobourg Peninsula and were living elsewhere, such as Croker Island (see section 5.6). From 1981 onwards, some Arrarrkbi returned to live on Cobourg Peninsula and re-establish their links with the land. Some cultural knowledge and practices may have been lost during the time away from Cobourg Peninsula and a change in some forms of technology may mean that the traditional practices are no longer necessary today. For example, where Arrarrkbi once walked across the land and paddled canoes across the sea, motor vehicles and boats are now more commonly used. This may mean that sites which were once important, such as inland freshwater wells or springs, may no longer have the same significance for Arrarrkbi whilst sites close to outstations may have increased in significance.

6.1.3 Assessment of Ecological Character Changes Against LAC

In order to be more definitive about changes to ecological character, the National Framework for ECDs (DEWHA 2008) requires an assessment of whether or not any LAC set as part of the ECD have been exceeded. Drawing upon the discussions above, Table 6-1 outlines this assessment.

This assessment is hampered by several key information gaps, including:

- the absence of a comprehensive baseline for key parameters at the time of listing
- no continuous data sets over the intervening period to the time of ECD preparation for critical components and processes at a landscape scale
- limited understanding of natural variability in some key parameters, given that tropical wetland environments can exhibit enormous variation within and between years or decades.

This situation is not uncommon to Ramsar sites around Australia, particularly given the size, paucity of scientific investigation, remoteness and diversity of habitats present at Cobourg Peninsula Ramsar site. This notwithstanding, the analysis presented in Table 6-1 should be viewed as a preliminary assessment of potential changes in ecological character of the site since listing.

While the level of quantitative information and data needed to provide a more definitive assessment of ecological character change (and to set more definitive LAC sought by the National Framework for ECDs) are not available, it would appear unlikely that any of the LAC presented in Table 6-1 have been meaningfully exceeded.

Overall, taking into account the findings of the three assessment approaches, there is no evidence to suggest that the site has experienced an ecological character change since the time of listing. Further information about determining change in ecological character can be found within the publication: 'National Guidance on Notifying Change in Ecological Character of Australian Ramsar Wetlands (Article 3.2)' (DEWHA 2009b).

Table 6-1 Assessment of ecological character changes against LAC

Number	Limit of Acceptable Change	LAC exceeded?	Comments
1. Reduction in habitat extent	Extent of each habitat type will not decline by more than 20 percent of the following baseline values^: • intertidal mud, sand and saltflats = 6212 ha • intertidal marshes (saltmarsh) = 2734 ha • intertidal forested wetlands (mangroves) = 26 207 ha • sand, shingle or pebble shores = 2070 ha • estuarine waters = 7592 ha Marine subtidal aquatic beds (seagrass) have not been mapped and represent an information gap, a baseline value cannot be set at this time. Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	Unknown – but unlikely.	Evidence of habitat substitution of salt marsh and saltpan for mangroves, and vice versa, is noted in AECOM (2011) in comparison with 1973 mapping. Overall areas are largely unchanged.
2. Reduction in habitat extent	Extent of each habitat type will not decline by more than 10 percent of the following baseline values^: • rocky marine shores (rocky cliffs) = 36.5 km Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected.	Unknown – but unlikely	Rocky cliffs were not identified in 1973 mapping, however variation in rocky cliff habitats is considered highly unlikely.
3. Reduction in habitat	A 25 percent loss in the number of mapped waterbodies (see Appendix A) or identified reef sites, based upon the following baseline values^: • coastal brackish/saline lagoons (with sea connection) = 28 lagoons • coastal freshwater lagoons = 4 lagoons • coral reef = 12 sites Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.	Unknown – but possible.	Quantitative information on the variation in these wetland types is not available. Coral reefs have suffered severe mortality due to coral bleaching, and the degree of recovery has not been assessed. Coastal lagoon systems are highly dynamic, possibly driven by storm surge and cyclonic events periodically opening and closing sea connections.
4. Reduction in habitat	A 25 percent loss in the number of mapped waterbodies (see Appendix A), based upon the following baseline values^: • seasonal freshwater lakes = 14 lakes • seasonal saline/brackish lakes = 7 lakes • permanent saline/brackish lakes = 8 lakes • freshwater springs = 22 springs Note: natural processes may result in periodic shift in state between these wetland types, consequently replacement	Unknown – but possible.	Quantitative information on the variation in these wetland types is not available. Inland lake systems are highly dynamic, possibly driven by storm surge and cyclonic events causing saltwater intrusion.

Number	Limit of Acceptable Change	LAC exceeded?	Comments
	of one with another may not necessarily constitute a change in character unless other components or services/benefits are significantly affected.		
5. Reduction in habitat extent	No decline in the extent of *Melaleuca* forests by more than 10 percent of the following baseline value^: 770 ha Note: an increase in any particular habitat type does not in itself represent a change in character unless other components or services/benefit are significantly affected	Unknown – but possible	Quantitative information on the variation in *Melaleuca* forest is not available, however evidence of *Melaleuca* loss at Danger Point was observed in 2010 due to a change of state of a wetland from fresh to saline conditions resulting in the death of large numbers of *Melaleuca*. Some degree of recovery is expected if these lagoons are truly dynamic systems.
6. Marine turtles	The average number of nesting attempts at core turtle nesting areas on Black Point, Smith Point, Danger Point and Greenhill Island does not decline by more than 20 percent. Note no baseline data exists at present.	Unknown – but unlikely	The absence of systematically collected data over appropriate spatial and temporal scales precludes an assessment of this LAC. Large changes in marine turtle use however are not thought to have occurred since listing.
7. Waterbird breeding colonies	Identified sites continue to support breeding colonies of a similar waterbird assemblage. Insufficient current, systematically collected baseline data to enable a quantitative LAC to be described. Long-term LAC to be confirmed on completion of data collection as part of a recommended baseline monitoring program.	Unknown – but unlikely	The absence of systematically collected data over appropriate spatial and temporal scales precludes an assessment of this LAC. Large changes in waterbird use however are not thought to have occurred since listing.
8. Contemporary living culture	Due to the lack of quantitative data regarding 'living culture' attributes, the limits of acceptable change are unable to be defined quantitatively. However a change in the ability of Arrarrkbi to own, occupy, access and use the land and resources of Garig Gunak Barlu National Park could impact on 'living culture'. A change in the ability of Arrarrkbi to use and transmit cultural practices, knowledge and spirituality could impact on 'living culture'	Unknown	Anecdotally, Arrarrkbi languages are decreasing in use. Joint management arrangements continue to enable Arrarrkbi to occupy, access and use the land and resources. This facilitates the use and transmission of cultural practices, knowledge and spirituality.
9. Threatened species	An unacceptable change would have occurred if the site no longer supported at least one of the following species of reptile (flatback turtle, green turtle, leatherback turtle, hawksbill turtle, Olive Ridley turtle, loggerhead turtle), and mammal (dugong)	Unknown – but unlikely	The absence of systematically collected data over appropriate spatial and temporal scales precludes an assessment of this LAC. Most species have received only limited survey focus.

Note: In characterising exceedance of an LAC in the Table, possible responses (based on data availability) include 'Yes', 'No', or 'Unknown'. For those LAC where an 'Unknown' response is supplied, additional justification is provided based on expert opinion using the following categories: 'Very Unlikely'; 'Unlikely'; 'Possible'; 'Likely'; 'Very Likely'.

7 INFORMATION GAPS, MONITORING AND EDUCATION

7.1 Information Gaps

The ECD preparation process promotes the identification of information or knowledge gaps about the Ramsar site. In the context of the identified critical components, processes and services/benefits in this ECD, Table 7-1 summarises the key information and knowledge gaps. Other information gaps are discussed below.

Table 7-1 Summary of key information/knowledge gaps

Description of Wetland Element	Description of Information/Knowledge Gap
Critical Components	
C1. Diversity and connectivity of wetlands	• An adequate baseline describing the extent of different wetland habitat types across the site is needed to assess future changes to ecological character over time. The majority of Ramsar wetland habitat types have been mapped across the site (AECOM 2011). Several habitat types have been poorly defined, including seagrass (type B) and coral reef (type C). • A better understanding of the natural variation exhibited by several wetland types, particularly coastal lagoons that appear to oscillate between saline and freshwater-dominated environments, probably driven by cyclonic events and extreme storm surge. Seagrass and coral habitats are also likely to vary widely in response to cyclonic events.
Supporting Components	
Populations of migratory and resident waterbirds	• There are no systematic data describing the distribution and abundance of waterbird or shorebird species within the Park. An adequate baseline is needed to identify any future changes in the distribution and abundance of this species over time and space.
Monsoon rainforest	• There are no broad-scale empirical data describing variability over time in extent of monsoon rainforests within the Ramsar site.
Terrestrial habitats	• There are no critical information gaps in the context of this ECD.
Aquatic invertebrates	• There is some systematic data describing the distribution and abundance of invertebrates within the site. An adequate baseline is needed to identify any future changes in the distribution and abundance of these species over time and space.
Populations of freshwater fish or freshwater turtles	• There are no systematic data describing the distribution and abundance of freshwater fish or freshwater turtles within the site. An adequate baseline is needed to identify any future changes in the distribution and abundance of this species over time and space.
Critical Processes	
P1. Marine turtle nesting	• There is little systematic data describing nesting densities, reproductive success rate, peak nesting activity, seasonality and annual variation. • The genetic stock of the green turtle population is ambiguous, may represent separate genetic material to the Gulf of Carpentaria breeding unit. • There is little information on the regularity of the use of the site for breeding by the leatherback, Olive Ridley or hawksbill turtles.

Description of Wetland Element	Description of Information/Knowledge Gap
P2. Waterbird breeding colonies	• There is insufficient, systematically collected information on the species and number of breeding waterbirds, their seasonality, annual variation, nesting densities and reproductive success rate. • There is a lack of a comprehensive and integrated map of breeding areas for key waterbird species. • There have not been regular counts for migratory and resident waterbirds since listing across the full range of wetland habitat types.
Supporting Processes	
Climate	• There are no critical information gaps in the context of this ECD.
Geology and geomorphology	• There are no critical information gaps in the context of this ECD.
Hydrology	• There is no systematic data, and little anecdotal data, describing the transition of coastal lagoons from freshwater to salt water systems during an annual cycle. • There is some data on the groundwater resources of the peninsula, though locally this is very restricted and there is insufficient information on the dependence of wetlands on groundwater. • An adequate baseline is needed to identify any future changes in the water resources of the peninsula over time and space.
Water quality	• There is insufficient information on the natural variability in water quality of the various wetland habitats found within the Ramsar site, both between seasons and major impacting processes such as cyclones and extreme storms. An adequate baseline is needed to identify any future changes in the water quality of the peninsula over time and space.
Fire regime	• Regional studies have assessed fire regimes over time and impacts on some vegetation communities (i.e. monsoon rainforests and coastal grasslands); however, continued monitoring of fire regimes is required especially in terms of responses of new weed species to fire.
Biological processes	• There are no critical information gaps in the context of this ECD.
Critical Services/Benefits	
S1. Contemporary living culture	• Many cultural elements are undocumented, including cultural practices and knowledge, some languages and much spirituality (which may be inappropriate to record or document).
S2. Maintenance of global biodiversity	• There is a general lack of suitable surveys for the threatened species within the site, including the reliance of some species on the wetland habitats (e.g. dugong). • There are currently no formal species-level monitoring programs that measure trends in abundance, or responses of these species to designated management actions.
Supporting Services/Benefits	
Fisheries resource values	• There are no available data describing patterns in fisheries abundance over time or within different areas of the Ramsar site. An adequate baseline is needed to identify any future changes in the distribution and abundance of species over time and space. • There is no information on the specific spawning habitats for aquatic fauna that utilise the Ramsar site.
Recreation and tourism	• There is insufficient understanding of the impact of tourism and recreation use on the wetland values of the Ramsar site.
Scientific research and education	• There are no critical information gaps in the context of this ECD.
Historic indigenous and non-indigenous cultural heritage	• Many historical elements remain to be documented, including the location and condition of the shipwrecks, and other aspects of Arrarrkbi,

Description of Wetland Element	Description of Information/Knowledge Gap
	Macassan and European heritage.
Biological products	• There are no critical information gaps in the context of this ECD.

As noted in Section 1.3.1.2, the actual boundary of the Ramsar site aligns with the low-water mark. To date, an accurate dataset describing the bathymetry, and therefore low-water mark, around the site is not available. Information gaps exist in terms of the use and dependence of different species on the Ramsar site. For instance, freshwater fish and turtles and migratory shorebirds are poorly understood, though may represent critical components of the site.

Key information gaps also exist in terms of the impacts of key threatening processes. The impact of exotic ungulates (particularly banteng, buffalo and pigs) on the wetland values of the site is poorly understood. Anecdotal evidence, and limited studies, have described some negative effects however long-term changes and the extent of landscape/ecosystem damage is not known. There are also no empirical data describing the impacts of non-indigenous fauna (particularly cane toads) on native fauna populations.

7.2 Monitoring Needs

In the context of the site's Ramsar status and the current ECD study, the primary monitoring needs relate to the need to assess the suitability of limits of acceptable change (versus natural variability) and to assess more definitively if changes to ecological character have occurred or are being approached. The monitoring needs may also inform future iterations of the site's plan of management. Principally, this monitoring should relate to the following (note no attempt is made to imply priority of any particular monitoring need):

- broad-scale observation/monitoring of wetland habitat extent, at a frequency and resolution that would enable identification of variation beyond the triggers suggested in the LAC (refer C1 and S2, LAC 1 – 5).
- targeted monitoring programs for threatened species, measuring trends in abundance and responses to management actions. Specifically this should target presence and usage of the site, particularly reproductive dynamics for breeding marine turtles (refer P1 and S2, LAC 6 and 9)
- regular counts of breeding, roosting and feeding waterbirds at identified breeding sites (refer P2). The monitoring regime should reflect that envisaged in LAC 7
- habitat condition monitoring, principally in the form of monitoring underlying supporting processes such as water quality and hydrological processes or surrogate biological indicators (refer hydrology and water quality supporting processes)
- a monitoring program for non-indigenous flora and fauna, providing data on habitat, densities and damage. Data needs to be analysed within the appropriate quantitative frameworks to provide robust appraisals of the threats of non-indigenous species (risk analysis) and the options for control (cost–benefit analyses) (see Finlayson et al. 2006; Bradshaw et al. 2007) (refer current and future threats)
- monitor the ability of Arrarrkbi to live 'on country' within Garig Gunak Barlu National Park and to access the land which is fundamental to the maintenance of 'living culture' (refer S1 and LAC 8). The program should include information on use an transmission of Arrarkbi languages, cultural

practices and cultural knowledge, as well as impediments to living 'on country' including lack of health services, schools, resources, limited employment and the remoteness of the location

- monitor the number, nature and condition of archaeological materials and sites associated with wetland environments and habitats that contribute to historical cultural heritage values of Arrarrkbi, Macassan and European sites (refer supporting services)
- monitor visitor numbers, access and impact on natural and cultural resources (note that Garig Gunak Barlu National Park currently monitors visitor and vehicle numbers) (refer supporting services).

7.3 Communication, Education, Participation and Awareness

Under the Ramsar Convention a Program of Communication, Education, Participation and Awareness (CEPA) was established to help raise awareness of wetland values and functions. At the Conference of Contracting Parties in Korea in 2008, a resolution was made to continue the CEPA program in its third iteration for the next two triennia (2009 – 2015).

The vision of the Ramsar Convention's CEPA Program is: "People taking action for the wise use of wetlands." To achieve this vision, three guiding principles have been developed:

- The CEPA Program offers tools to help people understand the values of wetlands so that they are motivated to become advocates for wetland conservation and wise use and may act to become involved in relevant policy formulation, planning and management.
- The CEPA Program fosters the production of effective CEPA tools and expertise to engage major stakeholders' participation in the wise use of wetlands and to convey appropriate messages in order to promote the wise use principle throughout society.
- The Ramsar Convention believes that CEPA should form a central part of implementing the Convention by each Contracting Party. Investment in CEPA will increase the number of informed advocates, actors and networks involved in wetland issues and build an informed decision-making and public constituency.

The Ramsar Convention encourages that communication, education, participation and awareness are used effectively at all levels, from local to international, to promote the value of wetlands.

A comprehensive CEPA program for an individual Ramsar site is beyond the scope of an ECD, but key communication messages and CEPA actions, such as a community education program, can be used as a component of a management plan.

Three of the objectives of the Gurig National Park Plan of Management (CPSB 1987) relate to the interpretation, education and provision of information for visitors. The Gurig Plan also aims to promote an understanding of national park philosophies among the traditional owners and to encourage their involvement in the management of the Park. Management guidelines to support these objectives are provided in the Plan.

Similarly, through recognition of the educational values of the marine park, the Marine Park Plan (NRETAS 2007) aims to provide appropriate communication programs and information. It also recognises the need to communicate the management strategy being adopted to conserve the values of the Park and to provide an understanding of the aspects of Arrarrkbi culture, lifestyle and resource use. Strategies for management of educational values are outlined in the Plan.

Key CEPA messages for the Ramsar site arising from this ECD, which should be promoted through these objectives, strategies and associated actions, include:

- The wetlands of Cobourg Peninsula are characterised by a diverse and well-connected range of habitats. The site supports all but one marine/coastal wetland type, and all but six inland wetland types represented in the bioregion. The combined value of these various habitats is a critical component of the sites ecological character.
- Cobourg Peninsula supports breeding and other life cycle functions of significant populations of seabirds and nesting of globally threatened green and flatback turtles. It is also one of the few locations in Australia where leatherback turtles have been known to nest.
- The management of the site and surrounding National Park provide an example of long-standing joint management practices, between the traditional owners and caretakers (the Arrarrkbi) and the Northern Territory government.
- The Ramsar site contains significant archaeological evidence demonstrating the interaction and influences over time between three cultures: the Arrarrkbi, Macassans and Europeans. The continued presence, influence and knowledge of the Arrarrkbi is an outstanding example of 'living culture' that has relied upon, adapted and been adapted by the wetlands and associated habitats.
- The ecological character of the Ramsar site appears to have been maintained since listing in 1974. This is in part attributed to the encapsulation of the entire site catchment within Garig Gunak Barlu National Park.
- Some key threatening processes have the potential to impact on these values, and their severity is currently poorly understood. Principal among these is the presence of large herds of feral ungulates (that is banteng, water buffalo, horses, pigs), which are only partially controlled by fencing and hunting. The impacts of cane toads are not yet obvious but experience elsewhere suggests they can significantly alter fauna assemblages. Pest weeds are yet to substantially impact upon wetlands, and control programs need to carefully monitor any further encroachment.
- Broad-scale ecological health monitoring is needed for the site in order to inform proper management. This should focus on the LAC and knowledge gaps outlined in this ECD.

8 REFERENCES

AECOM (2011) *Research of key knowledge gaps in the Ecological Character of the Cobourg Peninsula Ramsar site, Northern Territory*, A report to the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Allsop, Q, de Lestang, P, Griffin, R and White, G (2006) *Fishnote No. 27: Barramundi – Your Questions Answered*. Government Publication, Northern Territory Government, Darwin. [Online] http://www.nt.gov.au/d/Content/File/p/Fishnote/FN27.pdf

Alongi, DM (1990) 'The ecology of tropical soft-bottom benthic ecosystems', *Oceanography and Marine Biology Annual Review* **28**: 381-496

Andersen, AN, Braithwaite, RW, Cook, GD, Corbett, LC, Williams, RJ, Douglas, M, Gill, AM, Setterfield, S and Muller, WJ (1998) 'Fire research for conservation management in tropical savannas: introducing the Kapalga fire experiment', *Australian Journal of Ecology* **23**: 95-110

Anderson, I (1996) 'Alien animal culls backfire' *New Scientist* **151**(2041): 6

Baker, B, Price, O, Woinarski, JCZ, Gold, S, Connors, G, Fisher, A, Hempel, C (2005). *Northern Territory Bioregions - assessment of key biodiversity values and threats.* A resource document to accompany the Northern Territory Parks and Conservation Masterplan. Darwin, N.T., Department of Natural Resources, Environment and the Arts.

Bamford, M, Watkins, D, Bancroft, W, Tischler, G and Wahl, J (2008) 'Migratory shorebirds of the East Asian – Australiasian Flyway; Population estimates and internationally important sites', *Wetlands International – Oceania*. Canberra

Barwick L, Birch, B and Evans, N (2007) 'Iwaidja Jurtbirrk songs: Bringing language and music together' *Australian Aboriginal Studies* **2007/2**: 6-34

Bayliss, B, Brennan, K, Eliot, I, Finlayson, M, Hall, R, House, T, Pidgeon, B, Walden, D and Waterman, P (1997) 'Vulnerability assessment of predicted climate change and sea level rise in the Alligator rivers Region, Northern Territory, Australia', *Supervising Scientist Report 123*. Supervising Scientist, Canberra. [Online] http://environment.gov.au/ssd/publications/ssr/123.html

Bayliss, P, Bartolo, R and van Dam, R (2008) 'Quantitative ecological risk assessments for the Daly River'. In: *Ecological risk assessments for Australia's Northern Tropical Rivers*. A report to Land and Water Australia. (Eds. Bartolo, R, Bayliss, P and van Dam, R). pp 272-415. [Online] http://www.environment.gov.au/ssd/tropical-rivers/triap-sp2.html

Bayliss, P, van Dam, R, Boyden, J, and Walden D (2006) 'Ecological risk assessment of Magela floodplain to differentiate mining and non-mining impacts'. In: *eriss* research summary 2004-2005 Supervising Scientist Report 189. (Eds. K.G. Evans, J. Rovis-Hermann, A. Webb and D.R. Jones) pp. 172-185. Supervising Scientist, Darwin Northern Territory. [Online] http://environment.gov.au/ssd/publications/ssr/pubs/ssr189-print.pdf

Behler, JL, Pritchard, PCH and Rhodin, AGL (Eds.) (1995) 'The leatherback turtle, *Dermochelys coriacea*', *Chelonian Conservation and Biology*, **2**: 139-319

Berkes, F, Folke, C, and Gadgil, M (1995) 'Traditional Ecological Knowledge, Biodiversity, Resilience and Sustainability'. In: *Biodiversity Conservation* (Eds: Perrings, C, Muler, K, Folke, C, Holling, C and Jansson, B) Kluwer Academic Publishers, The Netherlands pp. 281-299

Billyard, RW (ed.) (1995), *The cultural and ecological significance of Popham Creek, Cobourg Peninsula*, Parks and Wildlife Commission of the Northern Territory, Darwin, NT

Bishop, KA, Allen, SA, Pollard, DA and Cook, MG (2001) 'Ecological studies on the freshwater fishes of the Alligator Rivers Region, Northern Territory: Autecology'. Supervising Scientist for the Alligator Rivers Region. Australian Government Publishing Service, Canberra. [Online] http://www.environment.gov.au/ssd/publications/ssr/145.html

Blake, N, Wightman, G and Williams, L (1998) *Iwaidja Ethnobotany: Aboriginal plant knowledge from Gurig National Park, Northern Australia*. NT Uniprint, Northern Territory University, Darwin

BMT WBM (2010) *Kakadu-Vulnerability to Climate Change Impacts*. A report to the Australian Government Department of Climate Change (in prep)

Bowman, D (1993) 'Effect of large herbivore exclusion on understorey biomass in three plant communities on Cobourg Peninsula', *Northern Territory Naturalist*, **14:** 1-6

Bowman, D & Panton, WJ (1991) 'Sign and habitat impact of Banteng (*Bos javanicus*) and pug (*Sus scrofa*), Cobourg Peninsula, Northern Australia', *Australian Journal of Ecology*, **16**(1): 15-7

Bowman, D & Panton, W (1994) 'Fire and cyclone damage to woody vegetation on the north coast of the Northern Territory, Australia', *Australian Geographer*, **25**: 32-5

Bowman, D & Panton, WJ (1995) 'Munmarlary revisited: Response of a north Australian Eucalyptus tetrodonta savanna protected from fire for 20 years', *Australian Journal of Ecology*, **20**(4): 526-31

Bowman, D, Franklin, D, Price, O & Brook, B (2007) 'Land management affects grass biomass in the *Eucalyptus tetrodonta* savannas of monsoonal Australia', *Austral Ecology*, **32**(4): 446-52

Bowman, D, Panton, W & Mcdonough, L (1990) 'Dynamics of Forest Clumps on Chenier Plains, Cobourg Peninsula, Northern Territory', *Australian Journal of Botany*, **38**(6): 593-601

Bradshaw, CJA, Field, IC, Bowman, DMJS and Haynes, C (2007a) 'Current and future threats from non-indigenous animal species in northern Australia: a spotlight on World Heritage Area Kakadu National Park', *Wildlife Research* **34**: 419-436

Bradshaw, CJA, Isagi, Y, Kaneko, S, Bowman, D & Brook, BW (2006) 'Conservation value of non-native banteng in northern Australia', *Conservation Biology*, **20**: 1306-11

Bradshaw, CJA, Isagi, Y, Kaneko, S, Brook, BW, Bowman, DMJS & Frankham, R (2007b) 'Low genetic diversity in the bottlenecked population of endangered non-native banteng in northern Australia', *Molecular Ecology*, **16**: 2998-3008

Brocklehurst, P & Lynch, B (2009) *Melaleuca survey of the Top End, Northern Territory*, Department of Natural Resources, Environment, The Arts and Sport, Darwin, N.T.

Brocklehurst, P (2010) *Vegetation Communities: Cobourg Peninsula / Garig Gunak Barlu National Park*, Department of Natural Resources, Environment, The Arts and Sport, Darwin, N.T.

Brockwell S, Levitus R, Russell-Smith, J and Forrest, P (1995) *Aboriginal Heritage*. In: Press T, Lea D, A Webb and A Graham (ed.) Kakadu Natural and Cultural Heritage management Australian Nature Conservation Agency & North Australia Research Unit, ANU, Australia

Brook, B, Bowman, D, Bradshaw, C, Campbell, B & Whitehead, P (2006) 'Managing an Endangered Asian Bovid in an Australian National Park: The Role and Limitations of Ecological-Economic Models in Decision-Making', *Environmental Management*, **38**(3): 463-9

Bruce, AJ (1982) '*Thorella cobourgi,* new genus, new species, a hippolytid shrimp from the Northern Territory, Australia', *Journal of Crustacean Biology*, **2**(3): 451-458

Bureau of Meteorology (BOM) (2011) [accessed 21 February 2011] http://www.bom.gov.au/cyclone/about/northern.shtml#history

Burrows, D 2008. In GP Lukacs and CM Finlayson (eds) (2008) *A Compendium of Ecological Information on Australia's Northern Tropical Rivers. Sub-project 1 of Australia's Tropical Rivers – an integrated data assessment and analysis (DET18)*. A report to Land & Water Australia. National Centre for Tropical Wetland Research, Townsville, Queensland

Ceccarelli, D (2009) *Impacts of Plastic Debris on Australian Marine Wildlife*. Report by CandR Consulting for the Department of Environment, Water, Heritage and the Arts

Chaloupka G (1993) *Journey in Time*, Reed Books Australia

Chatto, R (2000) *Technical Report no. 69: Waterbird breeding colonies in the top end of the Northern Territory*, Parks and Wildlife Commission of the Northern Territory

Chatto, R (2001) *The distribution and status of colonial breeding sea birds in the Northern Territory*, Parks and Wildlife Commission of the Northern Territory

Chatto, R (2003) *The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory*, Parks and Wildlife Commission of the Northern Territory

Chatto, R (2006) *The distribution and status of water birds around the coast and coastal wetlands of the Northern Territory*, Parks and Wildlife Commission of the Northern Territory

Chatto, R & Baker, B (2008) *The distribution and status of marine turtle nesting in the Northern Territory*, Parks and Wildlife Service, Department of Natural Resources, Environment, The Arts and Sport

Choquenot, D (1993) 'Growth, body condition and demography of wild banteng (*Bos javanicus*) on Cobourg Peninsula, Northern Australia', *Journal of Zoology*, **231**: 533-42

Clausnitzer, V, Kalkman, VJ, Ram, M, Collen, B, Baillie, JEM, Bedjanic, M, Darwall, WRT, Dijkstra, K-DB, Dow, R, Hawking, J, Karube, H, Malikova, E, Paulson, D, Schütte, K, Suhling, F, Villanueva, RJ, von Ellenrieder, N & Wilson, K (2009) 'Odonata enter the biodiversity crisis debate: The first global assessment of an insect group', *Biological Conservation*, **142**(8): 1864-9

Cobourg Peninsula Sanctuary and Marine Park Board (2009) *Annual Report 2008-2009*. Unpublished report, Cobourg Peninsula Sanctuary and Marine Park Board

Cobourg Peninsula Sanctuary Board (CPSB) (1987) *Gurig National Park Plan of Management*. Department of Natural Resources, Environment and the Arts

Cogger, HG and Lindner, DA (1969) 'Marine turtles of northern Australia', *Australian Zoologist*, **15**: 150-9

Cook, GD (1994) 'The fate of nutrients during fires in a tropical savanna', *Australian Journal of Ecology* **19:** 359-365

Cowie, ID, Short, PS and Osterkamp Madsen, M (2000) 'Floodplain Flora: A Flora of the Coastal Floodplains of the Northern Territory, Australia', *Australian Biological Resources Study*, Canberra

CSIRO (2009) 'Water in the Timor Sea Drainage Division. Water for a Healthy Country Flagship'. Australia Government, National Water Commission. [Online] http://www.clw.csiro.au/publications/waterforahealthycountry/nasy/documents/TimorSea/NASY-Timor-Sea-Drainage-factsheet.pdf

Davie, PJF (2002) 'Crustacea: Malacostraca: Phyllocarida, Hoplocarida, Eucarida (Part 1)', *Zoological Catalogue of Australia* **19.3A**. CSIRO Publishing: Collingwood.

