ECOLOGICAL CHARACTER DESCRIPTION FOR THE LOGAN LAGOON RAMSAR SITE

Department of Sustainability, Environment,
Water, Population and Communities

August 2012

Elgin Associates Pty Ltd

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.

Disclaimer

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 Sustainability, Environment, Water, Population and Communities 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.

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Cover image: Barry Baker – Aerial view of Logan Lagoon looking north-west (17th July 2009).

Abbreviations and Acronyms

AAB	Atlas of Australian Birds
CAMBA	China-Australia Migratory Bird Agreement
CEPA	Program of Communication, Education and Public Awareness
CMS	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
DEH	Department of Environment and Heritage (Commonwealth)
DEWHA	Department of the Environment, Water, Heritage and the Arts (Commonwealth)-formerly DEH
DPIPWE	Department of Primary Industries, Parks, Water and Environment (State)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth) – formerly DEWHA
ECD	Ecological Character Description
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
IUCN	International Union for the Conservation of Nature and Natural Resources
JAMBA	Japan-Australia Migratory Bird Agreement
NC Act	*Nature Conservation Act 2002* (Tasmania)
NES	National Environmental Significance
NVA	Natural Values Atlas
PWS	Parks and Wildlife Service
RIS	Ramsar Information Sheet
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
TSP Act	*Threatened Species Protection Act 1995* (Tasmania)
TPC	Tasmanian Planning Commission

1. EXECUTIVE SUMMARY

The Convention on Wetlands (Ramsar, Iran, 1971) commonly called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia was one of the first 18 countries to become a signatory to the Convention in 1975. The Ramsar Convention Bureau maintains a List of Wetlands of International Importance that includes all the Australian sites, ten of which are in Tasmania. The Ramsar criteria for listing wetlands of international importance include sites containing representative, rare or unique wetland types within their bioregion; and sites of international importance for conserving biological diversity.

In November 1982, the Logan Lagoon wetland system was designated a 'Wetland of International Importance' under the Ramsar Convention. As a contracting party, Australia has a number of obligations with regards to the management of listed wetlands; in particular, to manage listed wetlands in a manner that maintains their "ecological character". One of the management tools used in the protection of Ramsar sites is an Ecological Character Description (ECD). ECDs are required for all existing Ramsar sites and for all proposed Ramsar nominations before the required documentation is forwarded to the Ramsar Secretariat. This is the first time an ECD has been prepared for Logan Lagoon since its listing in 1982.

The aims of an ECD were originally detailed by McGrath (2006) and now form the basis for 'The Statement of Purpose' which originates from the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands: Module 2 of the National Guidelines for Ramsar Wetlands — Implementing the Ramsar Convention in Australia* (DEWHA 2008a).

An ECD should contain all relevant information that helps establish the range of natural variation in components, processes and services at a site within a given time frame. The condition of a Ramsar site can then be assessed against a baseline, together with any information which has been received subsequently, enabling managers to report whether there have been significant changes to the ecological character.

The preparation process should engage relevant stakeholders so that the goals and management objectives of the ECD are consistent among all users. This may include (but is not limited to): local community members and groups, Indigenous groups, local Councils, State and Commonwealth departments, research and educational facilities, and other identified interest groups.

The specific objectives of the ECD for the Logan Lagoon Ramsar site (Logan Lagoon) are to produce a comprehensive description of the ecological character that aims to:

1. Describe the critical components, processes and benefits/services of Logan Lagoon at the time of listing (1982) and the relationships among them;

2. Describe the current condition (2010) of critical components, processes and benefits/services of the wetland found at Logan Lagoon and the relationships among them;

3. Develop a conceptual model for Logan Lagoon that displays the ecological character of the site in terms of components, processes and benefits/services and the relationships among them;

4. Quantify the limits of acceptable change for the critical components, processes and benefits/services of the site;

5. Identify actual or likely threats/risks to the ecological components, processes or services of the site; and

6. Identify knowledge gaps, monitoring needs, and communication, education and public awareness (CEPA) messages.

Information on the ecological character of Logan Lagoon is scarce, with very little research or monitoring conducted at the site. Despite the paucity of quantitative information, there is a range of databases and documents that contain qualitative data. The Logan Lagoon Management Plan (Parks and Wildlife Service 2007) details much of the available information at the time of its preparation (2000 – 2004) and this was supplemented with more recent information. A meeting of the Steering Committee was held on Flinders Island in July 2009, which allowed participants to become familiar with the Flinders Island region, the Logan Lagoon Ramsar site, local issues, and discuss the requirements of the project in general. A flight over the site was conducted which provided a valuable perspective of the location and physical geography, and all of the aerial photographs in this ECD were taken on the flight.