Day, JW, Hall, CAS, Kemp, WM and Yanez-Arancibia, A (1989) *Estuarine Ecology*. John Wiley & Sons: New York

Department of Foreign Affairs (1974), *Background information on Cobourg Peninsula Wildlife Sanctuary*, report submitted to Ramsar Convention Secretariat

Department of the Environment, Water, Heritage and the Arts (2008a), 'Australian Indigenous cultural heritage, Culture Portal', [Online] http://www.cultureandrecreation.gov.au/articles/indigenous/ [accessed 17 November 2010]

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008b) 'National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands'. Canberra. [Online] http://www.environment.gov.au/water/publications/environmental/wetlands/pubs/module-2-framework.pdf

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009a), 'Bilateral migratory bird agreements', http://www.environment.gov.au/biodiversity/migratory/waterbirds/bilateral.html [Accessed October 15 2010]

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009b) 'Matters of National Environmental Significance: Significant impact guidelines 1.1 *Environment Protection and Biodiversity*

Conservation Act 1999'. Commonwealth of Australia, http://www.environment.gov.au/epbc/publications/pubs/nes-guidelines.pdf [Accessed October 15 2010]

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009c), 'Threat Abatement Plan for the impacts of marine debris on vertebrate marine life', http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2010) 'Australian National Shipwreck Database', https://apps5a.ris.environment.gov.au/shipwreck/public/wreck/search.do [Accessed October 5 2010]

Director of National Parks (2007) 'Kakadu National Park Management Plan 2007-2014'. Director of National Parks. [Online] http://www.environment.gov.au/parks/publications/kakadu/pubs/management-plan.pdf

Douglas, MM, Bunn, SE and Davies, P (2005) 'River and wetland food webs in Australia's wet-dry tropics: general principles and implications for management', *Marine and Freshwater Research* **56**: 329-342

Duke, NC (1992) *Mangrove Floristics and Biogeography*. In: Tropical Mangrove Ecosystems (Volume 41), Coastal and Estuarine Studies Series. (Eds. A.I. Robertson and D.M. Alongi) American Geophysical Union, Washington DC. pp 63-100

Eckert, KL, Eckert, SA, Adams, TW and Tucker, AD (1989) 'Inter-nesting migrations by leatherback sea turtles (*Dermochelys coriacea*) in the West Indies. *Herpetologica*, **45**: 190-94

Environment Australia (2003) *Recovery Plan for Marine Turtles in Australia*.

Environment Protection Agency (EPA) (2003) 'Stranding Report – Dugongs'. Environment Protection Agency and the Queensland Parks and Wildlife Service, [Online] http://www.epa.qld.gov/nature_cpnservation/wildlife/caring_for_wildlife/marine_strandings

Fensham, RJ (1993) 'The impact of pig rooting on populations of *Burmannia* sp., a rare rainforest herb on Bathurst Island', *Proceedings of the Royal Society of Queensland*, **103**: 5-12

Finlayson, CM, Cowie, ID and Bailey, BJ (1993) 'Biomass and litter dynamics in a *Melaleuca* forest on a seasonally inundated floodplain in tropical, Northern Australia'. *Wetlands Ecology and Management* **2**: 177–188

Finlayson, CM, Lowry, J, Grazia Bellio, M, Nou, S, Pidgeon, R, Walden, D, Humphrey, C and Fox, G (2006) 'Biodiversity of the wetlands of the Kakadu Region, northern Australia'. *Aquatic Science* **68**: 374-399

Fletcher, P, Bridgman, D and Dermoudy, P (2000) *Cobourg Peninsula Historic Sites: Gurig National Park*. Parks and Wildlife Commission of the Northern Territory, Australia

Foster, D (1997) *Australian Institute of Aboriginal and Torres Strait Islander Studies Report Series: Gurig National Park*, Australian Institute of Aboriginal and Torres Strait Islander Studies: Canberra

Frith, HJ & Calaby, JH (eds) (1974) *Fauna survey of the Port Essington District, Cobourg Peninsula, Northern Territory of Australia*, Division of Wildlife Research Technical Paper No. 28, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia

Fukuda, Y, Whitehead, P and Boggs, G (2007) 'Broad-scale environmental influences on the abundance of saltwater crocodiles (*Crocodylus porosus*) in Australia', *Wildlife Research* **34**: 167-176

Ganter E (1996) Indigenous participation in coastal management on the Northern Territory, Australia: issues and options. *Ocean and Coastal Management* **33**(1-3): 193-212

Geoscience Australia (2008) *Cobourg Peninsula Hydrogeological Assessment*. Unpublished draft report

GhostNets Program (2010), 'Marine debris data collected on 1st-3rd September 2010 on the Cobourg Peninsula, Northern Territory', letter to BMT WBM (9th November 2010)

Gomelyuk, VE (2000) *Assessment of condition of rock oysters at Cobourg Marine Park*, Northern Territory Parks and Wildlife Service, Darwin, N.T.

Gomelyuk, VE (2003) *Checklist of coral and rock reef fish species at Garig Gunak Barlu National Park*, Darwin, Australia

Gomelyuk, VE (2007) 'Severe coral bleaching in 2002-2003 at Cobourg Marine Park, Northern Territory, Australia', *The Beagle, Records of the Museums and Art Galleries of the Northern Territory* **23**: 11-9

Gomelyuk, VE (2009) 'Fish assemblages composition and structure in three shallow habitats in north Australian tropical bay, Garig Gunak Barlu National Park, Northern Territory, Australia', *Journal of the Marine Biological Association of the UK*, **89**(3): 449-60

Griffin, R (1995) *Wetland Habitats and Barramundi*. In: Wetland Research in the Wet-Dry Tropics of Australia. Supervising Scientist Report 101. pp. 64-68. [Online] http://environment.gov.au/ssd/publications/ssr/101.html

Harper, BA Stroud, SA McCormack, M and West, S (2008) 'A review of historical tropical cyclone intensity in northwestern Australia and implications for climate change trend analysis'. *Australian Meteorological Magazone* **57**(2): 121-141.

Harrison L, McGuire, L, Ward, S, Fisher, A, Pavey, C, Fegan, M and Lynch, B (2009) 'An inventory of sites of international and national significance for biodiversity values in the Northern Territory'. Department of Natural Resources, Environment, the Arts and Sport, Darwin, NT. http://www.nt.gov.au/nreta/environment/conservation/reports.html

Harrison R. (2005) 'Contact archaeology and native title', *Australian Aboriginal Studies* **2005/1**: 16-29

Hay, T, Gribble, N, de Vries, C, Danaher, K, Dunning, M, Hearnden, M, Caley, P, Wright, C, Brown, I, Bailey, S & Phelan, M (2005) *Methods for monitoring the abundance and habitat of the northern Australia mud crab Scylla serrata. Final Report FRDC Project 2000/142*, Northern Territory Department of Business, Industry and Resource Development

Hennessy, K, Page, C, McInnes, K, Walsh, K, Pittock, B, Bathols, J and Suppiah, R (2004) *Climate Change in the Northern Territory*. Consultancy report for the Northern Territory Department of Infrastructure, Planning and Environment. CSIRO Atmospheric Research. [Online] http://www.cmar.csiro.au/e-print/open/hennessy_2004a.pdf

Heritage Advisory Council, Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (2010) 'NT Heritage Register', [Online] http://www.nt.gov.au/nreta/heritage/ntregister/index.html [Accessed October 29, 2010]

Heritage Advisory Council, Department of Natural Resources, Environment, the Arts and Sport (NRETAS) (2007), 'Cape Don Lighthouse Complex', [Online] http://www.nt.gov.au/nreta/heritage/ntregister/declared/capedon/index.html [Accessed October 29, 2010]

Hewitt, J, Thrusfh, S & Dayton, P (2008) 'Habitat variation, species diversity and ecological functioning in a marine system', *Journal of Experimental Marine Biology and Ecology*, **366**(1-2): 116-22

Higgins M. (1999) Indigenous Natural Resource Management: Attitudes and Activities Relating to Feral Animals. Honours thesis, La Trobe University Melbourne

Hoegh-Guldberg, O, Anthony, K, Berkelmans, R, Dove, S, Fabricus, K, Lough, J, Marshall, P, van Oppen, M, Negri, A & Willis, B (2007), 'Chapter 10: Vulnerability of reef-building corals on the Great Barrier Reef to climate change', in J Johnson & P Marshall (eds), *Climate Change and the Great Barrier Reef: A Vulnerability Assessment*, Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia

Hope, R & Smit, N (1998) 'Marine turtle monitoring in Gurig National Park and Coboug Marine Park', in Kennett, R, Webb, A, Duff, G, Guinea, M and Hill, G (eds), *Marine Turtle Conservation and Management in Northern Australia*, Northern Territory University, Darwin, pp. 53-62

Hughes, RJ (1978) *The Geology and Mineral Occurrences of Bathurst Island, Melville Island and Cobourg Peninsula, Northern Territory*. Department of National Resources, Bureau of Mineral Resources, Geology and Geophysics, Australian Government Publishing Service, Canberra

Hughes, RJ and Senior, BR (1973) *Progress Report on the Geology of the Bathurst Island, Melville Island, Cobourg Peninsula and Fog Bay 1:250,000 Sheet Areas, Northern Territory*. Department of Minerals and Energy, Bureau of Mineral Resources, Geology and Geophysics, Canberra

Indigenous Studies Program, University of Melbourne (ISP) (2007) Agreements, Treaties and Negotiated Settlements Project: *Cobourg Peninsula Aboriginal Land and Sanctuary Act 1981* (NT)', [Online] http://www.atns.net.au/agreement.asp?EntityID=1646 [Accessed October 5 2010]

Jelbart, J, Ross, P & Connoly, R (2007) 'Fish assemblages in seagrass beds are influenced by the proximity of mangrove forests', *Marine Biology*, **150**: 993-1002

Leach GJ, Delaney R and Fukuda, Y (2009) 'Management Program for the Saltwater Crocodile in the Northern Territory of Australia, 2009 – 2014'. Northern Territory Department of Natural Resources,

Environment, The Arts and Sport, Darwin. [Online] http://www.nt.gov.au/nreta/wildlife/programs/pdf/crocmanagementplan_2009.pdf

Letts, G (1964) 'Feral animals in the Northern Territory', *Australian Veterinary Journal*, **40**: 84-8

Letts, GA, Bssingwaithe, A and de Vos, WEL (1979) *Feral animals of the Northern Territory: report of the Board of Inquiry*. (Government printer: Darwin)

Limpus, CJ (2008) *A biological review of Australian marine turtles*, Queensland Environmental Protection Agency. Freshwater and Marine Sciences Unit

Lonsdale, WM and Lane, AM (1994) 'Tourist vehicles as vectors of weed seeds in Kakadu National Park, Northern Australia', *Biological Conservation* **69**(3): 277-283

MacFarlane, WJ (1996) 'Habitat Utilisation by Macroinvertebrates and Fish and Their Trophic Interactions in Magela Creek' Internal report 211, Supervising Scientist, Canberra

Manson, FJ, Loneragan, NR, Harch, BD, Skilleter, GA, Williams, L (2005) 'A broad-scale analysis of links between coastal fisheries production and mangrove extent: A case-study for northeastern Australia', *Fisheries Research* **74**: 69-85

McGladdery, S E 2007, 'Why the interest in pearl oyster health?' pp. 3-6. In: Bondad-Reantaso, MG, McGladdery, SE, and Berthe, FCJ. *Pearl oyster health management: a manual.* FAO Fisheries Technical Paper No. 503. Rome, FAO. 120p

Melville, AJ and Connolly, RM (2003) 'Spatial analysis of stable isotope data to determine primary sources of nutrition for fish' *Oecologia* **136**: 499–507

Meynecke, J-O, Lee, SY & Duke, NC (2008) 'Linking spatial metrics and fish catch reveals the importance of coastal wetland connectivity to inshore fisheries in Queensland, Australia', *Biological Conservation*, **141**: 981-96

Millennium Ecosystem Assessment (2003) *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washington, D.C.

Mitchell, S (1995) 'Foreign contact and indigenous exchange networks on the Cobourg Peninsula, north western Arnhem Land', *Australian Aboriginal Studies* **1995/2**: 44-48

Mitchell, S. (1996) 'Dugongs and dugouts, sharptacks and shellbacks: Macassan contact and Aboriginal marine hunting on the Cobourg Peninsula, North Western Arnhem Land', *Indo-Pacific Prehistory Association Bulletin* **15** (Chiang Mai Papers, Volume 2):181-191

NAFI, (2010) North Australian Fire Information website [Online] http://www.firenorth.org.au/nafi2/ [Accessed 10/11/10]

Nagelkerken I, Blaber SJM, Bouillon S, Green P, Haywood M, Kirton LG, Meynecke JO, Pawlik J, Penrose HM, Sasekumar A, Somerfield PJ (2008) 'The habitat function of mangroves for terrestrial and marine fauna: A review', *Aquatic Botany* **89**: 155-185

National Land and Water Resources Audit (NLWRA) (2002) *Report of the National Land and Water Resources Audit*. Turner, Australian Capital Territory

National Ocean and Atmospheric Administration (NOAA) (2010) [Online] http://coralreefwatch.noaa.gov/satellite/ [Accessed 12 October 2010]

Nichols, W, Killingbeck, K & August, P 1998, 'The influence of geomorphological hetereogeneity on biodiversity II. a landscape perspective', *Conservation Biology*,**12**(2): 371-9

Northern Land Council (NLC) (2003), 'Northern Land Council', [Online] http://www.nlc.org.au/ [Accessed October 5 2010]

NRETA (2007) 'Corals in the Northern Territory – Fact Sheet', Department of Natural Resources, Environment and The Arts, [Online] http://www.nt.gov.au/nreta/wildlife/marine/pdf/coralreefs.pdf

NRETAS (2007) *Cobourg Marine Park Plan of Management*, Department of Natural Resources, Environment, The Arts and Sport

Palmer, C, Fitzgerald, P, Wood, A, McKenzie, A (2010) *2010 Report - Monitoring and assessment of inshore dolphins in Cobourg Marine Park (Garig Gunak Barlu National Park) Project no. 2007 / 134*, Northern Territory Department of Natural Resources, Environment, The Arts and Sport

Panton, W (1993) 'Assessment of Banteng grazing on coastal plains, Cobourg Peninsula: an update on Bowman (1993)', *Northern Territory Naturalist*, **14**: 7-9

Papayannis, T and Pritchard, DE (2008) *Culture and wetlands – a Ramsar guidance document*, Ramsar Convention, Gland, Switzerland

Parks and Wildlife Commission of the Northern Territory (PWCNT) (1998) *Information Sheet on Ramsar Wetlands (RIS) – Cobourg Peninsula*. Obtained from http:\\www.environment.gov.au

Parks and Wildlife Commission of the Northern Territory (PWCNT) (2010) *Garig Gunak Barlu National Park Draft Plan of Management*

Parks and Wildlife Service of the Northern Territory, Department of Infrastructure, Planning and Environment (2003) 'Draft management program for the dugong (*Dugong dugon*) in the Northern Territory of Australia'

Peterson, N and Tonkinson, M (1979) *Cobourg Peninsula and Adjacent Islands Land Claim*. Darwin, Northern Land Council

Petty, A, Douglas, M, Ferdinands, K (2008) Riparian Zones and Paperbarks: 'Landscape change'. In: *Kakadu National Park Landscape Symposia Series 2007-2009*. Symposium 1: Landscape Change Overview, 17-18 April 2007, South Alligator Inn, Kakadu National Park. Internal Report 532, Supervising Scientist, Darwin. pp 35-42 [Online]
http://environment.gov.au/ssd/publications/ir/pubs/ir532.pdf

Prowse, G, Zaar, U and Matthews, I (1999) *Water Resources East Central Arnhem Land*, Northern Territory Department of Lands, Planning and Environment

Pusey, B, Kennard, MJ and Arthington, AH (2004) *Freshwater Fishes of North-Eastern Australia*. CSIRO Publishing

Ramsar Convention Secretariat (2007) *Designating Ramsar sites:* 'The Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance', *Ramsar handbooks for the wise use of wetlands* (3rd Edition), **14**. Ramsar Convention Secretariat, Gland, Switzerland

Ramsar Convention Secretariat (2010) 'The List of Wetlands of International Importance' http://www.ramsar.org/pdf/sitelist.pdf [Accessed October 5, 2010]

Roberts, R, Jones, R and Smith MA (1993) 'Optical dating at Deaf Adder George, Northern Territory, indicates human occupation between 53,000 and 60,000 years ago', *Australian Archaeology* **31**: 58-59

Roelofs, A, Coles, RG and Smit, N (2005) 'A Survey of Intertidal Seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island'. Report to the National Oceans Office. Tasmania, Australia. [Online] http://www.environment.gov.au/coasts/mbp/publications/north/pubs/seagrass-survey-report-2005.pdf

Russell D, (2004) 'Aboriginal–Makassan interactions in the eighteenth and nineteenth centuries in northern Australia and contemporary sea rights claims' *Australian Aboriginal Studies*: 3-17

Russell-Smith, J (1991) 'Classification, species richness, and environmental relations of 2004/1monsoon rain forest in northern Australia', *Journal of Vegetation Science*, **2**: 259-78

Russell-Smith, J, Yates, CP, Whitehead, PJ, Smith, R, Craig, R, Allan, GE, Thackway, R, Frakes, I, Cridland, S, Meyer, MCP & Gill, AM (2007) 'Bushfires 'down under': patterns and implications of contemporary Australian landscape burning', *International Journal of Wildland Fire*, **16**(4): 361-77

Russell-Smith, J (1995) 'Fire management'. In: *Kakadu: Natural and Cultural Heritage and Management*. (eds Press, T, Lea, D, Webb, A and Graham, A) Australian National University North Australia Research Unit, Darwin. pp 217–237

Russell-Smith, J (1995) 'Flora'. In: *Kakadu: Natural and Cultural Heritage and Management*. (eds Press, T, Lea, D, Webb, A and Graham, A) Australian National University North Australia Research Unit, Darwin. pp 127–166

Russell-Smith, J and Bowman, DMJS (1992) 'Conservation of monsoon rainforest isolates in the Northern Territory', *Biological Conservation* **59**: 51-63

Salinger, MJ, Renwick, JA, Mullan, AB (2001) 'Interdecadal Pacific Oscillation and South Pacific Climate', *International Journal of Climatology* **21:** 1705-1721

Saynor, M J, Walden, D, Hall, R, Ryan, B (2000) 'Climate Record for the Alligator Rivers Region'. Paper 3. In: *Assessment and Monitoring of Coastal Change in the Alligator Rivers Region, Northern Australia*. (Eds. I Eliot, M Saynor, M Eliot and C Finlayson) Supervising Scientist Report 157, Supervising Scientist, Darwin. pp. 51-56. [Online] http://www.environment.gov.au/ssd/publications/ssr/pubs/ssr157.pdf

Skeat, AJ, East, TJ and Corbett, LK (1996) 'Impact of Feral Water Buffalo'. In: *Landscape and Vegetation Ecology of the Kakadu Region, Northern Australia*. (Eds. CM Finlayson and I von Oertzen) Kluwer Academic Publishers, Netherlands. pp 155–177

Skilleter, G, Olds, A & Loneragan, N (2005) 'The value of patches of intertidal seagrass to prawns depends on their proximity to mangroves', *Marine Biology*, **147**: 353-65

Sloan, S, Wallner, B and Mounsey, R (1998) *Fishing Debris around Groote Eylandt in the Western Gulf of Carpentaria*. Australian Fisheries Management Authority: Canberra

Specht, RL (ed.) (1964) 'American-Australian scientific expedition to Arnhem Land', *Zoology* **4**

Stern, H, de Hoedt, G and Ernst, J (2003) *Objective Classification of Australia Climates*. Commonwealth Bureau of Meterology, Melbourne. [Online] http://www.bom.gov.au/climate/environ/other/koppen_explain.shtml

Tacon, P (1988) *Three Cultures: An investigation into the Aboriginal, European and Macassan archaeological sites of the Cobourg Peninsula, N.T., Australia*. A report to the Conservation Commission of the Northern Territory. Australian National University, Canberra

Tacon, P and Davies, S (2004) 'Transitional traditions: 'Port Essington' bark-paintings and the European discovery of Aboriginal aesthetics', *Australian Aboriginal Studies* **2004/2**: 72-86

Timmins, R, Duckworth, J, Hedges, S, Steinmetz, R & Pattanavibool, A (2008) *Bos* '*javanicus*', [Online] http://www.iucnredlist.org [Accessed 12 November 2010]

Toyne P, and Johnston, R (1991) 'Reconciliation, or the new dispossession? Aboriginal land rights and nature conservation', *Habitat* **June 1991**: 8-10

Turner, M & Batianoff, G (2007) 'Chapter 20 - Vulnerability of island flora and fauna in the Great Barrier Reef to climate change', in J Johnson & P Marshall (eds), *Climate Change and the Great Barrier Reef*, Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia

Ummenhofer, C, England, M, McIntosh, P, Meyers, G, Pook, M, Risbey, J, Sen Gupta, A, Taschetto, A (2009) 'What causes southeast Australia's worst droughts?', *Geophysical Research Letters*, **36**

UNEP/CMS Secretariat (2004) 'CMS – Convention on Migratory Species', [Online] http://www.cms.int/ [Accessed October 15 2010]

van Dam, RA, Walden, DJ and Begg, GW (2002) 'A Preliminary Risk Assessment of Cane Toads in Kakadu National Park'. Scientist Report 164, Supervising Scientist, Darwin. [Online] http://www.environment.gov.au/ssd/publications/ssr/pubs/ssr164.pdf

Vigilante, T and Bowman, DMJS (2004) 'The effects of fire history on the structure and floristic composition of woody vegetation around Kalumburu, North Kimberley: a landscape-scale natural experiment', *Australian Journal of Botany* **52**: 381–415.

Ward, J, Tockner, K & Schiemer, F (1999) 'Biodiversity of floodplain river ecosystems: ecotones and connectivity', *Regulated Rivers: Research & Management*, **15**(1-3): 125-39

Wasson, RJ, Bayliss, P and Cleland, S (in prep.) *River Flow and Climate in the 'Top End' of Australia for the Last 1000 Years, and the Asian-Australian monsoon*

Webb, GJW, Manolis, SC and Ottley, B (1994) *Crocodile Management and Research in the Northern Territory: 1992-94*. Proceedings of the 12th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of the IUCN. Pattaya, Thailand, 2-6 May 1994. IUCN (The World Conservation Union), Gland, Switzerland

West, J (1998) 'Language's consequences: a test of linguistic-based measures of culture using Hofstede's dimensions', [Online] http://www.joelwest.org/Papers/WestGraham1998.pdf [Accessed 15 October 2010]

Wetlands International (2006) *Waterbird Population Estimates – Fourth Edition*. Wetlands International, Wageningen, The Netherlands

White N and Meehan, B (1993) 'Traditional ecological knowledge: A lens on time'. In: *Traditional Ecological Knowledge: Wisdom for Sustainable Development*. (Eds: Williams N & Baines, G) Centre for Resource and Environmental Studies, Australian National University, Canberra. pp 31-40

White, D (2003) *Marine Debris in Northern Territory Waters 2003*. WWF-Australia Report, WWF-Australia: Sydney

White, D (2006) *Marine Debris in Northern Territory Waters 2004*. WWF-Australia Report, WWF-Australia: Sydney

Wightman, GM (1989) 'Mangroves of the Northern Territory', *Northern Territory Botanical Bulletin*. Conservation Commission of the Northern Territory, Darwin

Williams, RJ, Griffiths, AD and Allan, GE (2002) 'Fire regimes and their impacts in the mulga (*Acacia aneura*) landscapes of central Australia', in *Australian Fire Regimes: Contemporary Patterns and Changes Since European Settlement. State of the Environment Second Technical paper Series (Biodiversity), Series 2*. Department of Environment and Heritage

Wilson, GE (1974) *Map and Technical Description of Cobourg Peninsula Flora and Fauna Reserve prepared by the Department of Northern Australia to the Department of Foreign Affairs* (in relation to the nomination of the site under the Ramsar Convention)

Wilson, BA, Brocklehurst, PS, Clark, MJ & Dickinson, KJM (1990) *Vegetation survey of the Northern Territory, Australia: Explanatory notes to accompany 1:1 000 000 map sheets*

Woinarski, JCZ and Baker, B (2002) 'Biodiversity Audit - Bioregional case study: Tiwi-Cobourg bioregion, Northern Territory', *National Land & Water Resources Audit - A program of the Natural Heritage Trust*

Woinarski, JCZ and Gambold, N (1992) 'Gradient analysis of a tropical herpetofauna: distribution patterns of terrestrial reptiles and amphibians in Stage III of Kakadu National Park, Australia', *Wildlife Research*, **19**: 105-127

Young, E (2003) 'Can a fence halt the march of the cane toad?', *New Scientist*, **179**(2411): 11

Zaar, U (2003) *Water resources of West Arnhem Land*, Department of Infrastructure, Planning and Environment: Conservation and Natural Resources Group, Darwin, NT

9 GLOSSARY

Arrarrkbi (also spelt Arrarrbi), the Iwaidja language name used for traditional Indigenous owners of Garig Gunak Barlu National Park (literal translation is 'human, man or indigenous person')

Acceptable change, means the variation that is considered acceptable in a particular measure or feature of the ecological character of the wetland. Acceptable variation is that variation that will sustain the service, component or process to which it refers.

Aeolian sedimentation, means deposition of material transported by wind.

Aquatic/marine fauna, in the context of this report relates to fauna species that spend all or the majority of their life cycle in or underwater. As such this grouping primarily relates to fish, marine reptiles, aquatic mammals such as dugong and cetaceans, and aquatic/marine invertebrates.

Djang, Dreaming track or place; sacred site in Arrarrkbi culture

Ecological character, defined under Resolution IX.1 Annex A: 2005 of the Ramsar Convention as, the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.

Expert opinion, in the context of interpreting LAC relates to competent, experienced, independent individuals that have formal qualifications or otherwise expert knowledge in the disciplines of wetland ecology, hydrology or associated fields.

IMCRA bioregion, refers to the Interim Marine and Coastal Regionalisation for Australia (Provincial Scale) to the 200 metre isobath and derived from biological and physical data, (for example, coastal geomorphology, tidal attributes, oceanography, bathymetry and intertidal invertebrates).

Isthmus, a relatively narrow strip of land (with water on both sides) connecting two larger land areas.

Lowest Astronomical Tide (LAT), The lowest levels which can be predicted to occur under average meteorological conditions. In Australia this is the zero value from which all tides are measured.

Mean Low Water Springs (MLWS), the average lowest level to which tides retreat during the period of greatest tidal range (that is spring tides).

National ECD Framework document, refers to the National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands (DEWHA 2008) and its successive documents as endorsed by the Natural Resource Management (NRM) Ministerial Council.

Phreatophytic Vegetation, vegetation that extends root systems into groundwater aquifers.

Ramsar Criteria, refers to the nine Criteria for the listing of a site as internationally significant under the provisions of the Ramsar Convention. Also referred throughout the report as the Nomination Criteria for the site.

Sedimentation, means the process of deposition of sediment of any size. This is often colloquially referred to as siltation, but this term implies that only silt-sized material is deposited.

Shorebirds, as used in this report, refers to both resident and migratory species which are ecologically dependent upon wetlands from the following families: Scolopacidae; Burhinidae; Haematopodidae; Recurvirostridae; Charadriidae; and Glareolidae. Shorebirds form a sub-set of the waterbird grouping.

Values, means the perceived benefits to society, either direct or indirect that result from wetland functions. These values include human welfare, environmental quality and wildlife support.

Waterbirds, refers to those species which are ecologically dependent upon wetlands from the following families: Anseranatidae, Anatidae, Podicipedidae, Anhingidae, Phalacrocoracidae, Pelecanidae, Ardeidae, Threskiornithidae, Ciconiidae, Gruidae, Rallidae, Scolopacidae, Rostratulidae, Jacanidae, Burhinidae, Haematopodidae, Recurvirostridae, Charadriidae, Glareolidae, Laridae and Sternidae (after Kingsford and Norman 2002; Wetlands International 2006). Only those species of gulls (Laridae) and terns (Sternidae) which make extensive use of shallow, inshore waters or inland wetlands are included. Whilst at least some other species of other families traditionally regarded as “seabirds” (that is, Spheniscidae, Phaethontidae, Sulidae, Fregatidae, Stercorariidae and Alcidae) also make use of shallow, inshore waters (and thus could be therefore be considered as waterbirds), these have not been included in the waterbird group (following precedent within Wetlands 2006). Shorebirds form a sub-set of the waterbird grouping.

Wetlands, is used in this report in the context of the definition under the Ramsar Convention which includes, areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Wetland-dependent terrestrial fauna, in the context of this report relates to fauna species that occur within or otherwise are dependent on wetland habitats but do not spend the majority of their life cycle underwater (for example, non-aquatic species). As such this grouping primarily relates to birds, amphibians such as frogs, non-aquatic mammals such as water mouse, non-aquatic reptiles and terrestrial invertebrates.

Wetland flora, in the context of this report relates to flora species that are characterised as wetland or wetland-dependent species or populations.

Wetland ecosystem components, as defined in the ECD National Framework document, are the physical, chemical and biological parts or features of a wetland.

Wetland ecosystem processes, as defined in the National Framework document, are the dynamic forces within the ecosystem between organisms, populations and the non-living environment. Interactions can be physical, chemical or biological.

Wetland ecosystem benefits or services (includes the term ecosystem services), as defined in the National Framework document, are the benefits that people receive from wetland ecosystems. In general, benefits and services are based on or underpinned by wetland components and processes and can be direct (for example, food for humans or livestock) or indirect (for example, wetland provides habitat for biota which contribute to biodiversity).

APPENDIX A: COBOURG PENINSULA WETLAND MAPS

High Point

Giles Point

Irgul Point

Gulalung Point

RAFFLES BAY

Liamaryil River

NATIONAL PARK BOUNDARY

PROJECT ID 60156682
LAST MODIFIED dte 13-Dec-2010
FILE NAME 60156682G_ENV_01

AECOM

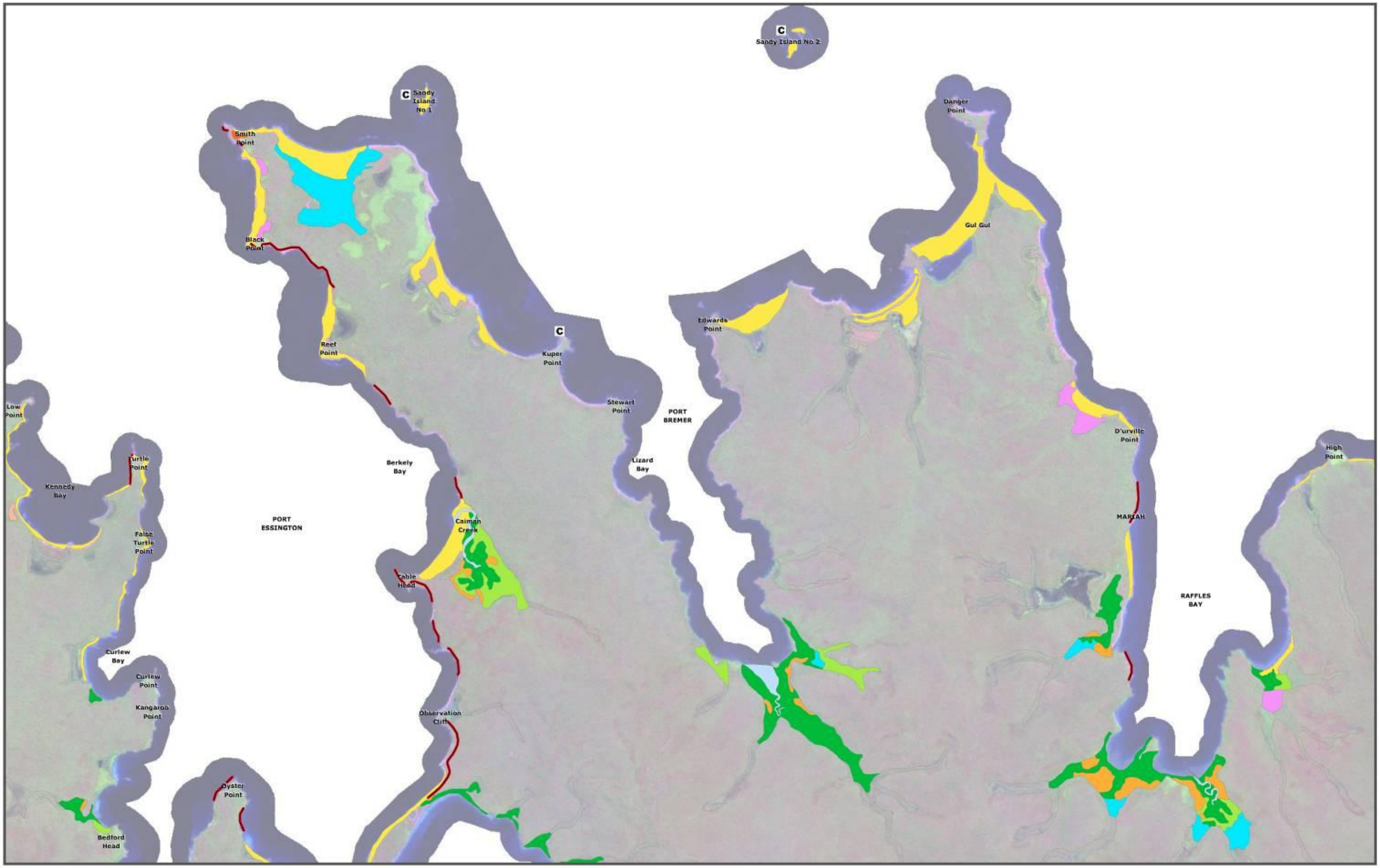
Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

C Coral Reefs
D - Rocky Marine Shores
F - Estuarine waters
Q - Permanent saline lakes
Ss - Seasonal saline marshes/pools
R - Seasonal saline lakes and flats
Sp - Permanent saline marshes/pools
I - Intertidal forested wetlands/mangroves
H - Intertidal marshes
G - Intertidal mud or salt flats
E - Sand

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset A



PROJECT ID: 60156682
LAST MODIFIED: dxe 13-Dec-2010
FILE NAME: 60156682G_ENV_01

AECOM

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

N W E S

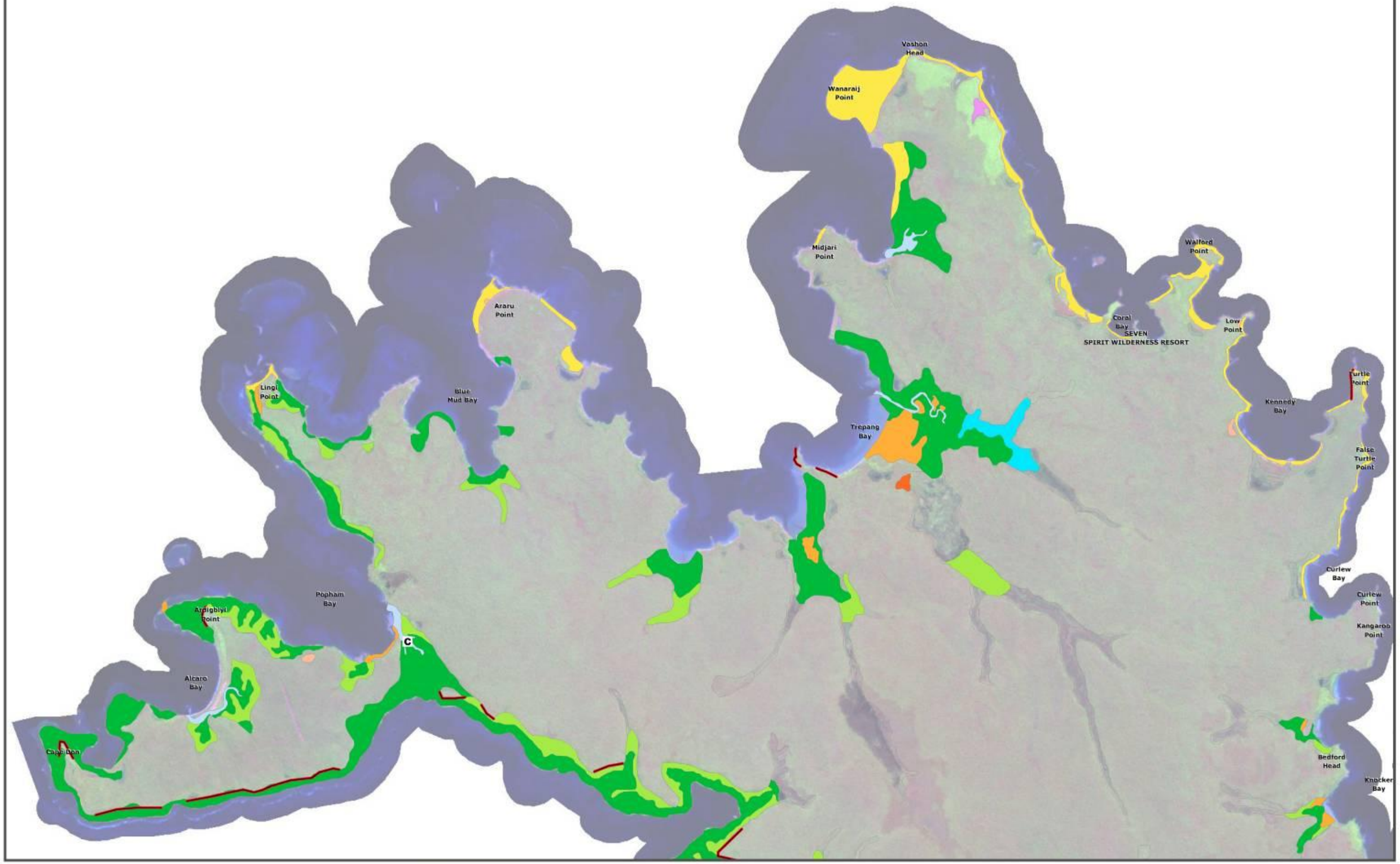
Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

C Coral Reefs
D - Rocky Marine Shores
F - Estuarine waters
Q - Permanent saline lakes
Ss - Seasonal saline marshes/pools
R - Seasonal saline lakes and flats
Sp - Permanent saline marshes/pools
I - Intertidal forested wetlands/mangroves
H - Intertidal marshes
G - Intertidal mud or salt flats
E - Sand

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset A



PROJECT ID 60156682
LAST MODIFIED dxe 13-Dec-2010
FILE NAME 60156682G_ENV_01

AECOM

N W E S

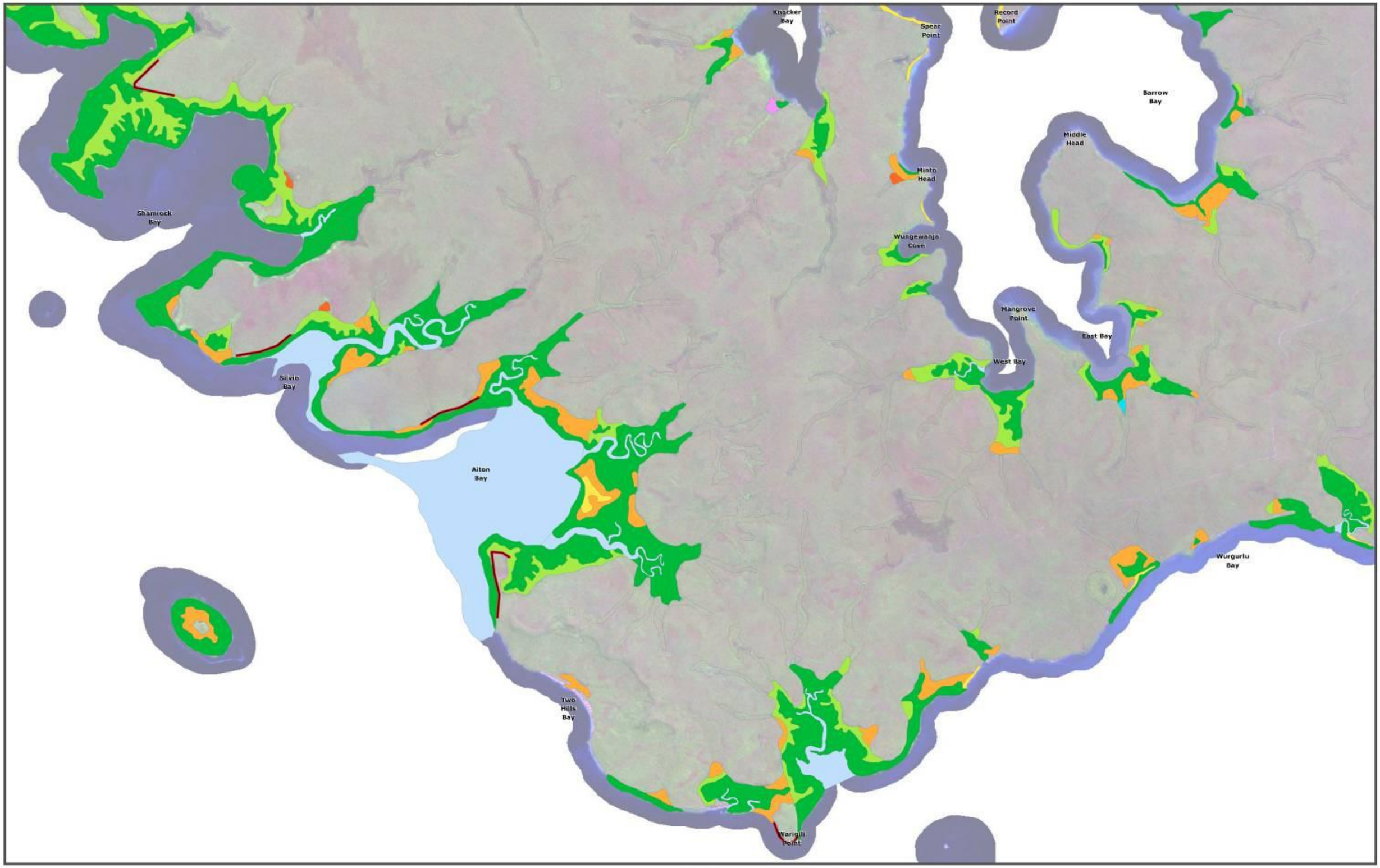
Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

C Coral Reefs	Q - Permanent saline lakes	Sp - Permanent saline marshes/pools	G - Intertidal mud or salt flats
D - Rocky Marine Shores	Ss - Seasonal saline marshes/pools	I - Intertidal forested wetlands/mangroves	E - Sand
F - Estuarine waters	R - Seasonal saline lakes and flats	H - Intertidal marshes	

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset A



PROJECT ID: 60156682
LAST MODIFIED: dec 13-Dec-2010
FILE NAME: 60156682G_ENV_01

AECOM

N W E S

Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

C Coral Reefs
D - Rocky Marine Shores
F - Estuarine waters
Q - Permanent saline lakes
Ss - Seasonal saline marshes/pools
R - Seasonal saline lakes and flats
Sp - Permanent saline marshes/pools
I - Intertidal forested wetlands/mangroves
H - Intertidal marshes
G - Intertidal mud or salt flats
E - Sand

RAMSAR WETLAND MAPPING AND CLASSIFICATION
Mapset A

Wurguriu Bay

Wangariu Bay

Warigili Point

Bluff Point

Wangoindjung Island

Warildagawaji Island

Webb Point

Wunamiyi Island

Morse Island

Nhoogout Island

PROJECT ID 60156682
LAST MODIFIED date 13-Dec-2010
FILE NAME 60156682G_ENV_01

AECOM

N W E S

Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

C Coral Reefs
D - Rocky Marine Shores
F - Estuarine waters
Q - Permanent saline lakes
Ss - Seasonal saline marshes/pools
R - Seasonal saline lakes and flats
Sp - Permanent saline marshes/pools
I - Intertidal forested wetlands/mangroves
H - Intertidal marshes
G - Intertidal mud or salt flats
E - Sand

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset A

High Point

Giles Point

Irgul Point

Gulalung Point

RAFFLES BAY

Llamaryl River

NATIONAL PARK BOUNDARY

PROJECT ID 60156682
LAST MODIFIED dw 13-Dec-2010
FILE NAME 60156682G_ENV_04

AECOM

Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

- J - Coastal brackish/saline lagoons
- P - Seasonal freshwater lakes
- Tp - Permanent freshwater marshes/pools
- Ts - Seasonal freshwater marshes/pools
- Xf - Freshwater tree-dominated wetlands
- N - Seasonal River/stream
- K - Coastal freshwater lagoons
- Y - Freshwater springs

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset B

Sandy Island No 2
Sandy Island No 1
Smith Point
Black Point
Reef Point
Kuper Point
Stewart Point
Low Point
Turtle Point
Kennedy Bay
False Turtle Point
PORT ESSINGTON
Berkely Bay
Lizard Bay
Caiman Creek
Table Head
Curlew Bay
Curlew Point
Kangaroo Point
Observation Cliff
Oyster Point
Bedford Head
Danger Point
Gul Gul
Edwards Point
PORT BREMER
D'urville Point
MARIAH
High Point
RAFFLES BAY

PROJECT ID 60156682
LAST MODIFIED dxe 13-Dec-2010
FILE NAME 60156682G_ENV_04

AECOM

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

N W E S

Scale: 1:100,000 (when printed at A3)

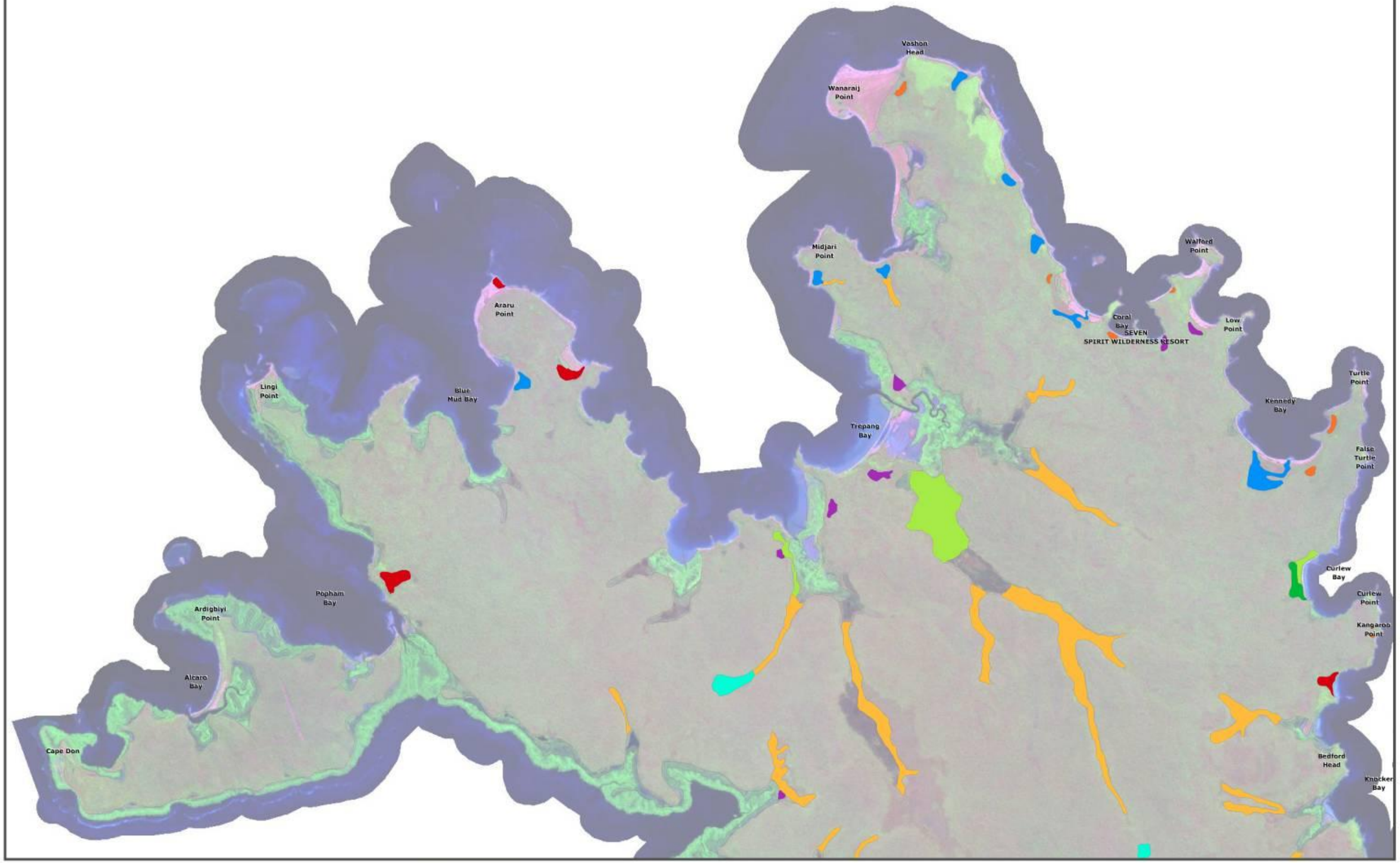
0 1 2 4
Kilometers

- J - Coastal brackish/saline lagoons
- P - Seasonal freshwater lakes
- Tp - Permanent freshwater marshes/pools
- Ts - Seasonal freshwater marshes/pools
- Xf - Freshwater tree-dominated wetlands
- N - Seasonal River/stream
- K - Coastal freshwater lagoons
- Y - Freshwater springs

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset B

2 of 5



PROJECT ID 60156682
LAST MODIFIED dxe 13-Dec-2010
FILE NAME 60156682G_ENV_04

AECOM

N W E S

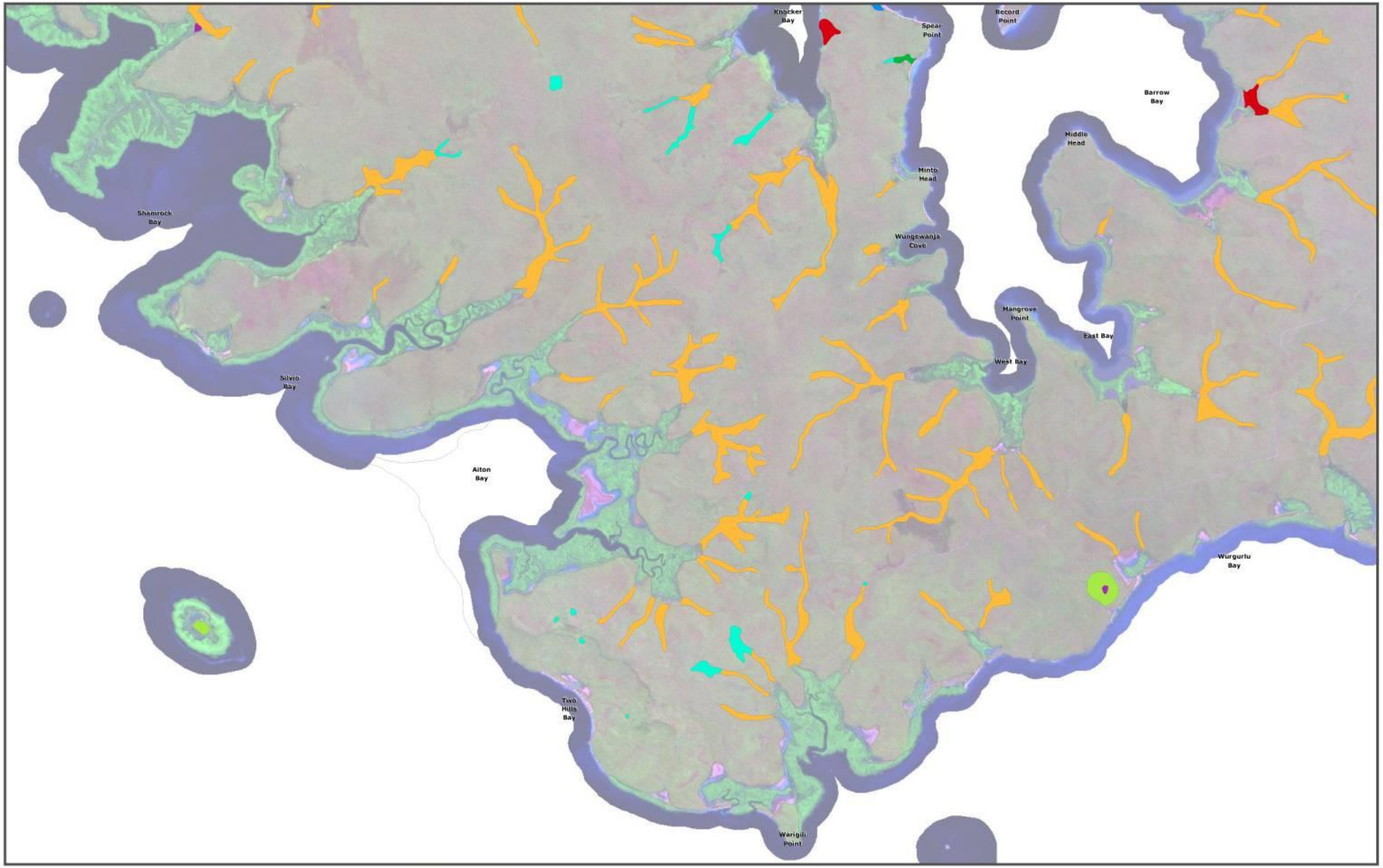
Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

- J - Coastal brackish/saline lagoons
- P - Seasonal freshwater lakes
- Tp - Permanent freshwater marshes/pools
- Ts - Seasonal freshwater marshes/pools
- Xf - Freshwater tree-dominated wetlands
- N - Seasonal River/stream
- K - Coastal freshwater lagoons
- Y - Freshwater springs

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset B



PROJECT ID 60156982
LAST MODIFIED dxe 13-Dec-2010
FILE NAME 60156682G_ENV_04

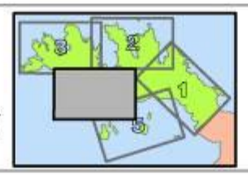
AECOM

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk.
AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

N W E S

Scale: 1:100,000
(when printed at A3)

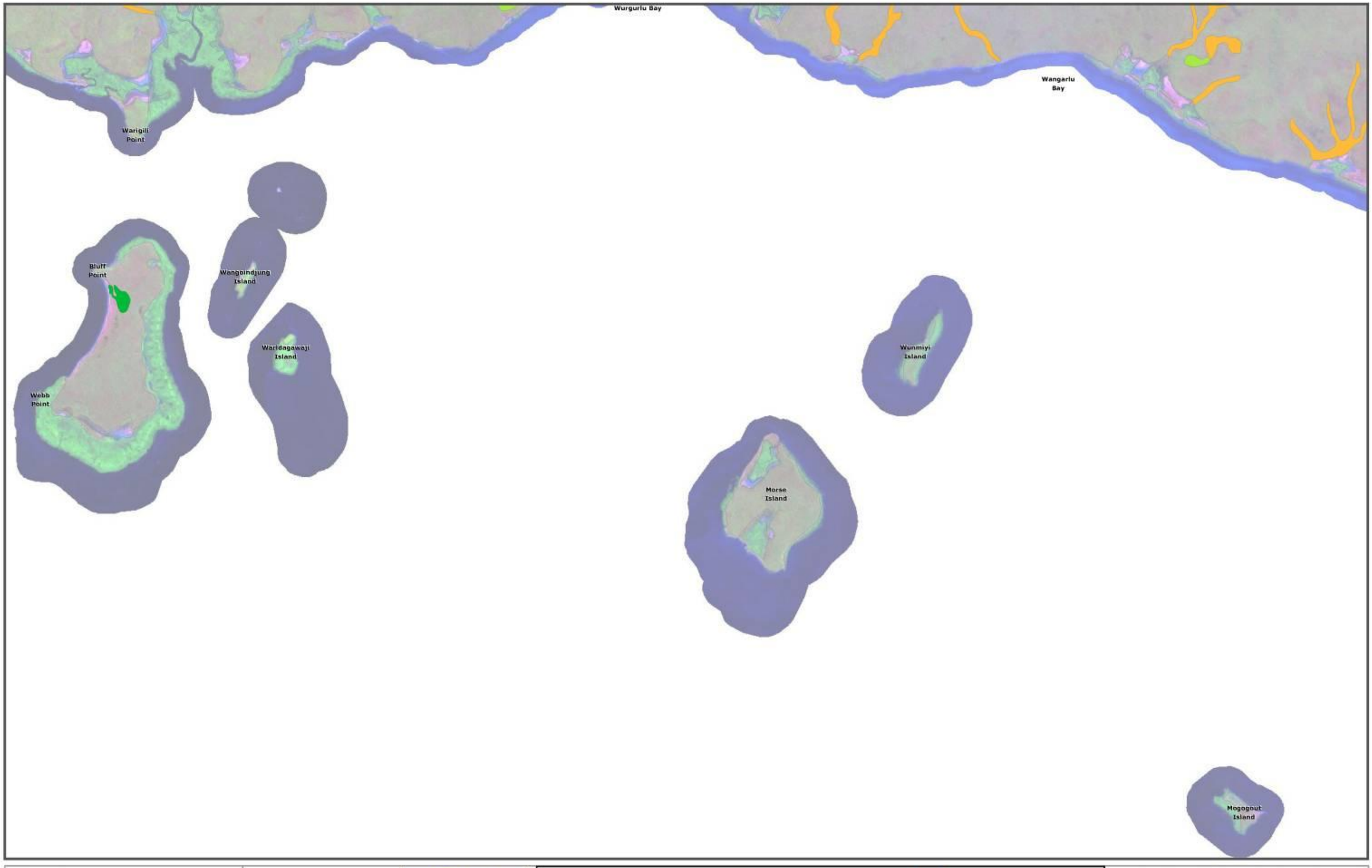
0 1 2 4
Kilometers



- J - Coastal brackish/saline lagoons
- P - Seasonal freshwater lakes
- Tp - Permanent freshwater marshes/pools
- Ts - Seasonal freshwater marshes/pools
- Xf - Freshwater tree-dominated wetlands
- N - Seasonal River/stream
- K - Coastal freshwater lagoons
- Y - Freshwater springs