General Site Description

Logan Lagoon is part of an extensive eastern Flinders Island parallel dune–coastal barrier system. The 2257 hectare Ramsar site is located in the south-east corner of Flinders Island in Bass Strait, Tasmania, approximately six kilometres north-east of the township of Lady Barron. The site is bounded by the sea to the east and south, by vacant Crown Land to the north, and private property along approximately two-thirds of the western boundary. It is enclosed within the Logan Lagoon Conservation Area which is managed by the Tasmanian Parks and Wildlife Service (Figure 31). It contains two sites listed on the Tasmanian Geoconservation Database; Logan Lagoon Holocene Shorelines and Planter Beach Coastal Barrier System, which are of conservation significance for Tasmania.

The Logan Lagoon estuary is the main hydrological feature at the site, comprising approximately 40 percent of the reserved area. The major inputs to the lagoon are surface water inflows from Pot Boil Creek and its tributaries, direct rainfall over the lagoon, groundwater discharge from the uppermost aquifer beneath the lagoon, and inflows of seawater via the lagoon entrance. The lagoon has a neutral pH, salinities similar to seawater, is relatively clear and has moderate levels of nutrients, particularly phosphate. The elevated levels of nutrients are most likely the result of runoff from nearby farmland in the catchment.

The present entrance to the sea is only open on an infrequent basis and generally a sand bar extends from the lagoon to the beach. During periods when the bar is open, there can be an outflow of lagoon water or an inflow of seawater into the lagoon, with the extent of seawater exchange being dependent on factors such as lagoon water levels, tides, extent of bar erosion and storm activity. It has been claimed that there have been periods when the entrance is closed and a very high water level has resulted in waterlogging of adjacent farmland. At such times, artificial opening of the lagoon mouth by excavating a channel to the

ocean has occurred during the past 50 years; however, this disrupts the natural hydrology and is a threat to the ecological character of the site.