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset B



PROJECT ID: 60156882
LAST MODIFIED: dxe 13-Dec-2010
FILE NAME: 60156882G_ENV_04

AECOM

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

N W E S

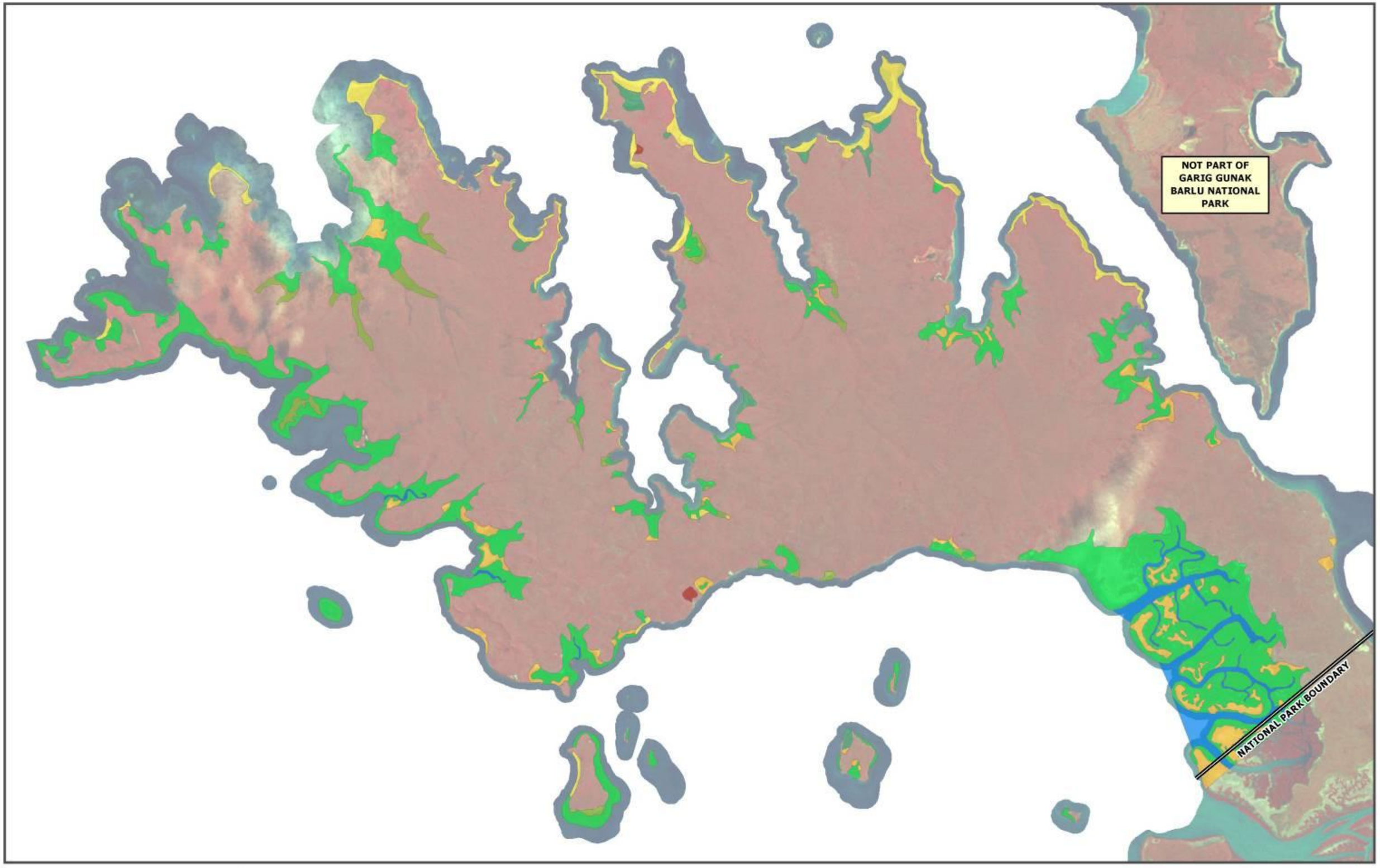
Scale: 1:100,000
(when printed at A3)

0 1 2 4
Kilometers

- J - Coastal brackish/saline lagoons
- P - Seasonal freshwater lakes
- Tp - Permanent freshwater marshes/pools
- Ts - Seasonal freshwater marshes/pools
- Xf - Freshwater tree-dominated wetlands
- N - Seasonal River/stream
- K - Coastal freshwater lagoons
- Y - Freshwater springs

RAMSAR WETLAND MAPPING AND CLASSIFICATION

Mapset B



PROJECT ID 60156682
LAST MODIFIED dve 27-Oct-2010
FILE NAME 60156682G_ENV_05

AECOM

Scale: 1:250,000
(when printed at A3)

0 2.5 5 10
Kilometers

- E: Sand, shingle or pebble shores
- F: Estuarine waters
- G: Intertidal mud or salt flats
- H: Intertidal marshes
- I: Intertidal forested wetlands/mangroves
- J: Coastal brackish/saline lagoons
- Xf: Freshwater tree-dominated wetlands

RAMSAR WETLAND MAPPING AND CLASSIFICATION
Historical Wetland Distribution (1973)

APPENDIX B: PROJECT COMMITTEES

The ECD and RIS update for the Cobourg Peninsula Ramsar site involved the formation of a Steering Committee to oversee development and review of the draft and final documents and a Knowledge Management Committee to provide expert input to the consultant project team about the site's ecological character.

B1 Steering Committee

A Steering Committee was created as part of the project and was chaired by the Department of Sustainability, Environment, Water, Population and Communities.

Steering Committee meetings undertaken during the project prior to submission of the draft document included:

Date	Type/Location	Meeting Purpose
24 May 2010	Teleconference	Provide overview of the scope of the project including the National Framework; discuss the draft critical services/benefits, component and processes.
December 2010	Face to Face	Presentation of the draft ECD for comment including overview of the structure, content and key findings of the document.
April 2011	Teleconference	Discussion on comments received on the Draft Final ECD and how these were to be addressed.

B2 Knowledge Management Committee

A Knowledge Management Committee (KMC) workshop was held on 16 July 2010 in Darwin. The agenda for the day consisted of a general presentation to provide an overview of the site and the methods to be used in preparing the ecological character description (based on the National Framework and Guidance).

The main focus of the day was a series of workshop style exercises that aimed to elicit from the KMC representatives:

- advice about the critical services/benefits that flow from the Nomination Criteria for the site including the noteworthy threatened flora and fauna species, important habitat features and services (for example, breeding, roosting, feeding) and similar matters
- advice about the critical services/benefits that are derived from human use or association with the site such as indigenous significance, fishing, recreational, tourism and similar activities (in a workshop setting)
- advice about the wetland processes (for example, hydrodynamics, water quality, etc) that underpin the wetland components in each of the conceptual model areas. This was important to

identify the most 'critical' processes that underlie wetland values in the study area and form the basis for future analysis of natural variability and limits of acceptable change

- advice about any perceived changes to ecological character of the site since listing and identification of previous or current threats to ecological character of the site (using a whiteboard exercise).

Notes on the key outcomes and comments made during the workshops are summarised in a progress report submitted to DSEWPaC during execution of the project.

B3 Stakeholder Consultation

B3.1 Background

Following on from the KMC workshop, one-on-one consultation meetings were undertaken with individuals or small groups of traditional owners or key stakeholders at their workplace, home or a nearby meeting venue. Traditional owners and stakeholders were identified in consultation with the Board of Management of Garig Gunak Barlu National Park, NT Parks and Wildlife staff and the Northern Land Council. Meetings were held in Darwin, Fogg Dam, Kakadu National Park, Garig Gunak Barlu National Park and Croker Island. The consultation meetings had the following objectives:

- To engage with and consult key stakeholders and traditional owners in appropriate forums.
- To empower key stakeholders and traditional owners to provide input into the study and for BMT WBM to gather information about key aspects of ecological character from the key stakeholders and traditional owners.
- To engender a shared understanding and acceptance of key management agencies of the critical natural and cultural services/benefits of the wetlands and the underpinning critical wetland processes and components which characterise the Ramsar values of Cobourg Peninsula.

The specific aims of the consultation meeting were to:

- provide information on the study and the process to be followed for development of an ECD
- present the outcomes of the KMC workshop
- provide a forum for feedback on the outcomes of the KMC workshop including identification of gaps and/or additional ecosystem services, components and processes, threats and ecological character changes that have occurred since listing
- document information on the ecological and cultural values of the site, and changes observed over time
- provide information on 'what's next' for the study.

Maps were used to assist discussions. In some cases, sites were visited with key stakeholders and issues discussed in the field. Notes were taken to record information provided by participants. The project flier was left with participants in case they wished to provide further information at a later date.

Traditional Owners and Board of Management members were paid for their time in accordance with payment rates advised by the Board of Management Registrar.

B3.2 Outcomes of Consultation

Twenty-two people were consulted on the project. Meetings were interactive and a substantial amount of information was shared by participants with the study team. The study team was also able to share information with participants on Ramsar in general and more specific topics. Topics covered included:

- Background to the project
- Why are we here?
- What is the Knowledge Management Committee meeting?
- Ramsar Convention
- Different types of wetland habitat types recognised by the Ramsar Convention
- Ramsar nomination Criteria
- Cultural characteristics
- Critical services
- Changes to the ecological character since listing
- Threats to the ecological character
- Continuing work.

Notes from the workshop were collated and provided to DSEWPaC as part of a progress report and used to develop the Cobourg Peninsula ECD and RIS Update documents.

B3.3 Conclusions

Successful meetings were held with a number of traditional owners and key stakeholders where substantial information was exchanged. While some people were not able to be consulted, a large effort was made to meet with these people and in most cases other people were able to speak on their behalf. Following field work, consultation was undertaken over the phone with some of the people who were unavailable for meetings.

Representatives from the Northern Land Council advised us that the traditional owners who we spoke to provided a good representation of the land owning clans of Cobourg Peninsula. The key stakeholders consulted were also able to provide valuable historical and current information on the natural and cultural values of Cobourg Peninsula.

The consultation meetings undertaken during fieldwork in August and September 2010, as described above, fulfilled the objectives of the Cobourg ECD and RIS Update Consultation Strategy by providing information to key stakeholders and traditional owners of Cobourg Peninsula and providing them with an opportunity to contribute to the study in an appropriate forum.

APPENDIX C: DETAILED METHODS

C1 Selection of Critical Services, Components and Processes

C1.1 Methods – Information Collation and Review Stage

The first step in ECD preparation outlined in the National Framework document is to identify the wetland services/benefits, wetland components and wetland processes present in the Ramsar site. These key terms are defined in the Glossary. This was initiated by undertaking a process of information collation and literature review.

As part of the information collation phase, literature and existing data relevant to the study area (site boundary and surrounds) were collated and reviewed. Relevant existing information was sourced from the following:

- published scientific papers
- database records (EPBC Protected Matters Search Tool, Parks Australia databases, etc.)
- quantitative data (bird count data, etc.)
- mapping products supplied by NRETAS and DSEWPaC (vegetation and wetland mapping)
- management plans, strategies and other policy documents
- grey literature from internet searches and other sources of data.

Each article of information was collated to a cursory level sufficient to determine its relevance to the study. The collected information was then reviewed to prioritise and identify information of direct relevance to the ECD.

As part of the information collation phase, key information sources to be used in the study were presented to the project Steering Committee and gaps were identified on the basis of these reviews. In some cases, additional information was supplied directly by Steering Committee representatives.

C1.2 Methods – Selection of Critical Components, Process and Services/Benefits

Following the information collation and review phase, the study team collectively identified the relevant components, processes and services/benefits of the wetland. This process was based primarily upon a review of the literature and professional opinion. Using the categories and list of components, processes and services/benefits from the National Framework as a guide, it was apparent that the Cobourg Peninsula Ramsar site provides a broad spectrum of components, processes and ecosystem services/benefits. This included: provisioning services such as provision of traditional foods, regulatory services such as erosion protection and water quality maintenance, cultural services such as recreational fishing and hunting, tourism, cultural heritage, education and

research and supporting ecosystem services such as biodiversity and the presence of endangered and vulnerable species.

Likewise, given the scope, areal extent and diversity of wetland environments present within the Cobourg Peninsula Ramsar site, all wetland components and processes from the National Framework were seen as occurring within the site, including a broad range of hydrological, climatic, geomorphologic, physiochemical, biogeochemical and biological processes. It was noted that while each of these processes play a part in underpinning normal wetland functioning, some of these factors such as coastal hydrodynamics and climate also operate at both regional scales and local scales.

As outlined in Section 2, a range of wetland habitat types are known to be present within the site boundaries including those designated within the coastal/marine, inland and man-made wetland categories under the Ramsar classification scheme. Within these systems, a rich diversity of wildlife exists from all the major groups of organisms (from planktonic organisms to vertebrates) which make up the components of the wetland.

With the full range of ecosystem components, processes and services/benefits represented, there was a need to identify the most important or critical in the context of the Ramsar site. Following the method within the National Framework, the assignment of a given wetland process, component or service/benefit as critical was determined with reference to the following criteria:

- the component, process or service/benefit is an important determinant of the unique character of the site
- the component, process or service/benefit is important for supporting one or more of the Ramsar Nomination Criteria under which the site was listed
- a change in a component, process or service/benefit is reasonably likely to occur over short or medium times scales (less than 100 years), and/or
- a change to the component, process or service/benefit will cause significant negative consequences.

To supplement the criteria from the National Framework, additional consideration was given to suggestions or recommendations regarding critical services, components or processes by the Steering Committee and Knowledge Management Committee (particularly where such information was also documented in scientific literature). Accordingly, a set of draft critical services/benefits were presented to the Knowledge Management Committee at its meeting in July 2010 and minor revisions made as part of this process.

In addition to critical components, processes and services/benefits, a range of other elements were identified as being important to the maintenance of biodiversity, morphological, physiochemical and biological processes. These 'supporting' components, processes and services/benefits, while important to wetland functioning, were in isolation were not considered to directly address the criteria listed above. For example, a change in water quality (a supporting process) would not itself be considered to result in a change to ecological character. While changes to a supporting element may result in an ecological response, it is considered that such changes would be adequately captured through assessment of LAC for critical components, processes or services/benefits.

Justification for inclusion of critical and supporting components, processes or services/benefits is provided in the body of this report.

In selecting key species/groups that underpin critical components, processes and services/benefits, the following methods were considered:

C1.3.1 Flora Species

In nominating particular wetland flora species or communities for consideration under the critical components, the following considerations were applied:

a. species should generally occur in aquatic environments (for example, macrophytes) or are otherwise considered to be wetland-associated species or communities, and

b. species or communities should be listed as threatened (that is, vulnerable or endangered) at the National (threatened under EPBC Act) and/or International (IUCN) level or are considered to be particularly noteworthy or critical from a regional biodiversity perspective (refer to Nomination Criterion 3). This includes species or communities that are perceived by the authors to be iconic to the site, or are designated as threatened under Northern Territory legislation (endangered or vulnerable at a State/Territory scale).

C1.3.2 Fauna Species

In nominating particular fauna species/groups for consideration under the critical components, the following considerations were applied:

1. Species should generally occur in aquatic or marine environments or are otherwise considered to be wetland-dependent terrestrial species (refer Glossary in Section 9 for definitions of these terms and Appendix D for list of species).

2. Species should be either:

    a. Designated as threatened (for example, endangered or vulnerable) at a national scale (under the EPBC Act) or international scale (under IUCN Red List), or

    b. Particularly noteworthy or critical from a regional biodiversity perspective (refer to Nomination Criteria 3 or 7). This includes species that are perceived by the authors to be iconic to the site, or are designated as threatened under Northern Territory legislation (endangered or vulnerable at a State/Territory scale).

3. Given the boundaries of the Ramsar site are largely confined to near-shore areas or internal waters, emphasis has been placed on inclusion of those species that use the site as core habitat, have significant population numbers and spend a large proportion of their life cycle within the site boundaries. This excludes vagrant species of conservation significance such as whales, sharks and migratory seabirds that may only occur in the Ramsar site infrequently but for which species records within the site exist.

C1.3.3 Populations

Populations of wetland biota that form the critical components are more generic groupings that recognise the abundance and diversity of animals that utilise the various wetland habitats of the site. This includes for example, amphibians, reptiles, mammals, fish, birds and aquatic invertebrates.

C2 Derivation of Limits of Acceptable Change

C2.1. General

Limits of Acceptable Change were derived using a staged approach as follows:

- determine values of the site. These represent the critical components (Section 3.4) and services/benefits (Section 3.8)
- identify critical processes underpinning site values. These are the critical processes, and are outlined in Section 3.6 of the report
- describe patterns in natural variability in critical components, processes and services/benefits indicators. Variability in indicators is described in Sections 3.4, 3.6 and 3.8 of the report
- define the patterns (short-term and long-term) in natural variability, and relative timescale of the LAC measure, and
- derive specific limits of acceptable change. The broad relative magnitude of acceptable change definitions was used to describe specific limits of acceptable change.

C2.2 Defining Relative Magnitude of Acceptability

The specific values of the site was determined on the basis of (i) known or likely patterns in the distribution and abundance of species and habitats that comprise the critical services/ benefits and components of the site, and (ii) expert opinion and or empirical data describing the criticality of the site to maintaining the survival of a species. Three levels of criticality were derived based on these factors (Least, Moderate and Highest Concern), as described in Table B-1 below.

Table C-1 Categories describing importance of the site to maintaining habitats and species that underpin the critical services/benefits and components

Distribution and criticality to populations	Abundant	Uncommon
Widespread globally and nationally, life-history functions supported in many areas elsewhere (species).	1a	2b
High diversity feature (habitat and community descriptor).	1b	2c
Habitat specialist with disjunct and very limited number of populations globally and nationally (species).	3a	3d
May be widespread nationally or regionally but is a critical breeding, staging or feeding site that is critical to survival of population (habitat and species).	3b	3e
Limited to bioregion but found in numerous basins, and is not known to be critical to survival of a species (habitat and species).	2a	3f
Limited to bioregion, found in a small number of basins and has limited distribution in the site (species).	3c	3g

Where least concern = 1 (green), of concern = 2 (yellow), most concern = 3 (orange)

The relative magnitude of acceptable change was then determined based on:

- The categories describing site values/importance described in Table B-1 above.
- Whether species/habitats that underpin the critical components or services/benefits are known or likely to be highly sensitive/intolerant to changes in environmental conditions.
- Known/likely patterns in natural temporal variability of indicators in the short-term (based on inter-annual cycles or episodic disturbance) and long-term (based on processes operating over time scales measured in decades). Three broad categories were adopted to describe variability at the two temporal scales (inter-annual and decadal):
  - Highly variable: greater than 60 percent change
  - Medium variable: ten to 60 percent change, and
  - Stable: less than ten percent change.
- A high level qualitative assessment of the consequences associated with changes in parameters outside natural variability was undertaken. Five consequence categories were derived, and are based in part on general risk categories developed by the SCFA – FRDC Project Team (2001) for the Risk Assessment Process for Wild Capture Fisheries (Version 3.2) (refer Table B-2).

Table C-2 Defining impact magnitude

Category	Habitat affected/modified	Key species	Ecosystem functioning
Major	Greater than 60 percent habitat	Mortality likely local extinction.	Total ecosystem collapse.
High	30-60 percent	Mortality may affect recruitment and capacity to increase.	Measurable impact to functions, and some functions are missing/ declining/ increasing outside historical range and/or facilitate new species to appear.
Moderate	five-30 percent	Mortality within some spp. Levels of impact at the maximum acceptable level.	Measurable changes to ecosystem components but no loss of functions (no loss of components).
Minor	less than five percent	Affected but no impact on local population status (e.g. stress or behavioural change to individuals).	Keystone species not affected, minor changes in relative abundance.
Negligible	less than one percent	No impact.	Possible changes, but inside natural variation.

APPENDIX D: FAUNA SPECIES LISTS

Site Mammal List

Scientific Name	Common Name	Reference Source						
		Begg 1983	EPBC Protected Matters Search 2010	NRETAS 2005	Woinarski 2002	Frith 1974	Marine Park Plan	AECOM 2011
BOVIDAE	**Bovids**							
Bos javanicus	banteng					✓		✓
Bubalus bubalis	feral water buffalo					✓		✓
CANIDAE	**Dogs and relatives**							
Canis familiaris dingo	dingo					✓		
CERVIDAE	**Deer**							
Cervus unicolor	sambar deer			✓				
DASYURIDAE	**Marsupial carnivores/insectivores**							
Antechinus bellus	fawn antechinus					✓		
Dasyurus hallucatus	northern quoll		✓	✓		✓		
Phascogale pirata	northern brush-tailed phascogale			✓				
DUGONGIDAE	**Dugongs**							
Dugong dugon	Dugong	✓					✓	✓
EMBALLONURIDAE	**Sheath-tailed bats**							
Taphozous flaviventris	yellow-bellied sheath-tailed bat					✓		
EQUIDAE	**Horses**							
Equus caballus	Timor pony					✓		
HIPPOSIDERIDAE	**Old world leaf-nosed bats**							
Rhinonicteris aurantius	orange horseshoe bat					✓		
MACROPODIDAE	**Kangaroos, wallabies and allies**							
Macropus agilis	agile wallaby					✓		
Macropus antilopinus	antilopine kangaroo					✓		
MURIDAE	**True mice, rats and gerbils**							
Conilurus pencillatus	brush-tailed rabbit-rat		✓	✓	✓	✓		✓
Hydromys chrysogaster	water-rat							
Mesembriomys gouldii	black-footed tree-rat					✓		
Melomys burtoni	grassland melomys	✓				✓		
Pseudomys delicatulus	delicate mouse					✓		
Rattus tunneyi	pale field rat					✓		
Xeromys myoides	water mouse		✓	✓				✓
MOLOSSIDAE	**Freetail bats**							
Mormopterus loriaecoburgiana	little north-western freetail bat		✓		✓			
PERAMALIDAE	**Bandicoots**							
Isoodon macrourus	northern short-nose bandicoot					✓		
PETAURIDAE	**Possums and gliders**							
Petaurus breviceps ariel	sugar glider					✓		

Scientific Name	Common Name	Reference Source						
		Begg 1983	EPBC Protected Matters Search 2010	NRETAS 2005	Woinarski 2002	Frith 1974	Marine Park Plan	AECOM 2011
PHALANGERIDAE	**Cuscuses and brushtail possums**							
Trichosurus arnhemensis	northern brushtail possum					✓		
PTEROPODIAE	**Megabats**							
Macroglossus minimus	northern blossom bat					✓		✓
Pteropus alecto	black flying fox					✓		✓
Pteropus scapulatus	little red flying fox					✓		✓
SUIDAE	**Pigs**							
Sus scrofa	feral pig					✓		✓
DELPHINIDAE	**Bottlenose dolphins**							
Orcaella heinsonhi	Australian snubfin dolphin							✓
Pseudorca crassidens	false killer whale							✓
Sousa chinensis	Indo-Pacific humpbacked dolphin							✓
Stenella attenuata	pan-tropical spotted dolphin							✓
Stenella longirostris	long-snouted spinner dolphion							✓
Tursiops aduncus	Indo-Pacific bottlenose dolphin							✓
VESPERTILIONIDAE	**Vespertilionid bats**							
Chalinolobus nigrogriseus rogersi	hoary bat					✓		
Chalinolobus gouldii venatoris	Gould's wattled bat					✓		
Eptesicus pumilus caurinus	little brown bat					✓		
Mormopterus loriae cobourgiana	little northern free-tailed bat					✓		
Myotis macropus	Southern large-footed myotis					✓		✓
Nycticeius greyii	Grey's broad-nosed bat					✓		
Nyctophilus arnhemiensis	Arnhem Land long-eared bat					✓		✓
Nyctophilus bifax daedalus	large northern long-eared bat					✓		✓

Site Reptile List

Scientific Name	Common Name	Reference Source						
		EPBC Protected Matters Search 2010	NRETAS 2005	Woinarski 2002	Chatto 2008	Frith 1974	Marine Park Plan	AECOM 2011
AGAMIDAE	**Dragons**							
Amphibolurus gilberti	Gilbert's lashtail					✓		
Amphibolurus temporalis	striped water dragon					✓		✓
Chlamydosarus kingii	frill-necked lizard					✓		
Diporiphora bilineata	two-lined dragon					✓		
BOIDAE	**Pythons**							
Antaresia childreni	children's python					✓		
Liasis mackloti	water python					✓		✓
Liasis olivaceus	olive python					✓		✓
Morelia spilota variegata	north-western carpet python					✓		
CHELONIIDAE	**Sea Turtles**							
Caretta caretta	loggerhead turtle	✓	✓				✓	✓
Chelonia mydas	green turtle	✓	✓	✓	✓		✓	✓
Eretmochelys imbricata	hawksbill turtle	✓	✓	✓	✓		✓	✓
Lepidochelys olivacea	Olive Ridley turtle	✓	✓	✓	✓		✓	✓
Natator depressus	flatback turtle	✓	✓	✓	✓		✓	✓
CHELIDAE	**Chelid turtles**							
Chelodina burrungandjii	Arnhem land long neck							✓
Chelodina rugosa	northern Australian snake-necked turtle					✓		
COLUBRIDAE	**Colubrid snakes**							
Boiga irregularis	brown tree snake					✓		
Dendrelaphis punctulatus	Australian tree snake					✓		
Tropidonophis mairii	keelback					✓		✓
CROCODYLIDAE	**Crocodiles**							
Crocodylus porosus	saltwater crocodile	✓				✓	✓	✓
DERMOCHELYIDAE	**Leathery Turtles**							
Dermochelys coriacea	leatherback turtle	✓	✓	✓	✓		✓	
ELAPIDAE	**Elapid snakes**							
Brachyurophis morrisi	Arnhem shovel-nosed snake							
Brachyurophis roperi	northern shovel-nosed snake							
Cryptophis pallidiceps	northern small-eyed snake					✓		
Demansia papuensis or *vestigiata*	black whipsnake					✓		
Demansia olivacea	olive whipsnake					✓		
Furina ornate	red-naped snake					✓		
Pseudechis australis	king brown					✓		
Pseudonaja nuchalis	western brown snake					✓		
GEKKONIDAE	**Geckoes**							
Strophurus ciliaris	spiny-tailed gecko					✓		

Scientific Name	Common Name	Reference Source						
		EPBC Protected Matters Search 2010	NRETAS 2005	Woinarski 2002	Chatto 2008	Frith 1974	Marine Park Plan	AECOM 2011
Gecko verticillatus	Lacerta gecko					✓		
Gehyra australis	top-end dtella					✓		
Hemidactylus frenatus	common house gecko					✓		
Heteronotia binoei	Binoe's prickly gecko					✓		
Oedura rhombifer	zigzag velvet gecko					✓		
Oedura marmorata	marbled velvet gecko					✓		
Phryia punctulata	-					✓		
HOMALOPSIDAE	**Australian mud-snakes**							
Cerberus rhynchops australis	bockadam					✓		✓
Fordonia leucobalia	crab-eating water snake					✓		✓
Myron richardsoni	mangrove snake					✓		✓
HYDROPHIIDAE	**Sea Snakes**							
Acalyptophis peronii	horned sea snake	✓					✓	✓
Aipysurus apraefrontalis	short-nosed sea snake						✓	
Aipysurus deboisii	Dubois' sea snake	✓					✓	✓
Aipysurus eydouxii	spine-tailed sea snake	✓					✓	✓
Aipysurus laevis	olive sea snake	✓					✓	✓
Astrotia stokesii	Stokes' sea snale							✓
Disteira kingii	spectacled sea snake	✓					✓	
Disteira major	olive-headed sea snake	✓					✓	✓
Enhydrina schistosa	beaked sea snake	✓					✓	✓
Hydrelaps darwiniensis	black-ringed sea snake	✓					✓	✓
Hydorphis atriceps	black-headed sea snake	✓					✓	
Hydrophis czeblukovi	fine-spined sea snake	✓					✓	
Hydrophis elegans	elegant sea snake	✓					✓	✓
Hydrophis inornatus	plain sea snake	✓					✓	
Hydrophis mcdowelli	small-headed sea snake	✓					✓	
Hydrophis ornatus	ornate reef snake	✓					✓	
Hydrophis pacificus	large-headed sea snake	✓					✓	
Lapemis curtus	short sea snake							✓
Lapemis hardwickii	spine-bellied sea snake	✓					✓	
Parahydrophis mertoni	northern mangrove sea snake	✓					✓	
Pelamus platuris	yellow-bellied sea snake	✓					✓	
PYGOPODIDAE	**Legless lizards**							
Delma borea	rusty-topped delma					✓		
Lialis burtonis	Burton's legless lizard					✓		
SCINCIDAE	**Skinks**							
Carlia amax	bauxite rainbow-skink							
Carlia gracilis	slender rainbow-skink							

Scientific Name	Common Name	Reference Source						
		EPBC Protected Matters Search 2010	NRETAS 2005	Woinarski 2002	Chatto 2008	Frith 1974	Marine Park Plan	AECOM 2011
Carlia munda	shaded-litter rainbow-skink					✓		
Ctenotus essingtonii	lowlands plain-backed ctenotus					✓		
Ctenotus hilli	top-end lowlands ctenotus					✓		
Ctenotus robustus	eastern striped skink					✓		
Cryptoblepharus metallicus and *cycgnatus*	snake-eyed skink					✓		
Eremiascincus douglasi	orange-sided bar-lipped skink					✓		
Glaphyromorphus darwiniensis	Darwin skink					✓		
Proablepharus tenuis	northern soil-crevice skink					✓		
Tiliqua scincoides intermedia	northern blue-tongued skink					✓		
TYPHLOPIDAE	**Blind snakes**							
Ramphotyphlops tovelli	Darwin blind snake					✓		
Ramphotyphlops unguirostris	claw-snouted blind snake							
VARANIDAE	**Goannas**							
Varanus gouldii gouldii	Gould's goanna					✓		
Varanus indicus	mangrove monitor							✓
Varanus mertensi	Merten's water monitor					✓		✓
Varanus panoptes	floodplain monitor							✓
Varanus scalaris	spotted tree monitor							
Varanus tristis	black-tailed monitor							

Site Amphibians List

Scientific Name	Common Name	Reference Source	
		Frith 1974	AECOM 2011
BUFONIDAE	**True toads**		
Bufo marinus	cane toad		✓
HYLIDAE	**Tree frogs**		
Litoria adelaidensis	slender tree frog	✓	
Litoria australis	giant frog	✓	✓
Litoria bicolor	northern dwarf tree frog	✓	✓
Litoria caerulea	Australian green tree frog	✓	✓
Litoria microbelos	javelin frog	✓	
Litoria nasuta	striped rocket frog	✓	✓
Litoria rothii	Roth's tree frog	✓	✓
Litoria rubella	desert tree frog	✓	✓
Litoria tornieri	Tornier's frog	✓	✓
Litoria wotjulumensis	wotjulum frog	✓	✓
MICROHYLIDAE	**Narrow-mouthed frogs**		
Austrochaperina adelphe	Northern Territory frog	✓	✓
MYOBATRACHIDAE	**Southern frogs**		
Crinia sp.	-	✓	
Crinia bilingua	bilingual froglet		✓
Crinia deserticola	desert froglet		✓
Crinia remota	remote froglet		✓
Limnodynastes convexiusculus	marbled frog	✓	✓
Limnodynastes dorsalis	western banjo frog	✓	
Heleioporus albopunctatus	western spotted frog	✓	
Notaden melanoscaphus	northern spadefoot toad		✓
Platyplectrum ornatus	ornate burrowing frog	✓	
Uperoleia inundata	floodplain toadlet		✓

Site Waterbird List

Scientific Name	Common Name	Reference Source						
		EPBC Protected Matters Search 2010	Chatto 2000	Chatto 2001	Birds Australia 2007	Chatto 2006	Frith and Calaby 1974	AECOM 2011
ANATIDAE	**Ducks, geese and swans**							
Anas gracilis	grey teal					✓	✓	✓
Anas superciliosa	pacific black duck				✓	✓	✓	✓
Aythya australis	hardhead					✓		✓
Dendrocygna arcuata	wandering whistling duck				✓	✓	✓	✓
Dendrocygna eytoni	plumed whistling-duck					✓		✓
Malacorhynchus membranaceus	pink-eared duck					✓		✓
Nettapus pulchellus	green pygmy goose					✓	✓	✓
Tadorna radjah	Burdekin duck				✓	✓	✓	✓
ANHINGIDAE	**Darters**							
Anhinga novaehollandiae	Australasian darter		✓		✓	✓	✓	✓
ANSERANATIDAE	**Magpie geese**							
Anseranas semipalmata	magpie goose	✓			✓	✓	✓	✓
ARDEIDAE	**Herons**							
Ardea alba	great egret	✓	✓		✓	✓		✓
Ardea garzetta	little egret		✓		✓	✓	✓	✓
Ardea ibis	cattle egret	✓	✓		✓	✓		✓
Ardea intermedia	intermediate egret		✓		✓	✓	✓	✓
Ardea modesta	eastern great egret				✓		✓	
Ardea novaehollandiae	white-faced heron				✓	✓	✓	
Ardea pacifica	white-necked heron					✓	✓	✓
Ardea picata	pied heron		✓		✓	✓	✓	
Ardea sacra	eastern reef heron						✓	✓
Ardea sumatrana	great billed heron					✓	✓	✓
Butorides striata	striated heron				✓		✓	✓
Ixobrychus flavicollis	black bittern							✓
Nycticorax caledonicus	nankeen night heron		✓		✓	✓	✓	✓
CICONIIDAE	**Storks**							
Ephippiorhynchus asiaticus	black-necked stork				✓	✓		✓
Jabiru mycteria	jabiru						✓	
GRUIDAE	**Cranes**							
Grus rubicunda	brolga				✓	✓	✓	✓
JACANIDAE	**Jacanas**							
Irediparra gallinacea	comb-crested jacana				✓	✓	✓	✓
LARIDAE	**Gulls**							
Chroicocephalus novaehollandiae	silver gull			✓	✓		✓	✓

Scientific Name	Common Name	Reference Source						
		EPBC Protected Matters Search 2010	Chatto 2000	Chatto 2001	Birds Australia 2007	Chatto 2006	Frith and Calaby 1974	AECOM 2011
Xema sabini	Sabine's gull							✓
PELECANIDAE	**Pelicans**							
Pelecanus conspicillatus	Australian pelican		✓		✓	✓	✓	✓
PHALACROCORACIDAE	**Cormorants and shags**							
Phalacrocoraz melanoleucos	little pied cormorant		✓		✓	✓	✓	✓
Phalacrocorax sulcriostis	little black cormorant		✓		✓	✓		
Phalacrocorax varius	pied cormorant		✓		✓	✓		
PODICIPEDIDAE	**Grebes**							
Tachybaptus novaehollandiae	Australasian grebe				✓	✓	✓	✓
RALLIDAE	**Rails**							
Amaurornis moluccana	rufous-tailed water-hen							✓
Eulabeornis castaneoventris	chestnut rail					✓	✓	✓
Fulica atra	Eurasian coot					✓		✓
Porphyrio porphyrio	purple swamphen					✓		✓
Porzana cinerea	white-browed crake					✓		✓
STERNIDAE	**Terns**							
Anous stolidus	common noddy			✓				
Chlidonias hybridus	whiskered tern					✓		
Chlidonias leucopterus	white-winged black tern					✓		✓
Gelochelidon nilotica	gull-billed tern					✓	✓	✓
Hydroprogne caspia	Caspian tern			✓	✓			✓
Onychoprion fuscatus	sooty tern							✓
Onychoprion anaethetus	bridled tern			✓				✓
Sterna albifrons	little tern	✓			✓	✓	✓	✓
Sterna dougallii	roseate tern			✓	✓			
Sterna hirundo	common tern							✓
Sterna sumatrana	black-naped tern			✓				
Thalasseus bengalensis	lesser crested tern			✓	✓			✓
Thalasseus bergii	greater crested tern			✓	✓		✓	✓
THRESKIORNITHIDAE	**Ibises and spoonbills**							
Platalea regia	royal spoonbill		✓		✓	✓		✓
Plegadis falcinellus	glossy ibis		✓		✓	✓	✓	✓
Threskiornis molucca	Australian white ibis		✓		✓	✓	✓	✓
Threskiornis spinicollis	straw-necked ibis		✓		✓	✓	✓	✓

Site Shorebird List

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Birds Australia 2001	Chatto 2003	Chatto 2006	Frith and Calaby 1974
BURHINIDAE	**Stone curlews**					
Burhinus grallarius	bush stone-curlew		✓			
Burhinus magnirostris	southern stone-curlew					✓
Esacus giganteus	beach stone-curlew		✓			✓
CHARADRIIDAE	**Plovers, dotterels and lapwings**					
Charadrius leschenaultii	greater sand plover		✓	✓		✓
Charadrius mongolus	lesser sand plover			✓		✓
Charadrius ruficapillus	red-capped plover		✓	✓		✓
Charadrius veredus	oriental plover	✓				
Erythrogonys cinctus	red-kneed dotterel			✓		✓
Pluvialis fulva	pacific golden plover			✓		✓
Pluvialis squatarola	grey plover			✓		✓
Vanellus miles	masked lapwing		✓		✓	✓
GLAREOLIDAE	**Pranticoles and coursers**					
Glareola maldivarum	oriental pranticole	✓				✓
Stiltia isabella	Australian pranticole		✓		✓	✓
HAEMATOPODIDAE	**Oystercatchers**					
Haematopus fuliginosus	sooty oystercatcher		✓			✓
Haematopus longirostris	Australian pied oystercatcher		✓			✓
PROCELLARIIDAE	**Petrels, prions and shearwaters**					
Calonectris leucomelas	streaked shearwater	✓	✓		✓	
RECURVIROSTRIDAE	**Avocets and stilts**					
Himantopus himantopus	black-winged stilt				✓	✓
SCOLOPACIDAE	**Sandpipers**					
Arenaria interpres	ruddy turnstone			✓		
Actitis hypoleucos	common sandpiper		✓	✓		✓
Calidris acuminata	sharp-tailed sandpiper			✓		
Calidris canutus	red knot			✓		
Calidris ferruginea	curlew sandpiper			✓		
Calidris ruficollis	red-necked stint		✓	✓		✓
Calidris tenuirostris	great knot			✓		
Gallinago megala	Swinhoe's snipe					✓
Limosa lapponica	bar-tailed godwit			✓		✓
Limosa limosa	black-tailed godwit			✓		✓
Limicola falcinellus	broad-billed sandpiper			✓		
Numenius madagascariensis	eastern Curlew		✓	✓		
Numenius phaeopus	whimbrel		✓	✓		✓

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Birds Australia 2001	Chatto 2003	Chatto 2006	Frith and Calaby 1974
Tringa brevipes	grey-tailed tattler		✓	✓		✓
Tringa nebularia	common greenshank			✓		✓
Tringa stagnatilis	marsh sandpiper			✓		
Xenus cinereus	Terek sandpiper			✓		

Site Non-Waterbird List

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
ACANTHIZIDAE	**Australasian warblers**							
Gerygone albogularis	white-throated gerygone				✓			
Gerygone chloronota	green-backed gerygone				✓		✓	✓
Gerygone levigaster	mangrove gerygone				✓			✓
Gerygone magnirostris	large-billed warbler						✓	✓
Gerygone olivacea	white-throated warbler						✓	
Smicrornis brevirostris	weebill				✓		✓	
ACCIPITRIDAE	**Hawks and eagles**							
Accipiter cirrocephalus	collared sparrowhawk							✓
Accipiter fasciatus	brown goshawk				✓			✓
Accipiter fasciatus didimus	northern brown goshawk						✓	
Accipiter novaehollandiae	grey goshawk						✓	
Aquila audax	wedge-tailed eagle						✓	
Aquila morphnoides	little eagle						✓	
Aviceda subcristata	crested hawk						✓	✓
Circus approximans	swamp harrier					✓	✓	✓
Circus assimilis	spotted harrier				✓			
Elanus notatus	black-shouldered kite						✓	
Erythrotriorchis radiatus	red goshawk	✓	✓	✓				✓
Haliaeetus leucogaster	white-bellied sea-eagle	✓			✓	✓	✓	✓
Haliastur indus	Brahminy kite				✓	✓	✓	✓
Haliastur sphenurus	whistling kite				✓		✓	✓
Hamirostra melanosternon	black-breasted buzzard				✓		✓	
Lophoictinia isura	square-tailed kite						✓	
Milvus migrans	black kite				✓		✓	
Pandion halietus	osprey					✓	✓	✓
Pandion halietus cristatus	eastern osprey				✓			
ACROCEPHALIDAE	**Marsh- and tree-warblers**							
Acrocephalus stentoreus australis	Australian reed-warbler						✓	✓
AEGOTHELIDAE	**Owlet-nightjars**							
Aegotheles cristatus	Australian owlet-nightjar				✓		✓	
ALCEDINIDAE	**River kingfishers**							
Alcedo azureus	azure kingfisher				✓		✓	✓
Alcedo pusilla	little kingfisher				✓		✓	✓
ALUDIDAE	**Larks**							

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
Mirafra javanica soederbergi	singing bushlark						✓	
APOLIDAE	**Swifts**							
Apus pacificus	fork-tailed swift	✓			✓			✓
ARTAMIDAE	**Woodswallows, currawongs and butcherbirds**							
Artamus leucorynchus	white-breasted woodswallow				✓		✓	
Artamus minor	little woodswallow							✓
Cracticus nigrogularis	pied butcherbird				✓		✓	
Cracticus quoyi spaldingi	black butcherbird						✓	✓
Cracticus torquatus argenteus	silver-backed butcherbird						✓	
CACATUIDAE	**Cockatoos**							
Cacatua galerita	sulphur-crested cockatoo				✓		✓	
Cacatua sanguinea	little corella						✓	
Calyptorhynchus banksii	red-tailed black-cockatoo				✓		✓	✓
Eolophus roseicapillus	galah				✓			
CAMPEPHAGIDAE	**Cuckoo-shrikes**							
Coracina novaehollandiae	black-faced cuckoo-shrike				✓		✓	✓
Coracina papuensis	white-bellied cuckoo-shrike				✓		✓	✓
Coracina tenuirostris melvillensis	Melville cicadabird	✓					✓	✓
Lalage leucomela	varied triller				✓		✓	✓
Lalage sueurii	white-winged triller				✓		✓	
CAPRIMULGIDAE	**Nightjars**							
Caprimulgus macrurus	large-tailed nightjar				✓		✓	
CASUARIIDAE	**Cassowaries and emus**							
Dromaius novaehollandiae	emu		✓				✓	✓
CLIMACTERIDAE	**Australian treecreepers**							
Climacteris melanurus	black-tailed treecreeper						✓	
COLLURICINCLIDAE	**Strike-thrushes**							
Colluricincla harmonica	grey strike-thrush				✓		✓	
Colluricincla megarhyncha	little strike-thrush				✓			
Colluricincla parcula	little thrush						✓	
COLUMBIDAE	**Doves and pigeons**							
Chalcophaps indica	emerald dove				✓		✓	
Ducula bicolor	pied imperial-pigeon				✓			✓
Ducula spilorrhoa	Torresian imperial-pigeon						✓	
Geopelia humeralis	bar-shouldered dove				✓		✓	
Geopelia striata	peaceful dove				✓		✓	
Geophaps smithii smithii	partridge pigeon (eastern)	✓	✓	✓	✓		✓	✓
Phaps chalcoptera	common bronzewing				✓		✓	

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
Ptilinopus regina	rose-crowned fruit-dove				✓		✓	✓
CORACIIDAE	**Rollers**							
Eurystomus orientalis	dollar roller				✓		✓	✓
CORVIDAE	**Crows and allies**							
Corvus orru	Torresian crow				✓		✓	
CUCULIDAE	**Old World cuckoos**							
Cacomantis pallidus	pallid cuckoo							✓
Cacomantis variolosus	brush cuckoo				✓			
Centropus phasianinus	pheasant coucal				✓		✓	✓
Chalcites basalis	Horsfield's bronze-cuckoo				✓			✓
Chalcites minutillus	little Bronze-cuckoo				✓		✓	✓
Chalcites osculans	black-eared cuckoo				✓			
Cuculus optatus	oriental cuckoo				✓			✓
Eudynamys scolopacea	koel						✓	✓
Scythrops novaehollandiae	channel-billed cuckoo							✓
DICAEIDAE	**Flowerpeckers**							
Dicaeum hirundinaceum	mistletoebird				✓		✓	
ESTRILIDIDAE	**Estrilid finches**							
Erythrura gouldiae	Gouldian finch	✓	✓	✓				✓
Lonchura castaneothorax	chestnut-breasted mannikin				✓		✓	
Neochmia phaeton	crimson finch				✓		✓	✓
Poephila acuticauda	long-tailed finch				✓		✓	
Poephila personata	masked finch						✓	
Taeniopygia bichenovii	double-bar finch						✓	
EUROSTOPODIDAE	**Nightjars and allies**							
Eurostopodus argus	spotted nightjar				✓		✓	✓
FALCONIDAE	**Falcons and caracaras**							
Falco berigora	brown falcon				✓			✓
Falco berigora centralia	inland brown falcon						✓	
Falco berigora melvillensis	northern brown falcon						✓	
Falco cenchroides	nankeen kestrel				✓		✓	✓
Falco longipennis	Australian hobby				✓		✓	
Falco peregrinus	peregrine falcon				✓		✓	
Falco subniger	black falcon				✓			
FREGATIDAE	**Frigatebirds**							
Fregata ariel	lesser frigatebird				✓		✓	✓
Fregata minor	greater frigatebird							✓
HALCYONIDAE	**Tree kingfishers**							
Dacelo leachii	blue-winged kookaburra				✓		✓	

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
Todiramphus chloris	collared kingfisher				✓			✓
Todiramphus macleayii	forest kingfisher				✓		✓	✓
Todiramphus pyrrhopygia	red-backed kingfisher						✓	
Todiramphus sanctus	sacred kingfisher				✓		✓	✓
HIRUNDINIDAE	**Swallows**							
Petrochelidon nigricans	tree martin				✓		✓	✓
MALURIDAE	**Wrens**							
Malurus melanocephalus	red-backed wren						✓	
MEGALURIDAE	**Megalurid warblers**							
Megalurus timoriensis alisteri	tawny grassbird						✓	✓
MEGAPODIIDAE	**Incubator birds**							
Megapodius freycinet tumulus	dusky scrubfowl						✓	
Megapodius reinwardt	orange-footed scrubfowl				✓			✓
MELIPHAGIDAE	**Honeyeaters**							
Cissomela pectoralis	banded honeyeater						✓	
Conopophila albogularis	rufous-banded honeyeater				✓		✓	✓
Conopophila rufogularis	rufous-throated honeyeater				✓			
Entomyzon cyanotis	blue-faced honeyeater				✓		✓	
Epthianura crocea	yellow chat				✓			
Lichenostomus unicolor	white-gaped honeyeater				✓		✓	✓
Lichmera indistincta	brown honeyeater				✓		✓	
Melithreptus albogularis	white-throated Honeyeater				✓		✓	
Myzomela erythrocephala	red-headed honeyeater						✓	✓
Myzomela obscura	dusky honeyeater				✓		✓	✓
Philemon argenticeps	silver-crowned friarbird				✓		✓	
Philemon citreogularis	little friarbird				✓		✓	
Ramsayornis fasciatus	bar-breasted honeyeater				✓		✓	✓
MEROPIDAE	**Bee-eaters**							
Merops ornatus	rainbow bee-eater	✓			✓		✓	✓
MONARCHIDAE	**Monarch flycatchers**							
Grallina cyanoleuca	magpie-lark				✓		✓	✓
Myiagra alecto	shining flycatcher				✓		✓	✓
Myiagra inquieta	restless flycatcher				✓		✓	✓
Myiagra rubecula	leaden flycatcher				✓		✓	✓
MOTACILLIDAE	**Wagtails, longclaws and pipits**							
Anthus novaeseelandiae	Australasian pipit				✓			✓
NEOSITTIDAE	**Sittellas**							
Daphoenositta chrysoptera	varied sittella				✓			
Neositta chyrsoptera leucoptera	white-winged sittella						✓	

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
ORIOLIDAE	**Orioles**							
Oriolus flavocinctus	yellow oriole				✓		✓	✓
Oriolus sagittatus	olive-backed oriole				✓		✓	
Sphecotheres vieilloti	Australasian figbird				✓			
OTIDIDAE	**Bustards**							
Ardeotis australis	Australian bustard		✓				✓	
PACHYCEPHALIDAE	**Whistlers**							
Pachycephala lanioides	white-breasted whistler				✓			✓
Pachycephala melanura	mangrove golden whistler				✓			✓
Pachycephala rufiventris	rufous whistler				✓		✓	
Pachycephala simplex	grey whistler				✓		✓	✓
PARDALOTIDAE	**Pardalotes**							
Pardalotus striatus melanocephalus and *uropygialis*	black-headed pardalote						✓	
Pardalotus striatus	striated pardalote				✓			
PASSERI	**Songbirds**							
Dicrurus bracteatus	spangled drongo				✓		✓	✓
Rhipidura albiscapa	grey fantail				✓			
Rhipidura dryas	Arafura fantail				✓			✓
Rhipidura leucophrys	willy wagtail				✓		✓	
Rhipidura rufiventris	northern fantail				✓		✓	
PETROICIDAE	**Australasian robins**							
Microeca fascinans	Jacky winter				✓			
Microeca flavigaster	lemon-bellied flycatcher				✓		✓	✓
Peneoenanthe pulverulenta	mangrove robin							✓
PHASIANIDAE	**Pheasants and partridges**							
Coturnix ypsilophora	brown quail				✓		✓	
PITTIDAE	**Pittas**							
Pitta iris	rainbow pitta				✓		✓	
PODARGIDAE	**Frogmouths**							
Podargus strigoides	tawny frogmouth				✓		✓	✓
POMATOSTOMIDAE	**Australo-Papuan babblers**							
Pomatostomus temporalis rubeculus	red-breasted babbler						✓	
PSITTACIDAE	**True parrots**							
Aprosmictus erythropterus	red-winged parrot				✓		✓	
Platycercus venustus	northern rosella				✓		✓	
Psitteuteles versicolor	varied lorikeet				✓		✓	
Trichoglossus haematodus	rainbow lorikeet				✓		✓	
PTILONORHYNCIDAE	**Bowerbirds**							

Scientific Name	Common Name	Reference Source						
		EPBC 2010	NRETAS 2005	Woinarski 2002	Birds Australia 2007	Chatto2006	Frith and Calaby 1974	AECOM 2011
Ptilonorhynchus nuchalis	great bowerbird				✓		✓	
STRIGIDAE	**True owls**							
Ninox connivens	barking owl				✓			✓
Ninox novaeseelandiae	southern boobook				✓		✓	✓
Ninox rufa	rufous owl				✓		✓	✓
SULIDAE	**Gannets and boobies**							
Sula dactylatra	masked booby							✓
Sula leucogaster plotus	brown gannet						✓	✓
TURNICIDAE	**Button-quails**							
Turnix castanota	chestnut-breasted button-quail			✓			✓	
TYTONIDAE	**Barn owls**							
Tyto alba delicatula	delicate barn owl						✓	
Tyto javanica	eastern barn owl				✓			
Tyto novaehollandiae	masked owl				✓		✓	
Tyto novaehollandiae kimberli	masked owl (northern)	✓	✓	✓	✓			✓
ZOSTEROPIDAE	**White-eyes**							
Zosterops luteus	yellow white-eye							✓

Site Fish List

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
ACANTHURIDAE	**Surgeonfishes, tangs and unicornfishes**					
Acanthurus auranticavus	orange-socket surgeonfish		✓			
Acanthurus grammopitlus	ring-tailed surgeonfish		✓	✓	✓	
Acanthurus lineatus	blue-lined surgeonfish		✓			
Acanthurus xanthopterus	yellowfin surgeonfish		✓			
Naso lituratus	orange-spined unicornfish		✓			
AMBASSIDAE	**Glass-perchlets**					
Ambassis commersoni	Western Chanda perch				✓	
Ambassis nalua	scalloped perchlet				✓	
AMPLYOPIDAE	**Worm gobbies**					
Brachyamblyopus	-				✓	
Ctenotrypauchen microcephalus	-				✓	
Trypauchenichthys	-				✓	
Trypauchenichthys typus	-				✓	
ANTENNERIIDAE	**Frogfish**					
Lophiocharon trisignatus	three-spot frogfish				✓	
Tathicarpus butleri	blackspot anglerfish				✓	
Tetrabrachium ocellatum	four-armed frogfish				✓	
APOGONIDAE	**Cardinalfishes**					
Apogon sp.	cardinalfish			✓	✓	
Apogon albimaculosus	-				✓	
Apogon brevicaudatus	-				✓	
Apogon coccineus	-				✓	
Apogon cooki	-				✓	
Apogon crassiceps	-				✓	
Apogon darnleyensis	-				✓	
Apogon ellioti	-				✓	
Apogon opercularis	-				✓	
Apogon poecilopterus	-				✓	
Apogon quadrifasciatus	-				✓	
Apogon ruppellii	-				✓	
Apogon victoriae	-				✓	
Archamia fucata	-				✓	
Archamia melasma	blackspot cardinalfish		✓			
Cheilodipterus quinquelineata	five-lined cardinalfish		✓			

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Fowleria aurita	-				✓	
Glossamia aprion	-				✓	
Gymnapogon cf. philippinus	-				✓	
Pseudamia n.sp.	-				✓	
APOLACTINIDAE	**Velvetfishes**					
Adventor elongatus	sandpaper velvetfish				✓	
ARIIDAE	**Forktailed catfish**					
Arius argyroleuron	sand catfish					✓
Arius bilineatus	roundsnout sea catfish				✓	
Arius polystaphylodon	Mozambican sea catfish				✓	
Arius proximus	Arafura catfish				✓	
Arius thallasinus	giant sea catfish			✓	✓	
ATHERINIDAE	**Hardyheads**					
Alanetta mugiloides	-				✓	
Atherinomorus endrachtensis	Eendracht land silverside				✓	
Hypoatherina temminckii	Samoan silverside				✓	
Pranesus	-				✓	
Pranesus endrachtensis	endracht hardyhead					✓
BALISTIDAE	**Triggerfishes**					
Balistoides conspicillum	clown triggerfish		✓			
BANJOSIDAE	**Banjofish**					
Banjos banjos	banjofish		✓			
BATRACHOIDIDAE	**Toadfish**					
Batrachomoeus	-				✓	
Batrachomoeus trispinosus	three-spined frogfish				✓	
Halophyrne deimensis	banded frogfish				✓	
Halophyrne ocellatus	ocellate frogfish				✓	
BELONIDAE	**Longtoms/Needlefins**					
Strongylura strongylura	spottail needlefish				✓	
Strongylura caudimaculata	-				✓	
Tylosurus gavialoides	stout longtom					✓
BLENNIIDAE	**Combtooth blennies**					
Meiacanthus grammistes	lined fangblenny		✓		✓	
Atrosalarias fuscus	-				✓	
Cirripectes filamentosus	-				✓	
Istiblennius	-				✓	
Laiphognathus multimaculatus	-				✓	
Omobranchus ferox	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Omobranchus germaini	-				✓	
Omobranchus punctatus	-				✓	
Omobranchus rotundiceps	-				✓	
Omobranchus verticalis	-				✓	
Omox biporos	-				✓	
Petroscirtes mitratus	-				✓	
Petroscirtes variabilis	-				✓	
Salarias	-				✓	
BOTHIDAE	**Right-eyed flounders**					
Arnoglossus	-				✓	
Grammatobothus polyophthalmus	-				✓	
Pseudorhombus	-				✓	
Pseudorhombus arsius	-				✓	
Pseudorhombus elevatus	-				✓	
Pseudorhombus russelli	-				✓	
BREGMACEROTIDAE	**Unicorn Codelts**					
Bregmaceros	-				✓	
CAESIONIDAE	**Fusilier fishes**					
Caesio caerulaurea	blue and gold fusilier		✓			
Caesio cuning	robust fusilier		✓	✓		
Pterocaesio chyrsozona	goldband fusilier		✓			
CALLIONYMIDAE	**Dragonets**					
Callionymus	-				✓	
Callionymus belcheri belcheri	-				✓	
Callionymus enneactis	-				✓	
Callionymus grossi	-				✓	
Callionymus pleurostictus	-				✓	
CARANGIDAE	**Jacks, pompanos, jack mackerels and scads**					
Alectis indica	Indian threadfin		✓	✓		
Alepes sp.	-				✓	
Alepes apercna	smallmouth scad			✓		
Carangoides caeruleopinnatus	-				✓	
Carangoides chrysophrys	longnose trevally			✓	✓	
Carangoides fulvoguttatus	gold-spotted trevally		✓			
Carangoides hedlandensis	-				✓	
Carangoides humerosus	-				✓	
Carangoides plagiotaenia	barcheek trevally		✓			
Carangoides talamparoides	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Caranx bucculentus	-				✓	
Caranx ignobilis	giant trevally		✓	✓	✓	
Caranx para	-				✓	
Caranx papyensis	brassy trevally					✓
Caranx sexfasciatus	bigeye trevally		✓	✓	✓	
Caranx tille	tille Trevally			✓		
Gnathanodon speciosus	golden trevally		✓	✓	✓	
Megalaspis cordyla	-				✓	
Monocanthus chinensis	fan-bellied leatherjacket		✓	✓		
Pantolabus radiatus	fringe-finned trevally			✓		
Scomberoides	-				✓	
Scomberoides commersonianus	-				✓	
Scomberoides tala	-				✓	
Scomberoides tol	-				✓	
Selar boops	oxeye scad			✓		
Selaroides leptolepis	smooth-tailed trevally		✓		✓	
Seriolina nigrofasciata	-				✓	
Trachinotus bailionii	northern dart		✓		✓	
Trachinotus blochii	snub-nose dart		✓	✓		
Ulua aurochs	silvermouth trevally			✓	✓	
Ulua mentalis	longraker trevally		✓			
CARCHARHINIDAE	**Requiem sharks**					
Carcharhinus amblyrhynchos	grey reef shark		✓			
Carcharhinus brevipinna	spinner shark				✓	
Carcharhinus dussumieri	whitecheek shark				✓	
Carcharhinus leucas	bull shark		✓			
Carcharhinus limbatus	blacktip shark				✓	
Carcharhinus melanopterus	blacktip reef shark		✓	✓	✓	
Carcharhinus sealei	blackspot shark				✓	
Carcharhinus sorrah	spot-tail shark					✓
Carcharhinus tilstoni	Australian black tip shark				✓	
Hemipristis elongatus	snaggletooth shark				✓	
Negaprion acutidens	sicklefin lemon shark			✓		
Rhizoprionodon acutus	milk shark				✓	
Triaenodon obesus	whitetip reef shark		✓	✓		
CENTRISCIDAE	**Razorfishes**					
Centriscus	-				✓	
CENTROGENYIDAE	**False scorpionfish**					

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Centrogenys vaigensis	false scorpionfish		✓			
CENTROPOMIDAE	**Snooks**					
Hypopterus macropterus	-				✓	
Lates calcarifer	-				✓	
Psammoperca vaigiensis	-				✓	
CEPOLIDAE	**Bandfishes**					
Acanthocepola abbreviata	-				✓	
Mugilidae (mullet)	-				✓	
Mugil cephalus	sea mullet					✓
Oedalechilus labiosus	-				✓	
Oedalechilus kesteveni	-				✓	
Liza	-				✓	
Liza alata	-				✓	
Liza melinoptera	-				✓	
Liza vaigiensis	-				✓	
Valamugil	-				✓	
Valamugil buchanani	-				✓	
Valamugil cunnesius	-				✓	
Valamugil seheli	-				✓	
CHAETODONTIDAE	**Butterflyfish**					
Chaetodon adiergastos	eye-patched butterflyfish		✓			
Chaetodon aureofasciatus	gold-banded butterflyfish		✓		✓	
Chaetodon baronessa	triangle butterflyfish		✓			
Chaetodon cintrinellus	speckled butterflyfish		✓			
Chaetodontoplus duboulayi	-				✓	
Chaetodon lineolatus	lined butterflyfish		✓			
Chaetodon lunalatus	redfin butterflyfish		✓			
Chaetodon lunula	racoon butterflyfish		✓			
Chaetodon raffiesii	latticed butterflyfish		✓			
Chaetodon speculum	oval-spot butterflyfish		✓			
Chaetodon trifascialis	chevron butterflyfish		✓			
Chaetodon vagabundus	vagabond butterflyfish		✓			
Chelmon marginatus	margined butterflyfish		✓	✓		
Chelmon mulleri	dusky butterflyfish		✓		✓	
Chelmon marginalis	-				✓	
Chelmon rostratus	beaked butterflyfish		✓			
Coradion chrysozonus	orange-banded coralfish		✓			
Euxiphipops sexstriatus	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Heniochus acuminatus	long-fin bannerfish		✓	✓	✓	
Heniochus diphreutes	schooling bannerfish		✓			
Parachaetodon ocellatus	ocellate coralfish		✓	✓	✓	
CHANIDAE	**Milkfish**					
Chanos chanos	milkfish		✓		✓	
CHIROCENTRIDAE	**Wolf Herrings**					
Chirocentrus dorab	dorab wolf herring				✓	
CLUPEIDAE	**Sardines and Herrings**					
Anodontostoma chacunda	Chacunda gizzard shad				✓	
Dussumieria elopsoides	slender sardine					✓
Herklosichthys	-				✓	
Herklosichthys koningsbergeri	Koningsberger herring				✓	
Herklosichthys lippa	Australian spotted herring				✓	
Pellona ditchela	Indian pellona				✓	
Sardinella	-				✓	
Spratelloides	-				✓	
Spratelloides delicatulus	delicate round herring				✓	
CONGRIDAE	**Congers**					
Conger wilsoni	cape conger				✓	
Lumiconger arafura	luminous conger				✓	
Uroconger lepturus	slender conger				✓	
CYNOGLOSSIDAE	**Tongue soles**					
Cynoglossus	-				✓	
Cynoglossus bilineatus	-				✓	
Cynoglossus puncticeps	-				✓	
Paraplagusia blochi	-				✓	
DACTYLOPTERIDAE	**Flying Gunnards**					
Dactyloptena	-				✓	
Dactyloptena papilio	butterfly flying-gunnard				✓	
DASYATIDAE	**Stingrays**					
Dasyatis sp.	stingray			✓	✓	
Dasyatis kuhlii	blue-spotted stingray		✓		✓	
Himantura uarnak	reticulate whipray				✓	
Pastinachus sephen	cowtail stingray			✓		
Taeniura sp.	fantail ray			✓		
Taeniura lymna	blue-spotted fantail ray		✓			
Taeniura melanospilos	black-spotted stingray		✓			
Taeniura meyeni	blotched fantail ray			✓		

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Himantura granulata	mangrove ray		✓			
DIODONTIDAE	**Porcupinefish**					
Diodon liturosus	black-blotched porcupinefish		✓		✓	
Tragulichthys jaculiferus	-				✓	
DREPANEIDAE	**Sicklefishes**					
Drepane punctuata	sicklefish					✓
ECHENEIDAE	**Remoras**					
Echeneis naucrates	live sharksucker			✓	✓	
Remora remora	-				✓	
ELEOTRIDIDAE	**Gudgeons**					
Mogurnda mogurnda	-				✓	
ELOPIDAE	**Ladyfishes**					
Elops hawaiensis	giant herring			✓		
ENGRAULIDAE	**Anchovies**					
Setipinna	-				✓	
Stolephorus	-				✓	
Stolephorus advenus	false Indian anchovy				✓	
Stolephorus waitei	spotty-face anchovy				✓	
Thryssa	-				✓	
Thryssa hamiltoni	Hamilton's thryssa				✓	
Thryssa setirostris	longjaw thryssa				✓	
EPHIPPIDAE	**Spadefishes**					
Platax batavianus	juvenile humpback batfish		✓			
Platax orbicularis	-				✓	
Platax pinnatus	pinnate batfish		✓			
Platax teira	Teira batfish		✓	✓		
Zabidius novamaculeatus	-				✓	
EXOCOETIDAE	**Flying Fishes**					
Cheilopogon	-				✓	
Parexocoetus mento	African sailfin flyingfish				✓	
FISTULARIIDAE	**Flutemouths**					
Fistularia	-				✓	
Fistularia commersoni	Cornet fish				✓	
GERREIDAE	**Mojarras**					
Gerres sp.	silver biddy		✓		✓	
Gerres abbreviatus	-				✓	
Gerres filamentosus	-				✓	
GINGLYMOSTOMATIDAE	**Carpet sharks**					

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Nebrius ferrugineus	tawny shark		✓	✓		
Hemiscyllium oscellatum	epaulette shark		✓			
GOBIIDAE	**Gobbies**					
Acentrogobius cf caninus	-				✓	
Acentrogobius viridipunctatus	-				✓	
Amblyeleotris gymnocephala	-				✓	
Amblygobius bynoensis	-				✓	
Amblygobius phalaena	-				✓	
Amoya gracilis	-				✓	
Bathygobius	-				✓	
Bathygobius fuscus	-				✓	
Bathygobius laddi	-				✓	
Bathygobius sp.9	-				✓	
Bryaninops amplus	-				✓	
Callogobius cf okinawae	-				✓	
Callogobius sp.15	-				✓	
Cryptocentroides insignis	-				✓	
Cryptocentrus	-				✓	
Cryptocentrus cf strigilliceps	-				✓	
Cryptocentrus russus	-				✓	
Drombus	-				✓	
Drombus triangularis	-				✓	
Eviota prasina	-				✓	
Eviota queenslandica	-				✓	
Eviota storthynx	-				✓	
Eviota sigillata	-				✓	
Favonigobius melanobranchus	-				✓	
Glossogobius biocellatus	estuary gobby					✓
Gnatholepis	-				✓	
Gobiodon	-				✓	
Gobiodon histrio	-				✓	
Gobiodon okinawae	-				✓	
Gobiodon sp.3 ?	-				✓	
Gobiodon sp.4 ?	-				✓	
Gobiopsis aporia	-				✓	
Gobius voigtii	-				✓	
Istigobius nigroocellatus	-				✓	
Istigobius ornatus	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Istigobius perspicillatus	-				✓	
Macrodontogobius wilburi	-				✓	
Mugilogobius sp.5	-				✓	
Mugilogobius stigmaticus	-				✓	
Mugilogobius	-				✓	
Oxyurichthys	-				✓	
Oxyurichthys papuensis	-				✓	
Oxyurichthys tentacularis	-				✓	
Palutris	-				✓	
Pandaka lidwilli	-				✓	
Parachaeturichthys polynema	-				✓	
Parioglossus philippinus	-				✓	
Priolepis nuchifasciatus	-				✓	
Pseudogobius	-				✓	
Ptereleotris microlepis	-				✓	
Silhouettea hoesei	-				✓	
Valenciennea n.sp.	-				✓	
Valenciennea muralis	-				✓	
Valenciennea puellaris	-				✓	
Yongeichthys criniger	-				✓	
GYMNURIDAE	**Butterfly Rays**					
Gymnura australis	Australian butterfly ray				✓	
HAEMULIDAE	**Grunts**					
Diagramma pictum labiosum	slate sweetlips		✓			
Plectorhynchus sp.	-				✓	
Plectorhynchus celebicus	orange-lined sweetlips		✓			
Plectorhynchus chaetodonoides	harlequin sweetlips		✓		✓	
Plectorhynchus flavomaculatus	lemon sweetlips		✓			
Plectorhynchus gibbosus	brown sweetlips		✓	✓		
Plectorhynchus labiosum	painted sweetlips		✓	✓		
Plectorhynchus lineatus	oriental sweetlips		✓			
Plectorhynchus multivittatum	many-lined sweetlips		✓			
Plectorhynchus picus	magpie sweetlips		✓		✓	
Plectorhynchus polytaenia	ribbon sweetlips		✓		✓	
Pomadasys sp.	-				✓	
Pomadasys kaakan	-				✓	
Pomadasys maculatus	-				✓	
HEMIRAMPHIDAE	**Garfish/Halfbeaks**					

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Arrhamphus sclerolepis	northern snubnose garfish				✓	
Hemiramphus far	black-barred halfbeak				✓	
Hyporhamphus neglectissimus	black-tipped garfish				✓	
Hyporhamphus quoyi	Quoy's garfish				✓	
Zenarchopterus buffonis	Buffon's river garfish				✓	
Zenarchopterus gilli	vivparous halfbeak				✓	
HOLOCENTRIDAE	**Squirrelfish and soldierfish**					
Myripristis violacea	lattice soldierfish		✓			
Sargocentrum rubrum	red squirrelfish		✓			
Adioryx ruber	Red squirrelfish				✓	
Myripristus violacea	Lattice soldierfish				✓	
ISTIOPHORIDAE	**Spearfishes**					
Istiophorus platypterus	-				✓	
Makaira indica	-				✓	
KYPHOSIDAE	**Sea chubs**					
Kyphosus cinerascens	snubnose rudderfish		✓			
Kyphosus vaigiensis	brassy drummer		✓			
LABRIDAE	**Wrasses**					
Anampses lennardi	blue and yellow wrasse		✓			
Cheilinus trilobatus	triple-tailed Maori wrasse		✓			
Cheilinus chlororus	yellow-dotted Maori wrasse		✓			
Choerodon cyanodus	blue tuskfish		✓	✓	✓	
Choerodon schoenleinii	blackspot tuskfish		✓		✓	
Choerodon vitta	-				✓	
Epibulus insidiator	sling-jaw wrasse		✓			
Halichoeres	-				✓	
Halichoeres dussumieri	-				✓	
Halichoeres melanochir	-				✓	
Halichoeres melanurus	-				✓	
Hemigymnus melapterus	half-and-half wrasse		✓			
Labroides dimidiatus	blue-streak cleaner wrasse		✓		✓	
Thalasoma lunare	moon wrasse		✓		✓	
LACTARIIDAE	**Milk trevallies**					
Lactarius lactarius	-				✓	
LATIDAE	**Perch-like fishes**					
Psammoperca waigensis	sand bass		✓			
LEIOGNATHIDAE	**Ponyfishes**					
Equula equula	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Equula interrupta	-				✓	
Gazza minuta	-				✓	
Leiognathus	-				✓	
Leiognathus bindus	-				✓	
Leiognathus cf berbis	-				✓	
Leiognathus decorus	-				✓	
Leiognathus equula	common ponyfish		✓	✓		
Leiognathus fasciatus	threadfin ponyfish		✓			
Leiognathus novaehollandiae	-				✓	
Leiognathus splendens	-				✓	
Secutor insidiator	-				✓	
Secutor ruconius	-				✓	
LETHRINIDAE	**Emperors**					
Lethrinus sp.	emperor			✓	✓	
Lethrinus laticaudis	grass emperor		✓	✓		
Lethrinus nebulosus	spangled emperor			✓		
Lethrinus ornatus	ornate emperor			✓		
Lethrinus choerorhynchus	-				✓	
LUTJANIDAE	**Snappers**					
Caesio cuning	-				✓	
Mesoprion yapilli	-				✓	
Lutjanus sp.	-				✓	
Lutjanus argentimaculus	mangrove jack		✓	✓	✓	
Lutjanus carponatus	Spanish flag snapper		✓	✓	✓	
Lutjanus decussatus	checkered snapper		✓			
Lutjanus erythropterus	crimson snapper			✓	✓	
Lutjanus fulviflammus	black-spot snapper		✓			
Lutjanus fulvus	-				✓	
Lutjanus guinguelineatus	five-lined snapper		✓			
Lutjanus gibbosus	humpback red snapper		✓	✓		
Lutjanus lemniscatus	-				✓	
Lutjanus malabaricus	saddletail snapper			✓		
Lutjanus rivulatus	scribbled snapper		✓			
Lutjanus russelli	Moses snapper		✓	✓	✓	
Lutjanus sanguineus	-				✓	
Lutjanus vaigiensis	-				✓	
Lutjanus vitta	brown-stripe snapper		✓		✓	
Symphorus nematophorous	Chinaman fish		✓			

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
MAGILOIDIDAE	**Grubfishes**					
Parapercis	-				✓	
MEGALOPIDAE	**Tarpons**					
Megalops cyprinoides	Indo-Pacific tarpon				✓	
MELANOTAEDIIDAE	**Rainbowfishes**					
Melanotaenis nigrans	black-banded rainbowfish				✓	
Atherina nigrans	-				✓	
Pseudomugil cyanodorsalis	blue-black blue-eye				✓	
MENIDAE	**Moon fish**					
Mene maculata	-				✓	
MOLIDAE	**Ocean sunfishes**					
Mola ramsayi	southern ocean sunfish		✓			
MONACANTHIDAE	**Leatherjackets**					
Anacanthus barbatus	-				✓	
Monacanthus chinensis	-				✓	
Paramonacanthus	-				✓	
Pervagor	-				✓	
MONODACTYLIDAE	**Moonyfishes**					
Monodactylus argenteus	silver batfish		✓			
MULLIDAE	**Goatfish**					
Mulloidichthys	-				✓	
Parupeneus barberinus	dash-and-dot goatfish		✓			
Parupeneus indicus	yellow-spot goatfish		✓			
Upeneus sp.	-				✓	
Upeneus sulphureus	-				✓	
Upeneus sundaicus	-				✓	
Upeneus tragula	bar-tailed goatfish		✓			
Upeneus vittalis	striped goatfish			✓		
MURAENESOCIDAE	**Pike Eels**					
Muraenesox cinereus	daggertooth pike conger				✓	
MURAENIDAE	**Moray eels**					
Gymnothorax favagineus	honeycomb moray		✓			
Gymnothorax fimbriata	fimbriated moray				✓	
Gymnothorax pictus	peppered moray		✓			
Gymnothorax sp.	-				✓	
MYLIOBATIDAE	**Eagle Rays**					
Aetobatus narinari	white-spotted eagle ray		✓	✓		
Manta birostris	manta ray		✓			

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
NEMIPTERIDAE	**Threadfin bream**					
Nemipterus hexodon	-				✓	
Nemipterus marginatus	-				✓	
Nemipterus peronii	-				✓	
Pentapodus porosus	north-west threadfin bream			✓		
Scaevius millii	-				✓	
Scolopsis sp.	threadfin bream			✓	✓	
Scolopsis bilineatus	twoline spinecheek		✓			
Scolopsis cancellatus lineatus	latticed monocle bream		✓			
Scolopsis monogramma	monogrammed monocle bream		✓	✓	✓	
Scolopsis temporalis	-				✓	
NOTOGRAPTIDAE	**Eel-blennies**					
Notograptus	-				✓	
Notograptus guttatus	-				✓	
OPHICHTHIDAE	**Snake Eels**					
Muraenichthys	-				✓	
OPHIDIIDAE	**Cuskeels**					
Dinomatichthys	-				✓	
Sirembo	-				✓	
OPISTOGNATHIDAE	**Jawfishes**					
Opistognathus castelnaui	-				✓	
Opistognathus darwinensis	-				✓	
Opistognathus latitabunda	-				✓	
Opistognathus papuensis	-				✓	
ORECTOLOBIDAE	**Wobbegongs**					
Chiloscyllium punctatum	brownbanded bamboo shark				✓	
Eucrossorhinus dasypogon	tasselled wobbegong		✓			
Hemiscyllium trispeculare	speckcled carpetshark				✓	
Stegostoma fasciatum	leopard shark				✓	
OSTRACIIDAE	**Boxfishes and allies**					
Ostracion cubicus	-				✓	
Rhynchostracion nasus	-				✓	
Rhynchostracion rhinorhynchus	horn-nosed boxfish		✓		✓	
OXUDERCIDAE	**Mudskippers**					
Periophthalmus argentilineatus	-				✓	
PARASTROMATIDAE	**Pomfrets**					
Parastromateus niger	-				✓	
PEGASIDAE	**Seamoths**					

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Parapegasus natans	walking fish				✓	
PEMPHERIDAE	**Sweepers**					
Pempheris sp.	bullseye		✓			
Leptobrama muelleri	-				✓	
PHOLIDICHTHYIDAE	**Convict blennies**					
Pholidichthys anguis	convict blenny		✓			
PLEURONECTIDAE	**Left-eyed flounders**					
Brachypleura novaezeelandiae	-				✓	
POMACENTRIDAE	**Damselfishes and clownfishes**					
Abudefduf bengalensis	-				✓	
Abudefduf septemfasciatus	-				✓	
Amblyglyphidodon ternatensis	ternate damsel		✓			
Amphiphron perideraion	pink anenomefish		✓			
Amphiprion ocellaris	western clown anenomefish		✓		✓	
Amphiprion rubrocinctus	black anenomefish		✓		✓	
Dascyllus reticulatus	reticulate dascyllus		✓			
Dischistodus fasciatus	-				✓	
Neoglyphidodon melas	royal damsel		✓			
Neopomacentrus cyanomos	-				✓	
Neopomacentrus filamentosus	-				✓	
Neopomacentrus violascens	-				✓	
Pomacentrus littoralis	-				✓	
Pomacentrus milleri	-				✓	
Stegastes	-				✓	
Stegastes obreptus	-				✓	
PLOTOSIDAE	**Eeltail catfish**					
Paraplotosus muelleri	white-tipped catfish		✓			
Plotosus lineatus	striped catfish		✓			
Euristhmus	-				✓	
Euristhmus nudiceps	naked-headed catfish				✓	
Paraplotosus albilabris	whitelip catfish				✓	
Paraplotosus butleri	sailfin catfish				✓	
PLATYCEPHALIDAE	**Flatheads**					
Elates ransonetti	dwarf flathead				✓	
Inegocia japonica	Japanese flathead				✓	
Papilloculiceps nematophthalmus	fringe-eye flathead				✓	
Platycephalus indicus	bartail flathead				✓	
Suggrundus bosschei	small-eyed flathead				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Suggrundus harrisii	-				✓	
Suggrundus rodericensis	spiny flathead				✓	
Suggrundus staigeri	northern rock flathead				✓	
Thysanophyrs otaitensis	fringe-lip flathead		✓			
POMACANTHIDAE	**Marine angelfish**					
Chaetodontoplus duboulayi	scribbled angelfish		✓	✓		
Pomacanthus sexstriatus	six-banded angelfish		✓			
POLYNEMIDAE	**Threadfins**					
Eleutheronema tetradactylum	blue threadfin salmon					✓
Polydactylus	-				✓	
Polynemus	-				✓	
Polynemus heptadactylus	-				✓	
Polynemus multiradiatus	-				✓	
Polynemus sheridani	-				✓	
Polynemus sexfilis	-				✓	
PRIACANTHIDAE	**Bulls-eyes**					
Priacanthus macracanthus	-				✓	
Priacanthus tayenus	-				✓	
PSENOPSIDAE	**Ruffes**					
Psenopsis	-				✓	
PSETTODIDAE	**Queensland halibuts**					
Psettodes erumei	-				✓	
PSEUDOCHROMIDAE	**Dottybacks**					
Pseudochromis fuscus	dusky dottyback		✓			
Congrogadus subducens	-				✓	
Pseudochromis	-				✓	
Pseudochromis punctatus	-				✓	
Pseudochromis wilsoni	-				✓	
RACHYCENTRIDAE	**Cobia**					
Rachycentron canadus	-				✓	
RHINOBATIDAE	**Guitarfish**					
Rhynchobatus djiddensis	giant guitarfish				✓	
Rhinobatus typus	giant shovelnose ray			✓		
RHINOPRENIDAE	**Threadfin scat**					
Rhinoprenes pentanemus	-				✓	
RHYNCHOBATIDAE	**Wedgefishes**					
Rhynchobatus djiddensis	white-spotted shovelnose ray		✓			
SALMONIDAE	**Salmon, trout and allies**					

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Albula neoguinaica	Indo-Pacific bonefish		✓			
SCARIDAE	**Parrotfish**					
Scarus ghobban	surf parrotfish		✓		✓	
Scarus sp.	-				✓	
SCATOPHAGIDAE	**Scats**					
Selenotoca multifasciata	-				✓	
Scatophagus argus	spotted scat					✓
SCIAENIDAE	**Jewfish**					
Atrobucca	-				✓	
Johnius	-				✓	
Johnius johnius	-				✓	
Nibea	-				✓	
SCOMBRIDAE	**Tunas**					
Euthynnus affinis	-				✓	
Rastrelliger kanagurta	-				✓	
Scomberomorus	-				✓	
Scomberomorus queenslandicum	-				✓	
Scomberomorus semifasciatum	-				✓	
SCORPSAENIDAE	**Scorpionfish**					
Dendrochirus	-				✓	
Hypodytes carinatus	bearded waspfish				✓	
Inimicus	-				✓	
Minous versicolor	plumstriped stingfish				✓	
Parascorpaena picta	painted scorpionfish		✓		✓	
Pterois lunulata	luna lion fish				✓	
Pterois volitans	common lionfish		✓			
Scorpaenodes	-				✓	
Scorpaenopsis	-				✓	
Synanceia horrida	estuarine stonefish				✓	
Scorpaenopsis oxycephala	tasselled scorpionfish		✓			
Scorpaenopsis venosa	ragged scorpionfish		✓			
SCYLLIORHINIDAE	**Catsharks**					
Aletomycterus macleayi	Australian marbled catshark				✓	
SERRANIDAE	**Seabasses and groupers**					
Centrogenys vaigiensis	-				✓	
Cephalopholis boenack	brown-banded rock-cod		✓	✓	✓	
Cephalopholis cyanostigma	blue-spotted rock-cod		✓			
Cephalopholis miniata	coral rock-cod		✓			

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Cromileptes altivelis	barramundi cod		✓		✓	
Diploprion bifasciatum	yellow emperor		✓			
Epinephelus	-				✓	
Epinephelus bleekeri	-				✓	
Epinephelus caeruleopunctatus	white-spotted grouper		✓		✓	
Epinephelus coioides	estuary cod		✓	✓		
Epinephelus fasciatus	-					
Epinephelus lanceolatus	giant grouper		✓			
Epinephelus quoyanus	long-finned rock-cod		✓		✓	
Epinephelus sexfasciatus	-				✓	
Epinephelus suillus	-				✓	
Epinephelus tauvina	-				✓	
Lotella rhacina	rock-cod					✓
Plectropomus maculatus	bar-cheek coral trout		✓	✓	✓	
SIGANIDAE	**Rabbitfishes**					
Siganus doliatus	blue-line rabbitfish		✓		✓	
Siganus fuscescens	mottled spinefoot		✓		✓	
Siganus guttatus	golden rabbitfish		✓			
Siganus javus	Java rabbitfish		✓			
Siganus lineatus	lined rabbitfish		✓			
Siganus nebulosus	-				✓	
Siganus virgatus	double-barred rabbitfish		✓		✓	
SILLAGINIDAE	**Whiting**					
Sillago	-				✓	
Sillago analis	-				✓	
Sillago maculata	-				✓	
Sillago sihama	-				✓	
SOLEIDAE	**Soles**					
Aesopia heterorhinos	-				✓	
Aseraggodes	-				✓	
Dexillichthys muelleri	-				✓	
Paradicula setifer	-				✓	
Pardachirus pavoninus	-				✓	
Zebrias quagga	-				✓	
SPARIDAE	**Breams and porgies**					
Acanthopagrus berda	black bream		✓			
Acanthopagrus palmaris	north-west black bream					✓
Chrysophrys auratus	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
SPHYRAENIDAE	**Barracudas**					
Sphyraena sp.	-				✓	
Sphyraena barracuda	great barracuda		✓		✓	
Sphyraena jello	pickhandle barracuda		✓	✓	✓	
Sphyraena obstusata	striped barracuda			✓	✓	
Sphyraenella sp.	-				✓	
SPHYRNIDAE	**Hammerhead sharks**					
Sphyrna lewini	scalloped hammerhead		✓		✓	
Sphyrna mokarran	great hammerhead				✓	
STEGOSTOMATIDAE	**Zebra sharks**					
Stegostoma fasciatum	zebra shark		✓	✓		
SYNGNATHIDAE	**Pipefishes**					
Choeroichthys brachysoma	short-bodied pipefish				✓	
Haliichthys taeniophorus	ribboned seadragon				✓	
Micrognathus micronotopterus	tidepool pipefish				✓	
Syngnathoides biaculeatus	alligator pipefish				✓	
Trachyrhamphus bicoarctata	double-ended pipefish				✓	
Trachyrhamphus intermedius	-				✓	
Trachyrhamphus longirostris	straightstick pipefish				✓	
SYNODONTIDAE	**Grinners**					
Saurida	-				✓	
Saurida micropectoralis	shortfin lizardfish				✓	
TERAPONTIDAE	**Grunters**					
Terapon sp.	trumpeter		✓		✓	
Amniataba caudovittata	-				✓	
Pelates quadrilineatus	-				✓	
Pelates sexlineatus	-				✓	
Terapon jarbua	-				✓	
Terapon puta	-				✓	
Terapon theraps	-				✓	
TETRAODONTIDAE	**Pufferfish and allies**					
Amblyrhynchotes	-				✓	
Arothron	-				✓	
Arothron alboreticulatus	-				✓	
Arothron manilensis	striped puffer		✓		✓	
Arothron stellatus	starry pufferfish		✓			
Chelonodon	-				✓	
Chelonodon patoca	-				✓	

Scientific Name	Common Name	Reference Source				
		EPBC Protected Matters Search 2010	Gomleyuk 2003	Gomleyuk 2009	Cobourg Peninsula Sanctuary and Marine Park Board 2007	AECOM 2011
Feroxodon multistriatus	ferocious pufferfish		✓	✓		
Lagocephalus	-				✓	
Lagocephalus gloveri	-				✓	
Lagocephalus lunaris	rough golden toadfish			✓	✓	
Lagocephalus sceleratus	-				✓	
Lagocephalus spadiceus	-				✓	
Tetraodon	-				✓	
Torquigener tuberculiferus	-				✓	
Torquigener whitleyi	-				✓	
TOXOTIDAE	**Archerfishes**					
Toxotes chatareus	seven-spot archerfish					✓
TRIANCANTHIDAE	**Tripodfishes**					
Triacanthus	-				✓	
Triacanthus biaculeatus	-				✓	
Tripodichthys	-				✓	
Tripodichthys angustifrons	-				✓	
Trixiphichthys weberi	-				✓	
TRICHIURIDAE	**Cutlassfishes**					
Trichiurus	-				✓	
TRIGLIDAE	**Gunnards**					
Triglidae sp.	-				✓	
TRIPTERYGIIDAE	**Triple-fins**					
Enneapterygius n.sp.	-				✓	
Helcogramma striata	-				✓	
URANOSCOPIDAE	**Stargazers**					
Ichthyoscopus fasciatus	-				✓	
Uranoscopus	-				✓	
Uranoscopus cognatus	-				✓	
VELIFERIDAE	**Veilfins**					
Velifer	-				✓	
ZANCLIDAE	**Moorish idols**					
Zanclos cornutus	Moorish idol		✓			

Site Invertebrate List

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
ACTEONIDAE	**Barrel bubble snails**						
Pupa fumata	-				✓		
Pupa sulcata	-			✓	✓		
ANGARIIDAE	**Angaria shells**						
Angaria delphinus	common delphinula			✓	✓		
ARCIDAE	**Ark clams**						
Anadara antiquata	-				✓		
Anadara granosa	blood cockle			✓			
Anadara inaequivalvis	-			✓			
Anadara maculosa	-				✓		
Arca multivillosa	-				✓		
Arca subnavicularis	turkeys wing				✓		
Arca ventricosa	ventricose ark				✓		
Austroglyphus sp.	-				✓		
Austroglyphus jukesi	-				✓		
Barbatia sp.	-				✓		
Barbatia amygdalumtostum	-			✓	✓		
Barbatia helblingi	-			✓			
Calcar stellare	-				✓		
Navicula terebra	-				✓		
Trisidos semitorta	half propeller ark				✓		
Trisidos youngie	-				✓		
ARCHITECTONICIDAE	**Staircase shells**						
Architectonica perspectiva	perspective sundial shell				✓		
ATTACUS	**Attacus moths**						
Attacus wardi	-						✓
BATILLARIIDAE	**Batillaria shells**						
Batillaria sp.	-				✓		
BUCCINIDAE	**True whelks**						
Cantharus erythrostoma	-				✓		
Cantharus fumosus	-			✓	✓		
Cantharus subrubiginosus	-				✓		
Engina alveolata	handsome engina			✓			
Phos senticosus	-				✓		
Pisania ignea	flame pisania				✓		
BULLIDAE	**Bubble snails**						
Bulla adamsi	-				✓		
Bulla ampula	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
BURSIDAE	**Frog shells**						
Dulcerana granularis	-				✓		
CAMAENIDAE	**Camaenid snails**						
Amphidromus cognatus	cognate land snail	✓					
CARDIIDAE	**Bivalve cockles**						
Acrosterigma elongata	-			✓			
Acrosterigma reevianum	-			✓			
Fragum unedo	Pacific strawberry cockle				✓		
Fragum whitleyi	-				✓		
Fulvia papyracea	paper cockle				✓		
Hemicardium hemicardium	-			✓			
Laevicardium maculosum	-				✓		
Lunulicardia retusa	-				✓		
Maoricardium setosum	-			✓			
Vasticardium elongatum	-				✓		
Vasticardium enode	-				✓		
Vasticardium flavum	-				✓		
Vepricardium setosum	-				✓		
CARDITIDAE	**Cockle clams**						
Beguina semiobiculata	-				✓		
Cardita sp.	-				✓		
Cardita crassicosta	-				✓		
Cardita incrassata	-			✓			
CERITHIIDAE	**Ceriths**						
Cerithium coralium	coral cerith			✓			
Cerithium sinensis	obelisk vertagus				✓		
Cerithium variegatum	-				✓		
Cerithium vergatus	-				✓		
Cerithium zebrum	-			✓			
Clypeomorus admirabilis	-			✓			✓
Clypeomorus baccatus	-				✓		
Clypeomorus dorsuosum	-				✓		
Clypeomorus morum	morus cerith				✓		
Clypeomorus traillii	-				✓		
Ischnocerithium echinatum	-				✓		
Pseudovertagus novaehollandiae	-				✓		
Rhinoclavis aspera	-				✓		
Rhinoclavis brettinghami	-			✓	✓		
CHAMIDAE	**Jewel boxes**						

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Chama fibula	-				✓		
Chama isotoma	-				✓		
Chama pulchella	-				✓		
CHITONIDAE	**Chitons**						
Acanthopleura gemmata	northern spined chiton			✓			
Acanthopleura spinosa	spiny chiton			✓			
COLUMBELLIDAE	**Dove snails**						
Pyrene sp.	-				✓		
Pyrene opulens	-				✓		
CONIDAE	**Cone shells and allies**						
Conus sp.	-				✓		
Conus achatinus	-			✓	✓		
Conus arenatus	sand dusted cone				✓		
Conus aulicus	-				✓		
Conus badius	-				✓		
Conus capitaneus	-				✓		
Conus chaldeus	-				✓		
Conus coronatus	crowned cone				✓		
Conus episcopus	-				✓		
Conus geographus	geography cone				✓		
Conus miles	-				✓		
Conus mustellinus	-				✓		
Conus nussatella	Nussatella cone				✓		
Conus planorbis	-				✓		
Conus rattus	rat cone				✓		
Conus sugillatus	-				✓		
Conus terebra	-				✓		
Conus tesselatus	-				✓		
Conus textile	cloth-of-gold cone				✓		
Conus vexillum	vexillum cone				✓		
Eucithara arenivaga	-			✓			
CORBICULIDAE	**Basket clams**						
Corbicula coaxans	-			✓	✓		
Corbula macgillivrayi	-				✓		
COSTELLARIIDAE	**Ribbed miters**						
Vexillum sp.	-				✓		
Vexillum caffrum	-				✓		
Vexillum plicarium	-			✓	✓		
Vexillum rufilosum	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Vexillum vulpeculum	-			✓	✓		
CYPRAEIDAE	**Cowries**						
Cypraea annulus	gold ringer				✓		
Cypraea arabica	Arabian cowry				✓		
Cypraea argus	-				✓		
Cypraea asellus	-				✓		
Cypraea bistrinotata	-				✓		
Cypraea caputserpentis	serpent's-dead cowry				✓		
Cypraea carneola	carnelian cowry				✓		
Cypraea caurica	-				✓		
Cypraea cribraria	-				✓		
Cypraea cylindrica	-				✓		
Cypraea eglantina	-				✓		
Cypraea erosa	gnawed cowry				✓		
Cypraea errones	-				✓		
Cypraea helvola	honey cowry				✓		
Cypraea hirundo	-				✓		
Cypraea isabella	-				✓		
Cypraea labrolineata	-				✓		
Cypraea limacina	-				✓		
Cypraea lynx	-				✓		
Cypraea macula	-				✓		
Cypraea mappa	map cowry				✓		
Cypraea miliaris	-				✓		
Cypraea moneta	money cowry				✓		
Cypraea pallidula	-				✓		
Cypraea pyriformis	-				✓		
Cypraea quadrimaculata	-				✓		
Cypraea saulae	-				✓		
Cypraea stolida	stolid cowry				✓		
Cypraea subviridis	-				✓		
Cypraea talpa	mole cowry				✓		
Cypraea tigris	tiger cowry				✓		
Cypraea vitellus	-				✓		
Cypraea walkeri	-				✓		
DONACIDAE	**Bean clams**						
Donax faba	Pacific bean donax			✓			
DORIDOIDEA	**Dorid nudibranchs**						
Glossodoris atromarginata	black-margined nudibranch			✓			

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
EPITONIIDAE	**Wendeltraps**						
Epitonium kanemoe	-			✓			
FASCIOLARIIDAE	**Tulip and spindle snails**						
Latirus paetelianus carpenteriansis	-				✓		
Peristernia incarnata	-			✓	✓		
FICIDAE	**Fig shells**						
Ficus subintermedia	underlined fig shell				✓		
FISSURELLIDAE	**Keyhole and slit limpets**						
Diodora jukesii	-			✓			
Diodora mus	-			✓			
Emarginula variegata	-			✓			
Scutus granulatus	-				✓		
GLAUCONOMIDAE	**Siphons**						
Glauconome cerea	-			✓			
GLYCYMERIDIDAE	**Dog cockles**						
Glycymeris sp.	-				✓		
Glycymeris persimilis	-				✓		
GRYPHAEIDAE	**Foam oysters**						
Pycnodonte hyotis	-				✓		
HAMINOEIDAE	**Haminoeid bubble snails**						
Aliculastrum cylindricum	cylindrical true bubble			✓	✓		
Atys naucum	white nut sheath bubble				✓		
HALIOTIDAE	**Abalones**						
Haliotis varia	green ormer			✓			
Sanhaliotus ovina	sheeps ear shell				✓		
Sanhaliotus squamata	-				✓		
Sanhaliotus varia	common ear shell				✓		
HESPERIIDAE	**Skipper butterflies**						
Taractrocera ilia	northern grass-dart butterfly	✓					
HIPPONICIDAE	**Hoof snails**						
Sabia sp.	-				✓		
HIPPOLYTIDAE	**Hump-backed shrimps**						
Thor spinipes						✓	
Thorella cobourgi						✓	
IRAVADIIDAE	**Iravad shells**						
Iravadia ornata	-			✓			
ISOGNOMONIDAE	**Tree oysters**						
Crenatula modiolaris	-				✓		
Crenatula viridis	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Isognomon isognomon	elongate toothed pearl shell			✓	✓		
JANTHINIDAE	**Purple snails**						
Janthina globosa	elongate janthina				✓		
LATERNULIDAE	**Lantern clams**						
Laternula constricta	-			✓			
LIMIDAE	**File clams**						
Limaria basilanica	Basilan lima			✓			
LITTORINIDAE	**Periwinkles**						
Littoraria articulata	-			✓			
Littoraria filosa	-			✓			
Littoraria scabra	-			✓	✓		
LOTTIIDAE	**True limpets**						
Patelloida saccharina	-			✓	✓		
LUCINIDAE	**Lucina clams**						
Anodontia philippiana	chalky buttercup			✓			
Divalucina cumingi	-				✓		
Divaricella ornata	-			✓			
Spicodakia bella	-				✓		
LYCAENIDAE	**Gossamer-winged butterflies**						
Ogyris iphis doddi	Dodd's azure butterfly	✓					
MACTRIDAE	**Annapella snails**						
Lutraria australis	European otter clam				✓		
Macrotoma angulifera	-				✓		
Mactra sp.	-				✓		
Mactra abbreviata	meretrix trough shell			✓			
Mactra dissimilis	-			✓	✓		
Mactra eximia	pretty trough shell				✓		
Mactra meretriciformis	-				✓		
Mactra reevei	-				✓		
Meropesta nicobarica	-			✓			
Notospisula sp.	-			✓			
MALLEIDAE	**Hammer oysters**						
Malleus albus	white hammer oyster				✓		
Malleus malleus	black hammer oyster				✓		
Parimalleus gregarius	-				✓		
Vulsella vulsella	sponge finger				✓		
MELOGENIDAE	**Crown conches**						
Volegalea wardiana	-				✓		
MESODEMATIDAE	**Marine bivalve clams**						

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Atactodea striata	striated little trough shell			✓			
MITRIDAE	**Mitre shells**						
Mitra variablis	variable miter				✓		
MURICIDAE	**Murex snails**						
Acurpurpura macgillivrayi	-				✓		
Chicoreus capucinus	-			✓			
Chicoreus torrefactus	firebrand murex snail				✓		
Conomurex luhuanus	blood-mouthed conch				✓		
Cronia pseudamygdala	Pseudo-almond purple				✓		
Drupa margariticola	-				✓		
Drupella rugosa	rugose drupe			✓			
Euphyllon cervicornis	-				✓		
Euphyllon cornucervi	-				✓		
Homolocanthus varicosus	-				✓		
Lataxiena blossvillei	-				✓		
Mancinella echinata	prickly rock shell				✓		
Morula fiscella	little basket drupe			✓			
Morula margariticola	-			✓			
Naquetia permaesta	-				✓		
Rapana rapiformis	turnip shell				✓		
Thais aculeata	-				✓		
Thais kieneri	Kiener's purple				✓		
Thais muricina	-			✓			
MYTILIDAE	**Common mussels**						
Lithophaga teres	cylinder date mussel			✓			
Modiolus micropterus	winged horse mussel			✓			
Modiolus nitidus	-				✓		
Modiolus philippinarum	Philippine horse mussel				✓		
Modiolus proclivus	-				✓		
Modiolus vagina suavifer	vagina horse mussel				✓		
Septifer bilocularis	deck mussel			✓			
Stavelia horrida	-				✓		
NASSARIIDAE	**Dog whelks**						
Nassarius glans	acorn dog whelk				✓		
Zeuxis dorsatus	unicolour dog whelk				✓		
NATICIDAE	**Moon snails**						
Eunaticina papilla	-				✓		
Natica sp.	-				✓		
Natica collei	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Natica gualterina	-				✓		
Naticarius alapapilionis	-				✓		
Polinices didyma	bladder moon shell			✓	✓		
Polinices melanostomus	black-mouthed moon shell				✓		
Polinices peselephanti	-				✓		
Polinices powisiana	-				✓		
Polinices pyriformis	pear shaped flat moon snail				✓		
Polinices sebae	-				✓		
Polinices simiae	-				✓		
NAUTILIDAE	**Nautiluses**						
Nautilus pompilius alumnus	chambered nautilus				✓		
NERITIDAE	**Nerites**						
Amphinerita polita	-				✓		
Nerita balteata	lineated nerite			✓			
Nerita chamaeleon	chameleon nerite			✓	✓		
Nerita lineata	common nerite				✓		
Nerita striate	-				✓		
Theliostyla albicilla	ox tongue nerite				✓		
NOETIIDAE							
Sheldonella lateralis	-			✓			
NUCULIDAE	**Nut clams**						
Nucula sp.	-			✓			
OCTOPODIDAE	**True octopuses**						
Hapalochlaena lunulatus	greater blue-ringed octopus				✓		
OLIVIDAE	**Olive snails**						
Oliva miniacea	Pacific common olive				✓		
Oliva oliva	-				✓		
Oliva ornata	-				✓		
Oliva vidua	-				✓		
ONCHIDIIDAE	**Onchid slugs**						
Onchidium sp.	-			✓			
OSTREIDAE	**True oysters**						
Crassostrea amasa	eastern oyster				✓		
Crassostrea echinata	spiny oyster				✓		
Dendrostrea folium	foliate oyster			✓			
Lopha cristagalli	Cock's comb oyster				✓		
Mimachlamys cruentata	-				✓		
Ostraea trapenzina	-				✓		
Plicatula essingtonensis	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Saccostrea cucullata	milky oyster		✓				✓
Saccostrea echinata	northern black lip oyster		✓	✓			
Saxostrea grandina	-				✓		✓
OVULIDAE	**Ovulids**						
Ovula ovum	common egg cowry				✓		
PLANAXIDAE	**Clusterwinks**						
Planaxis sulcatus	tropical periwinkle			✓			
PECTINIDAE	**Pectin scallops**						
Amusium pleuronectes	Asian moon scallop				✓		
Annachlamys leopardus	-				✓		
Chlamys fulvicostatus	-				✓		
Chlamys gloriosa	glorious scallop			✓			
Complicachlamys dringi	-			✓			
Complicachlamys radula	-			✓			
Decatopecten strangei	-				✓		
PHARIDAE	**Razor shells**						
Ensiculus cultellus	-			✓			
Ensiculus hilaris	-				✓		
Pharella wardi	-			✓			
PINNIDAE	**Pen shells**						
Atrina vexillum	-				✓		
Pinna bicolor	bicolour pen shell			✓	✓		
Servatrina pectinata	-				✓		
POTAMIDIDAE	**Helmet snails**						
Cerithidea anticipata	mangrove snail				✓		
Cerithidea cingulata	girdled horn snail			✓			
Cerithidea obtusa	red chut-chut snail			✓			
Telescopium telescopium	rodong snail			✓	✓		
Terebralia palustris	mangrove whelk			✓			
Terebralia semistriata	striate mud creeper			✓			
Terebralia sulcata	belitong snail			✓			
PSAMMOBIIDAE	**Sunset clams**						
Asaphis deflorata	gaudy sanguin				✓		
Gari sp.	-				✓		
Gari anomala	-				✓		
Gari togata	courtesan sunset clam			✓			
Soletellina sp.	-				✓		
Soletellina petalina	-			✓			
PTERIIDAE	**Winged and pearl oysters**						

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Austropteria saltata	-				✓		
Magnavicula bennetti	-				✓		
Pinctada margaritifera	black lip oyster				✓		
Pinctada maxima	mother-of-pearl shell				✓		
Pinctada sugillata	-			✓	✓		
PYRAMIDELLIDAE	**Pyramid shells**						
Milda ventricosa	ventricose pyramid				✓		
Otopleura auriscati	cat's ear pyramid				✓		
Volupsa maculosa	-				✓		
RANELLIDAE	**Tritons**						
Cabestanimorpha vespacea	-				✓		
Gelagna succincta	-				✓		
Lampusia pileare	hairy triton				✓		
Linatella cingulata	-				✓		
Lotoria lotoria	-				✓		
Ranularia caudata	-				✓		
Ranularia pyrum	-				✓		
Reticutriton pfeifferiana	-				✓		
SCYLLA	**Swimming crabs**						
Scylla serrata	mud crab						✓
SEMELIDAE	**Semele clams**						
Leptomya sp.	-			✓			
Semele sp.	-			✓			
SILIQUARIIDAE	**Slit worm shells**						
Siliquaria ponderosa	ponderous worm shell				✓		
SIPHONARIIDAE	**False limpets**						
Siphonaria atra	large false limpet				✓		
SOLECURTIDAE	**Solecurtus clams**						
Solecurtus sulcatus	-				✓		
SOLENIDAE	**Razor clams**						
Solen vagina	-				✓		
SPONDYLIDAE	**Thorny oysters**						
Spondylus sp.	-			✓	✓		
Spondylus ducalis	-				✓		
Spondylus pacificus fortior	-				✓		
Spondylus wrightianis	-				✓		
STROMBIDAE	**Fighting conches**						
Canarium mutabilis	changeable conch				✓		
Canarium urceus orrae	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Doxander campbellii	Campbell's conch				✓		
Doxander vittatus	riband market stromb				✓		
Euprotomus aurisdinae aratrum	-				✓		
Euprotomus bulla	-				✓		
Euprotomus womer iredalei	-				✓		
Gibberulus gibberulus	humpbacked conch				✓		
Lambis lambis	spider conch				✓		
Strombus campbelli	Campbell's stromb			✓			
Terebellum terebellum	terebellum conch				✓		
TELLINIDAE	**Tellins and macomas**						
Macalia sp.	-				✓		
Macalia bruguieri	-			✓			
Tellina sp.	-				✓		
Tellina compacta	-			✓			
Tellina inflata	-			✓	✓		
Tellina ovalis	oval tellin				✓		
Tellina perna	-				✓		
Tellina pharaonis	-			✓	✓		
Tellina staurella	-				✓		
Tellina virgata	virgate tellin				✓		
TEREBRIDAE	**Auger shells**						
Duplicaria evoluta	crenulate auger				✓		
Terebra areolata	-				✓		
Terebra dimidiata	-				✓		
Terebra subulata	-				✓		
TEREDINIDAE	**Shipworms**						
Bactronophorus thoracites	edible shipworm				✓		
Dicyathifer manni	-				✓		
Lyrodus bipartita	furrow shipworm				✓		
Lyrodus pedicellatus	blacktip shipworm				✓		
Teredo mindariensis	-				✓		
Teredothyra matacotana	-				✓		
TONNIDAE	**Tun shells**						
Casmaria erinaceus	-				✓		
Casmaria ponderosa	Atlantic casmaria				✓		
Cassis cornuta	yellow helmet				✓		
Phalium areola	helmet shell				✓		
Phalium bandatum bandatum	-				✓		
Semicassis bisulcatum	Japanese bonnet snail				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Semipallium lucalentum	-				✓		
Tonna allium	costate tun				✓		
Tonna chinensis	-				✓		
Tonna perdix	Atlantic partridge tun				✓		
TRIDACNIDAE	**Giant clams**						
Tridacna squamosa	fluted giant clam			✓	✓		✓
TRIVIIDAE	**False cowries**						
Trivia oryza	-				✓		
TROCHIDAE	**Top snails**						
Euchelus atratus	beaded top shell			✓			
Monilea califera	-				✓		
Monodonta labio	toothed top shell				✓		
Stomatalla phymotis	-				✓		
Stometalla sp.	-				✓		
Stometalla rubra	-				✓		
Thalotia sp.	-				✓		
Thalotia aruensis	-			✓			
Trochus hanleyanus	-			✓	✓		
Trochus maculatus	maculated top shell				✓		
Trochus niloticus	-				✓		
TURBINELLIDAE	**Pagoda and vase shells**						
Syrinx aruanus	Australian trumpet				✓		
TURBINIDAE	**Turban snails**						
Astralium stellare	northern star			✓			
Astralium rhodostomum	-				✓		
Senectus squamosus	-				✓		
Tectus pyramis	pyramid top			✓	✓		
Turbo laminiferus	-			✓			
Turbo petholatus	-				✓		
Turbo porphyrites	-				✓		
TURRITELLIDAE	**Tower shell**						
Turritella terebra	screw turret			✓			
VENERIDAE	**Venus clams**						
Antigona lamellaris	-				✓		
Callista planatella	-				✓		
Circe sp.	-				✓		
Circe scripta	-				✓		
Clementia papyrac	-			✓	✓		
Dosinia sp.	-				✓		

Scientific Name	Common Name	Reference Source					
		NRETAS 2005	Gomelyuk 2000	Billyard 1995	Frith and Calaby 1974	Bruce 1982	AECOM 2011
Dosinia mira	-			✓			
Dosinia scalaris	-				✓		
Dosinia sculpta	-			✓			
Gafrarium dispar	-				✓		
Gafrarium pectinatum	comb venus				✓		
Gafrarium tumidum	tumid venus			✓	✓		
Lioconcha fastigiata	-			✓			
Marcia hiantina	hiant venus			✓			
Maridosinia nitens	-				✓		
Paphia sinuosa	-				✓		
Paphia undulata	undulate venus				✓		
Periglypta reticulata	reticulated venus			✓			
Periglypta laqueata	-			✓			
Pitar affinis	-				✓		
Placamen sp. calophylla	-				✓		
Placamen calophylla	-				✓		
Placamen foliacea	-				✓		
Tapes dorsatus	turgid venus				✓		
Tapes variegata	-				✓		
Venus embrithes	-				✓		
VOLUTIDAE	**Volutes**						
Amoria turneri	-				✓		
Cymbiola sophia	-				✓		
Melo amphora	diadem volute				✓		
Melo umbilicatus	heavy baler				✓		
ZONITIDAE	**True glass snails**						
Trochomorpha melvillensis	Melville snail	✓					

Site Coral List (Billyard 1995)

Scientific Name	Common Name
ACROPORIDAE	**Table and pore corals**
Acropora bruegmanni	Bruegmann's acropora
Acropora digitifera	cluster acropora
Acropora formosa	Formosa staghorn coral
Acropora horrida	antler coral
Acropora valenciennesi	table coral
Acropora verweyi	-
Montipora aequituberculata	encrusting pore coral
Montipora crassituberculata	-
Montipora digitata	velvet coral
Montipora efflorescens	-
Montipora mollis	-
Montipora spongodes	velvet stone coral
Montipora turgescens	-
AGARICIIDAE	**Agarid corals**
Leptoseris scabra	porcelain coral
ASTROCOENIIDAE	**Astrocoenid corals**
Stylocoeniella guentheri	-
CAROPHYLLIIDAE	**Carophyllid corals**
Euphyllia divisa	frogspawn
DENDROPHYLLIIDAE	**Dendrophyllid corals**
Turbinaria mesenterina	pagoda coral
FAVIIDAE	**Honeycomb and brain corals**
Cyphastrea chalcidium	-
Cyphastrea microphthalma	lesser knob coral
Cyphastrea serailia	-
Echinopora lamellosa	hedgehog coral
Favia favus	head coral
Favia pallida	knob coral
Favia rotumana	-
Favia speciosa	-
Favites abdita	honeycomb coral
Goniastrea aspera	-
Goniastrea pectinata	lesser star coral
Goniastrea edwardsi	-
Goniastrea favulus	-
Goniastrea retiformis	-
Leptastrea pruinosa	spotted coral
Leptastrea purpurea	crust coral
Leptastrea transversa	transverse coral
Montastrea curta	star bolder coral
Platygyra daedalea	brain coral

Scientific Name	Common Name
Platygyra lamellina	lesser valley coral
Platygyra pini	-
Platygyra sinensis	-
Platygyra verweyi	-
FUNGIIDAE	**Mushroom corals**
Herpolitha limax	tongue coral
Fungia fungites	common mushroom coral
Fungia repanda	short tentacle plate coral
Heliofungia actiniformis	long tentacle plate coral
Lithophyllon edwardsi	-
MERULINIDAE	**Merulinid corals**
Hydnophora exesa	spine coral
Merulina ampliata	merulina coral
MUSSIDAE	**Meat and pineapple corals**
Lobophyllia corymbosa	brain root coral
Symphyllia radians	greater brain coral
Symphyllia recta	dented brain coral
OCULINIDAE	**Galaxy corals**
Galaxea astreata	octopus coral
PECTINIIDAE	**Lettuce and plate corals**
Echinophyllia aspera	chalice coral
Pectinia paeonia	lettuce coral
POCILLOPORIDAE	**Pocilloporid corals**
Stylophora pistillata	hood coral
Pocillopora damicornis	cauliflower coral
PORITIDAE	**Poritid corals**
Goniopora columna	flowerpot coral
Goniopora palmensis	-
Porites annae	encrusting bolder coral
Porites australiensis	-
Porites nigrescens	stony coral
Porites lobata	lobe coral
Porites lutea	-
Porites mayeri	-
SIDERASTREIDAE	**Siderastreid corals**
Psammocora contigua	branched sandpaper coral

Status of Wetland Dependent Vertebrate Fauna
Table Notes:
Column 1 – legislative status under the EPBC Act (VU: vulnerable; EN: endangered; M: migratory; L: listed).
Column 2 – legislative status under the TPWCA (EN: endangered; VU: vulnerable; DD: data deficient).
Column 3 – inclusion under international bilateral agreement (C: CAMBA; J: JAMBA; R: ROKAMBA; B: Bonn Convention)

Scientific Name	Common Name	1	2	3
Mammals				
Conilurus pencillatus	brush-tailed rabbit-rat	VU		
Dasyurus hallucatus	northern quoll	EN		
Xeromys myoides	water mouse	VU	DD	
Reptiles				
Caretta caretta	loggerhead turtle	EN,M,L		B
Chelonia mydas	green turtle	VU,M,L		B
Dermochelys coriacea	leatherback turtle	EN,M,L		B
Eretmochelys imbricata	hawksbill turtle	VU,M,L		B
Lepidochelys olivacea	olive Ridley turtle	EN,M,L		B
Natator depressus	flatback turtle	VU,M,L		B
Crocodylus porosus	saltwater crocodile	M,L		B
Varanus mertoni	Merten's water-monitor	VU		
Waterbirds				
Anseranas semipalmata	magpie goose	M,L		
Anous stolidus	common noddy	M		
Apus pacificus	fork-tailed swift	M,L		C,J
Ardea alba	great egret	M,L		C,B
Ardea ibis	cattle egret	M,L		C,J
Ardea garzetta	little egret	M		
Ardea modesta	easter great egret	M		C
Calonectris leucomelas	streaked shearwater	M,L		C,J,R
Childonias leucopterus	white-winged black tern	M		J,C,B
Fulica atra	eurasian coot			B
Grus rubicunda	brolga	M		
Plegadis falcinellis	glossy ibis	M		C,B
Sulo leucogaster plotus	brown gannet			C,J,R
Sterna albifrons	little tern	M,L		C,J,R,B
Sterna anaethetus	bridled tern	M		C,J
Sterna bengalensis	lesser crested tern	M		C,B
Sterna bergii	crested tern			J,B
Sterna caspia	caspian tern			C,B
Sterna dougalli	roseate tern	M		
Sterna nilotica	gull-billed tern			B
Sterna sumatrana	black-naped tern	M		C,J
Shorebirds				
Actitis hypoleucos	common sandpiper	M		C,J
Arenaria interpres	ruddy turnstone	M		C,J,R,B
Calidris acuminata	sharp-tailed sandpiper	M		C,J,R
Calidris canutus	red knot	M		C,J,R,B
Calidris ferruginea	curlew sandpiper	M		C,J,R,B
Calidris ruficollis	red-necked stint	M		C,J,R
Calidris tenuirostris	great knot	M		C,J,R,B
Charadrius leschenaultii	greater sand plover	M		C,J,R,B
Charadrius mongolus	lesser sand plover	M		C,J,R
Coturnix ypsilophora	brown quail			B
Gallinago megala	swinhoe's snipe			C,J,R

Scientific Name	Common Name	1	2	3
Glareola maldivarum	oriental pranticole	M,L		C,J,R
Himantopus himantopus	black-winged stilt			B
Limicola falcinellus	broad-billed sandpiper	M		C,J,R,B
Limosa laponica	bar-tailed godwit	M		C,J,R,B
Limosa limosa	black-tailed godwit	M		C,J,R,B
Numenius madagascariensis	eastern curlew	M		C,J,R
Numenius phaeopus	whimbrel	M		C,J,R,B
Pluvialis fulva	pacific golden plover	M		C,J,R
Pluvialis squatarola	grey plover	M		C,J,R,B
Tringa brevipes	grey-tailed Tattler	M		C,J,R
Tringa nebularia	common greenshank	M		C,J,R,B
Tringa stagnatilis	marsh sandpiper	M		C,J,R,B
Xenus cinereus	terek sandpiper	M		C,J,R
Non-waterbirds				
Pandion haliaetus	osprey	M		B
Haliastur indus	brahminy kite	M		
Epthianura crocea	yellow chat		E	
Erythrotriorchis radiata	red goshawk	VU	VU	
Fregata ariel	lesser frigatebird			C,J,R
Geophaps smithii smithii	partridge pigeon (eastern)	VU	VU	
Haliaeetus leucogaster	white-bellied sea-eagle	M		C,R
Merops ornatus	rainbow bee-eater	M		
Turnix castanota	chestnut-breasted button-quail		DD	
Tyto novaehollandiae kimberli	masked owl (northern)	VU		

References

Begg, R., Walsh, B., Woerle, F. and King, S. 1983, 'Ecology of *Melomys burtoni*, the Grassland Melomys (Rodentia: Muridae) at Cobourg Peninsula, NT' in *Australian Wildlife Research*, Vol. 10, pp259-267

Birdata, 2010, *Birdata Custom Species List* (Cobourg Peninsula)

Bruce, A. J. 1982, '*Thorella cobourgi,* new genus, new species, a hippolytid shrimp from the Northern Territory, Australia', *Journal of Crustacean Biology*, vol. 2(3), pp. 451-458.

Chatto, R. and Baker, B. 2008, *The distribution and status of marine turtles nesting in the Northern Territory* (Technical Report No. 77), Palmerston: Parks and Wildlife Commission (NT)

Chatto, R. 2006, *The distribution and status of waterbirds around the coast and coastal wetlands of the Northern Territory* (Technical Report No. 76), Palmerston: Parks and Wildlife Commission (NT)

Chatto, R. 2003, *The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory* (Technical Report No. 73), Palmerston: Parks and Wildlife Commission (NT)

Chatto, R. 2001, *The distribution and status of colonial seabirds in the Northern Territory* (Technical Report No. 70), Palmerston: Parks and Wildlife Commission (NT)

Chatto, R. 2000, *Waterbird breeding colonies in the Top End of the Northern Territory* (Technical Report No. 69), Palmerston: Parks and Wildlife Commission (NT)

Cobourg Peninsula Sanctuary and Marine Park Board, 2007. *Cobourg Marine Park Plan of Management*

NRETAS 2005, *Northern Territory Bioregions* (Northern Territory Parks and Conservation Masterplan), Darwin: Department of Natural Resources, Environment and the Arts

Franklin, D.C. 2008, 'Report 9: The waterbirds of Australian tropical rivers and wetlands' in *A compendium of Ecological Information on Australia's Northern Tropical Rivers. Sub-project 1 of Australia's Tropical Rivers – an integrated data assessment and analysis* (report to Land and Water Australia), Townsville: National Centre for Tropical Wetland Research

Frith, H.J., Calaby, J.H., Chippendale, G.M., Blackburn, H., Cogger, H.G., Lindner, D.A., Hitchcock, W.B. and Keith, K. 1974, *Fauna Survey of the Port Essington District, Cobourg Peninsula, Northern Territory of Australia* (Division of Wildlife Research Technical Paper No. 28), Melbourne: CSIRO

Gomleyuk, V.E. 2009, 'Fish assemblages composition and structure in three shallow habitats in north Australia tropical bay, Garig Gunak Barlu National Park, Northern Territory, Australia' in *Journal of the Marine Biological Association of the United Kingdom*, Vol. 89(3) pp449-460

Gomleyuk, V.E. 2003, *Checklist of Coral and Rock Reef Fish Species at Garig Gunak Barlu National Park* (Technical Report), Darwin: Parks and Wildlife Service of the Northern Territory

Parks and Wildlife Commission of the Northern Territory, 1995, *The Cultural and Ecological Significance of Popham Creek, Cobourg Peninsula*

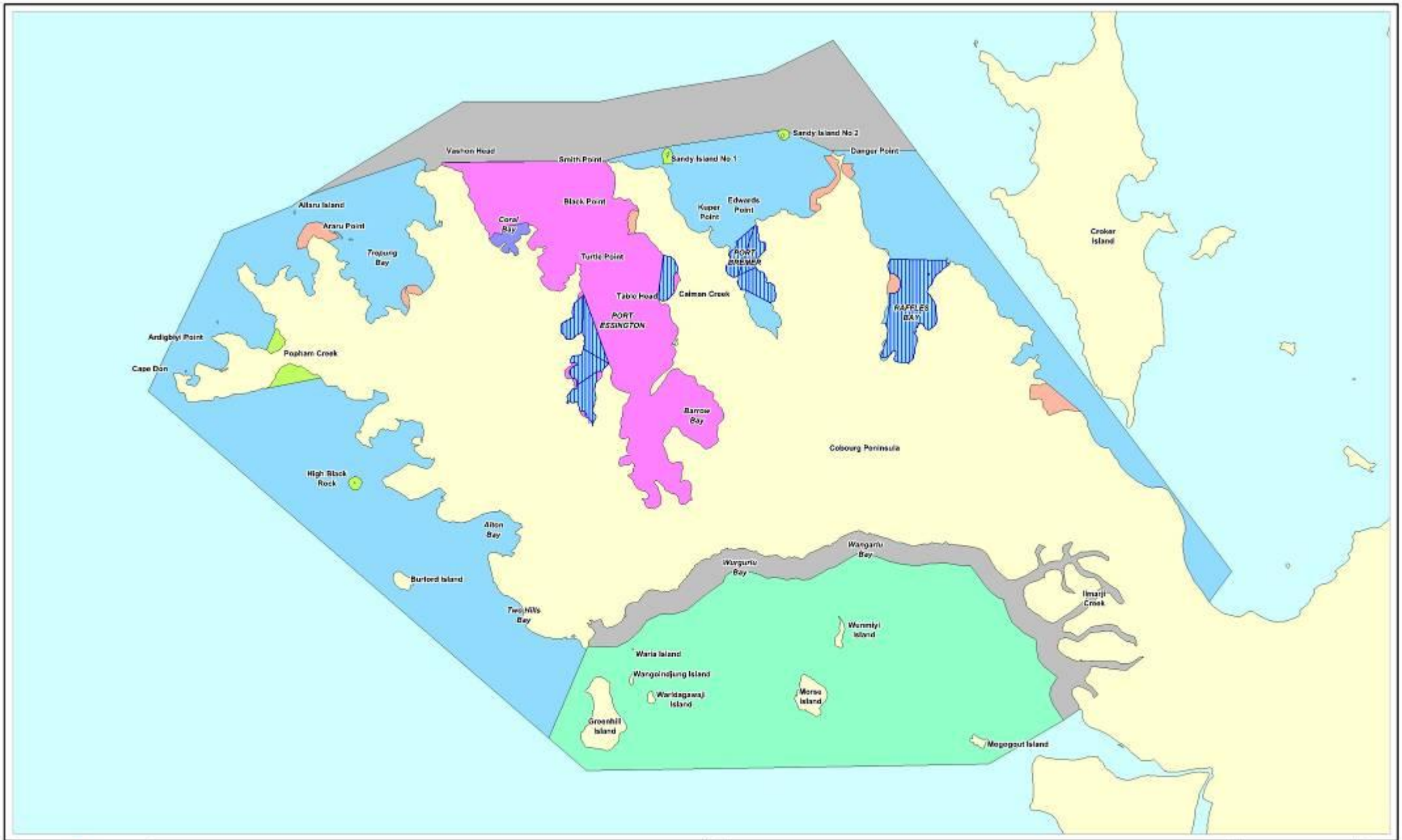
Woinarski, J. and Barker, B. 2002, *Biodiversity Audit – bioregional case study: Tiwi-Cobourg bioregion, Northern Territory* (prepared for National Land and Water Audit). Darwin

APPENDIX E: COBOURG MARINE PARK ZONING PLAN

Table E-1 Cobourg Marine Park Plan zone summary (source: NRETAS 2007)

Management Zone	Purpose	Management Strategy	Access
Multiple Use A	To provide for multiple use of the Park's resources including more intensive commercial fishing activities, protection of important conservation and scientific values and sustainable use of natural resources.	To provide appropriate areas for more intensive commercial fishing activities such as prawn trawling and netting and establish co-operative monitoring programs to monitor and manage those fisheries in the Park. Undertake research to better understand the values of this part of the Park.	Uses consistent with Park management objectives and values will be permitted to continue. Scope has been provided for future aquaculture prospects. These will be considered on a case by case basis.
Multiple Use B	To provide for multiple use of the Park's resources including less intensive commercial fishing activities, protection of important conservation and scientific values and sustainable use of natural resources.	To provide appropriate areas for less intensive commercial fishing activities and establish co-operative monitoring programs to monitor and manage those fisheries in the Park. Undertake research to better understand the values of this part of the Park.	Uses consistent with Park management objectives and values will be permitted to continue. Commercial netting, trawling and long-lining are not permitted in this zone. Recreational drag netting is not permitted in this zone. Scope has been provided for continued fishing and non-extractive tourism, as well as aquaculture prospects. These will be considered on a case by case basis.
Port Essington	To provide for a higher level of protection of marine biodiversity and habitats, and significant cultural heritage sites in an area of the Marine Park that sustains a higher level of visitor/recreation use.	Limit the range of commercial and recreational activities to those consistent with higher levels of visitor use. Establish cooperative monitoring programs and research to improve management and knowledge of the values of this part of the Park. Hand harvest of *trepang* is permitted in this zone by agreement with traditional owners.	Commercial fishing is restricted to *trepang* fishing only in this area. Recreational drag netting, crab potting and spear-fishing is not permitted in this zone. Scope has been provided for continued fishing and non-extractive tourism, as well as aquaculture prospects. These will be considered on a case by case basis.
Conservation	To protect significant species and their habitat including dugong and marine turtle populations.	To provide a high level of protection to the conservation values within the zone by limiting commercial, recreational and traditional owner activities and providing a focus for conservation initiatives.	No commercial or recreational fishing and no fishing tourism. Provision is made for non-extractive tours to be undertaken on a permit basis. No traditional hunting of turtle or dugong. Speed restriction of max 15 knots on motor boats in order to reduce incidence of dugong and turtle strikes. Anchoring and mooring will only be permitted on a permit basis.
Scientific Reference	To provide special protection to areas of high ecological significance and monitor condition over time. To protect sites of Aboriginal cultural significance.	Limit and regulate access. Establish research and monitoring programs for significant ecosystems and habitat. Manage Aboriginal sites of significance in accordance with relevant Commonwealth and NT legislation and in accordance with directions from traditional owners.	Highly restrictive access in order to protect values of outstanding scientific and conservation significance. Access by permit only.

Management Zone	Purpose	Management Strategy	Access
Coral Bay	To provide privacy to resort guests at Seven Spirit Bay Resort at Coral Bay.	Manage the area in accordance with the Lease Agreement and Marine Park Agreement. Access restricted to Seven Spirit Bay Resort staff and guests only.	Fishing Tourism opportunities, day use anchorage and traditional owner use will be permitted. Speed restriction of max 15 knots on motor boats in order to reduce incidence of dugong and turtle strikes. Anchoring and mooring will only be permitted on a permit basis.
Outstation Privacy Area	To protect the privacy of the traditional owners in the vicinity of their outstations and to provide for traditional Aboriginal resource use.	Through educational and promotional initiatives, enhance public awareness to ensure the protection of privacy for residents at outstations established on the sanctuary. Activities in this zone will not be regulated through legislation. Vessels may traverse zone, no fishing or anchoring (except in emergency). The number of outstation privacy areas is restricted to a maximum of eight within the life of this plan.	Through education and promotion enhance public awareness of the range of activities to provide for traditional Aboriginal resource use and to protect the privacy of the traditional owners in the vicinity of their outstations. Vessels may traverse zone, no fishing or anchoring (except in emergency conditions).



LEGEND

Pearling Leases

Cobourg Marine Park Zoning *

- Aboriginal Outstation Privacy Zone
- Conservation Zone
- Coral Bay Buffer Zone
- Multiple Use A Zone
- Multiple Use B Zone
- Port Essington Zone
- Scientific Reference Zone

* Northern Territory Department of Natural Resources, Environment and the Arts, 2007

Title:

Cobourg Marine Park Plan Zoning Scheme

Figure: **E-1**

Rev: **A**

N

0 7.5 15km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath :

APPENDIX F: ARCHAEOLOGICAL RESOURCES RELATED TO INDIGENOUS, MACASSAN AND EUROPEAN HERITAGE

Item/Place	Description
Indigenous archaeological resources	
Grinding tools, hollows and grooves	Tools similar to a mortar and pestle (Figure F-1), and hollows and grooves worn into rock, provide evidence of where Arrarrkbi have ground material such as ochre and plant food. Other types of grinding grooves (made from laterite or ironstone) were associated with rain-making and ceremonial practices (Tacon 1988).
Stone tools: tools such as axe heads, spear points, scrapers and blades	These stone tools give an insight into Arrarrkbi culture as they were traded with inland groups where the necessary materials (such as red ochre, silcrete, gneiss, dolerite, chert, slate, vein quartz and granite) required to construct the tools could be found (Mitchell 1995).
Harpoons	Constructed from fire-hardened ironwood were traditionally used to hunt marine animals. Following the arrival of Macassans in Australia, iron was adopted as the preferred material for harpoons (Mitchell 1996).
Middens	Large middens and mounds containing materials such as shells, coral, burnt laterite, turtle platelets, charred rocks, animal and human bones were found near Arrarrkbi campsites (Tacon 1988). A total of 56 midden sites have been recorded and/or excavated on the Cobourg Peninsula (P. Bourke pers. comm. 2010).
Fresh water wells	These wells were maintained by Arrarrkbi over long time periods in order to ensure a reliable source of drinking water (Figure F-2).
Stone arrangements	These often consisted of a number of stones arranged in lines or piles, usually associated with dreamtime activities and ceremonial practices (Tacon 1988).
Occupation sites	These included hunting camps and seasonally visited camps, often found near fresh water wells and springs.
Glass tools	These were tools fashioned from glass traded from the Macassans and Europeans (Harrison 2005).
Burial sites	Burial sites were noted during consultation with Arrarrkbi; the importance of looking after these, in order to respect the 'old people' (ancestors), was emphasised. Particular locations include the sand dunes near Gul Gul outstation, Reef Point and surrounds and caves where bones are held.
Bark paintings	The 'Port Essington' Arrarrkbi bark paintings, collected by Europeans from Cobourg Peninsula in the late 1800s, are considered to be the earliest surviving bark paintings from northern Australia, forming "an exceptional body of visual material culture" (Tacon and Davies 2004). These paintings existed at a time when European interest in, and appreciation of, bark paintings first began, leading to a thriving art industry today.
Macassan archaeological resources (Figure F-6)	
Fireplaces, smoke house	These items were associated with the processing of trepan (Figure F-3). Stone lines were

Item/Place	Description
pits, boiling cauldrons and stone lines	used to mark the most appropriate location for fireplaces from previous seasons.
Fresh water wells	Similar to the Arrarrkbi wells, these were maintained to ensure a reliable source of drinking water.
Tamarind trees	These were used to mark campsites and the tamarind fruit was used in cooking (Figure F-4).
Graves	
Bottle glass and pottery	Brought to Cobourg Peninsula by the Macassans and used as items to trade with the Arrarrkbi.
European (Figure F-7)	
Fort Wellington	This included a series of iron-stone, coral and lime ruins (fireplaces, floor slabs, water storage tank and wells), a cutting in the coral reef which was used by the ship's boats, a track to the settlement, many depressions in the ground, rubble and brick heaps, and various articles such as glass, pottery and nails.
Victoria Settlement	Includes 50 structures or sites related to the British military use of the area, two sites related to the Cobourg Cattle Company's use of the area and two ships' tanks of unknown origin
Cape Don Lighthouse complex	Includes the light tower, buildings and sheds.
Smith Point beacon	Figure F-5
Convalescent stations at Coral Bay and Spear Point	Includes building foundations, walkway, fresh water well and possibly graves
Customs House	Includes building foundations, water tank foundation, kitchen, chimney, metal, glass and oyster shells
Other places and objects	Includes: Father Confalieri's house at Black Point, Middle Head gardens and other government and private gardens, Ginger Palmer's camp and dugong kill site, Greenhill Island mission and school, lime kilns, stone arrangements and European camps

Figure F-1 Grinding tool from the Garig Gunak Barlu National Park interpretive centre (source: BMT WBM) © Copyright, Michelle McKemey

Figure F-2 Freshwater well at Araru Point (source: Melaleuca Enterprises) © Copyright, Michelle McKemey

Figure F-3 Cauldrons once used to process trepang (source: BMT WBM) © Copyright, Michelle McKemey

Figure F-4 Former Macassan camp site with tamarind tree, near Araru outstation (source: Melaleuca Enterprises) © Copyright, Michelle McKemey

Figure F-5 Smith Point beacon (source: Melaleuca Enterprises)
© Copyright, Michelle McKemey

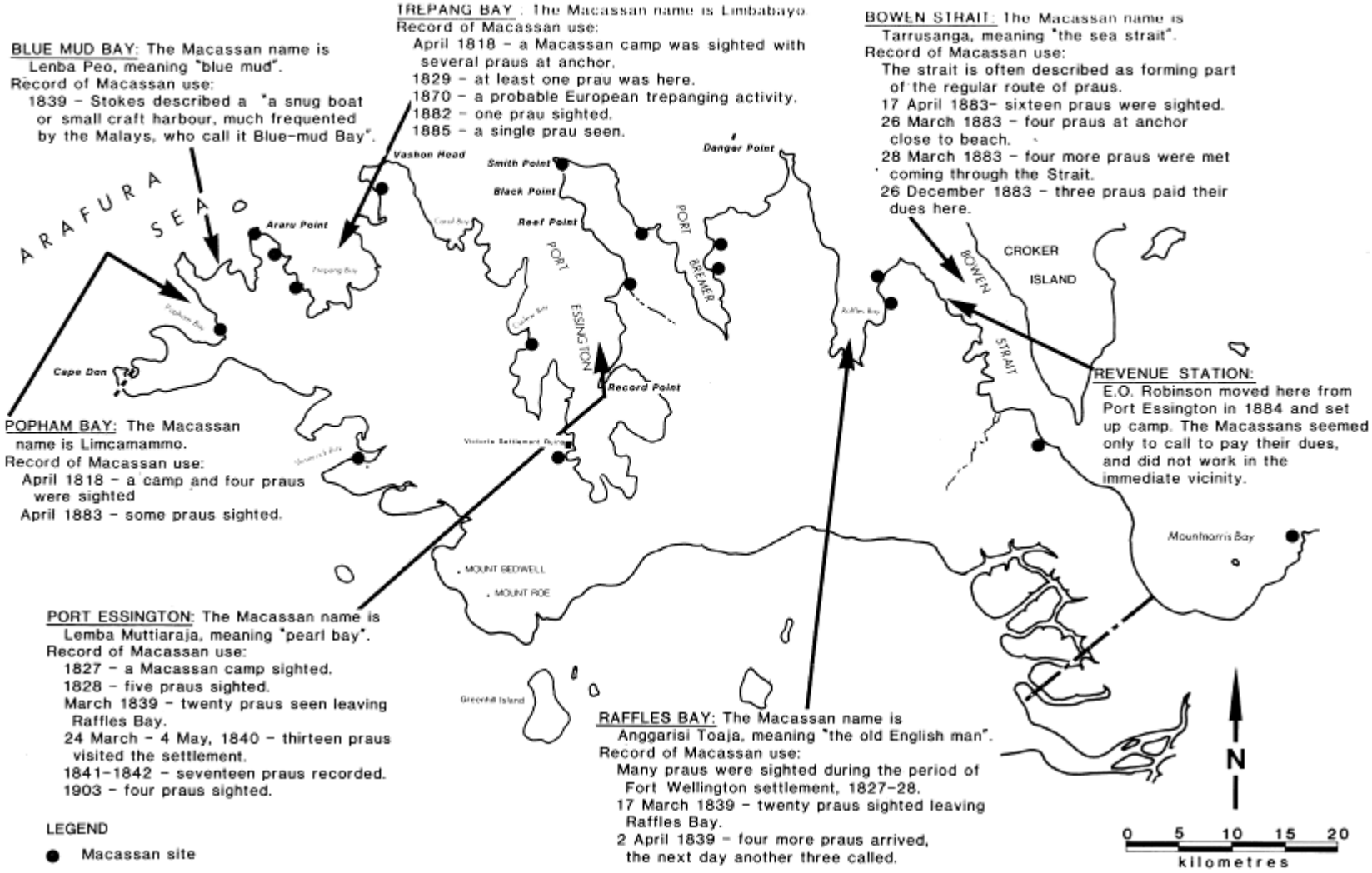


Figure F-6 Recorded Macassan sites (© Copyright, Cobourg Peninsula Sanctuary Board 1987)

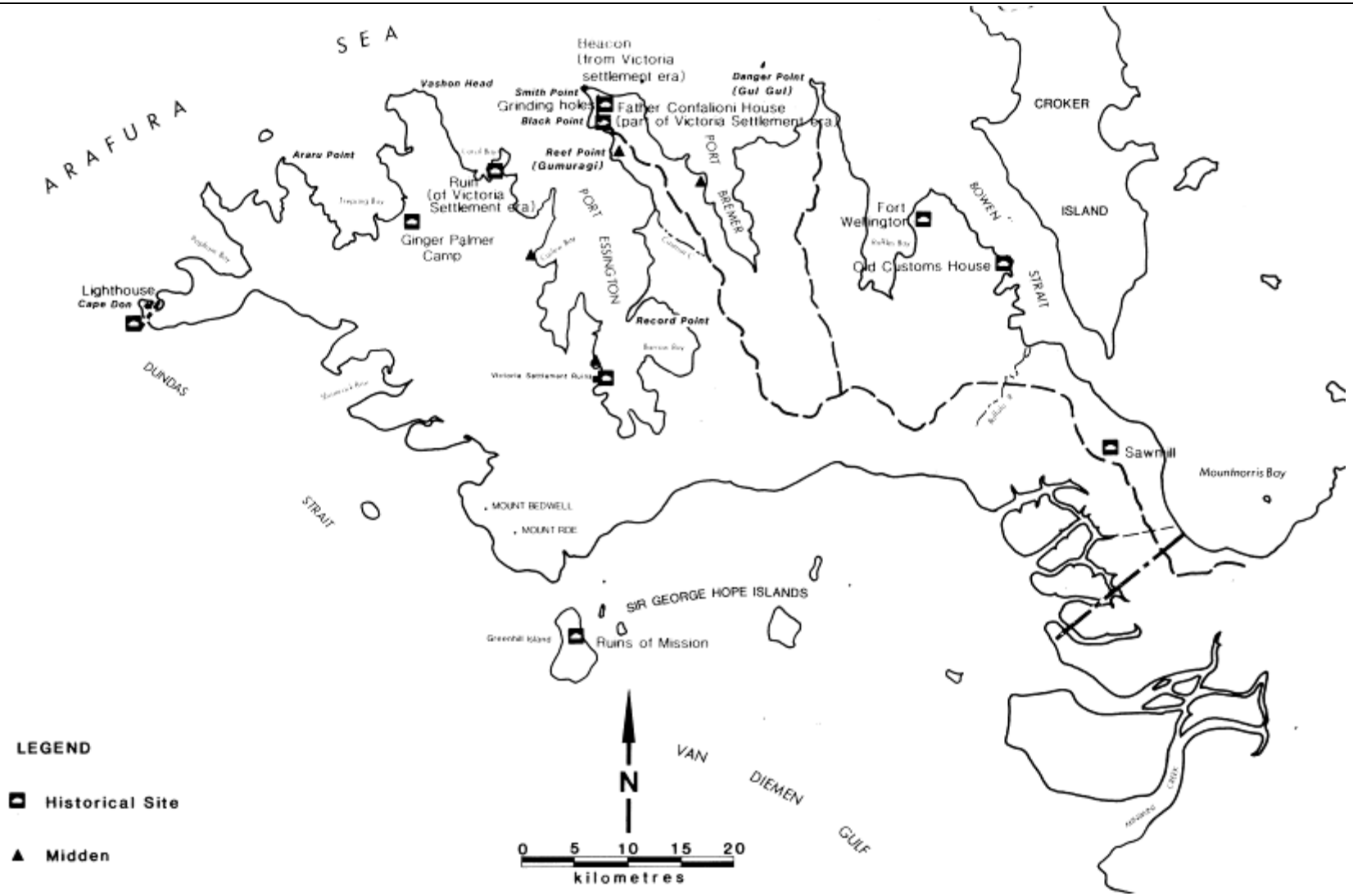


Figure F-7 Historic sites of Cobourg Peninsula (© Copyright, Cobourg Peninsula Sanctuary Board 1987)

References:

Cobourg Peninsula Sanctuary Board (CPSB) (1987) *Gurig National Park Plan of Management*. Department of Natural Resources, Environment and the Arts

Harrison R. (2005) Contact archaeology and native title. *Australian Aboriginal Studies* **2005/1**: 16-29

Mitchell, S. (1995) Foreign contact and indigenous exchange networks on the Cobourg Peninsula, north western Arnhem Land. *Australian Aboriginal Studies* **1995/2**:44-48

Tacon P. and S. Davies (2004) Transitional traditions: 'Port Essington' bark-paintings and the European discovery of Aboriginal aesthetics. *Australian Aboriginal Studies* **2004/2**:72-86