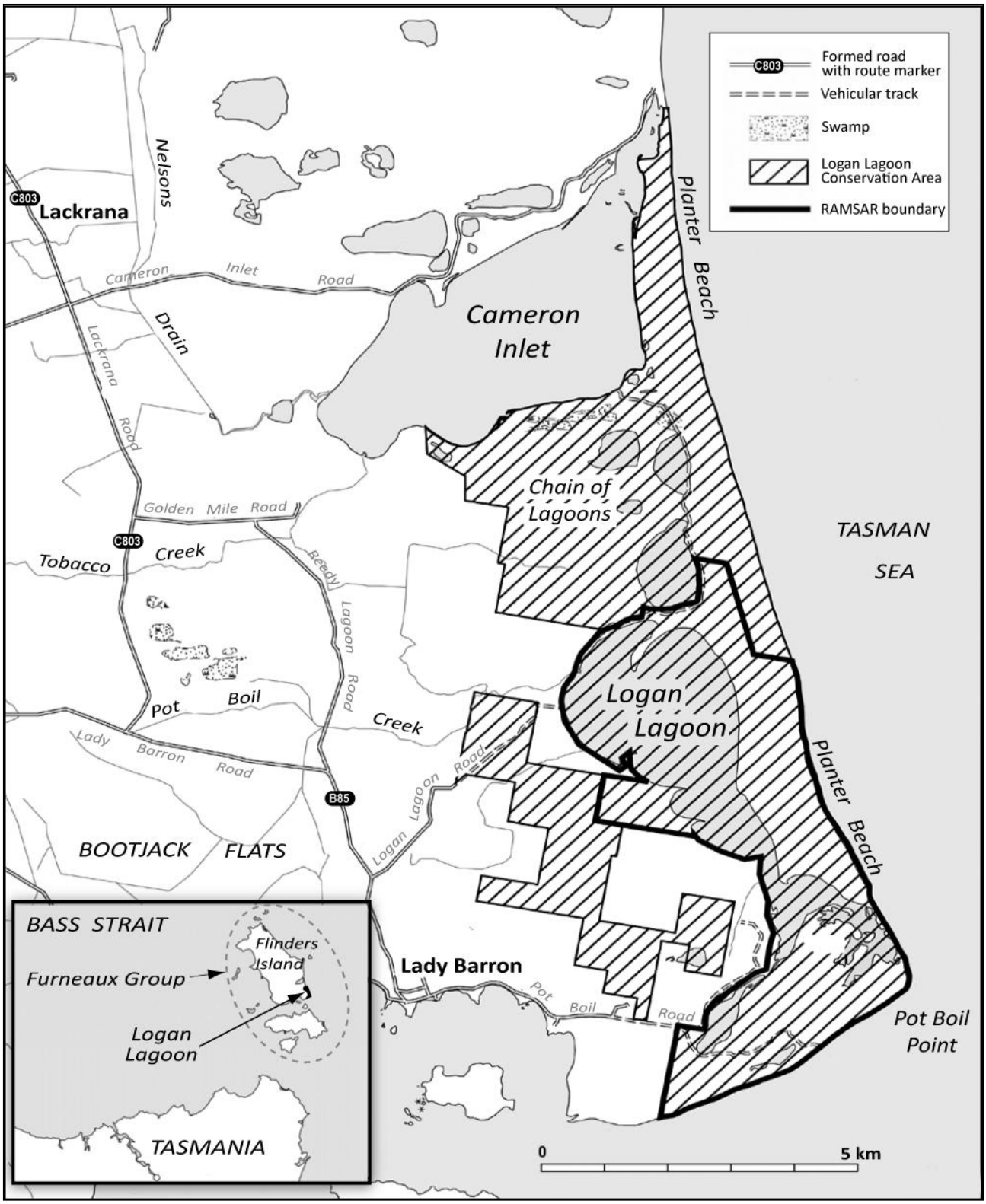

Figure 1. Location of Logan Lagoon Ramsar site in relation to Flinders Island, the Furneaux Group, Bass Strait and Tasmania (modified from Parks and Wildlife Service 2007 by Elgin Associates in 2010).

Winds prevail from the west in winter and the east in summer, driving evaporative processes that are facilitated by shallow water mass and elevated water temperatures. Consequently, the water level fluctuates in response to seasonal climatic conditions, with the site often remaining dry for long periods.

Major outflows include evaporation, seepage to groundwater during periods of lowered water table, and discharge to the sea via the lagoon entrance (when open).

The low-lying wetland-dependent vegetation around the lagoon is characteristic of a coastal wetland, comprising submerged macrophytes, saltmarsh, herblands and grasslands, some of which are of conservation significance in the Tasmanian Bioregion. The habitat changes to sedgeland, heathland and swampy forests away from the shores of the lagoon. There are remnant stands of shrub-dominated woodlands and forest to the east that have been protected from fire by the lagoon. The remaining areas of the site are dominated by a complex mosaic of coastal scrub, heath and non-eucalypt forests. Many of the vegetation species and their associated communities are of conservation value for the Tasmanian Bioregion and support a range of threatened fauna species which visit or reside at the site.

Logan Lagoon is an important site for resident and migratory birds. Over 160 bird species have been recorded on Flinders Island, many of which occur in the site. A number of threatened species, and 21 migratory waders, have been recorded at the site. Other non-avian fauna also use the site for foraging, breeding or as habitat refuge; many have conservation value, such as the endangered freshwater fish, the dwarf galaxias.

Criteria for Ramsar Listing

The Ramsar criteria for identifying wetlands of international importance have been reviewed in the period since the site was first designated. Under the current criteria, Logan Lagoon meets a fourth and fifth criterion in addition to the original three criteria for which the site was listed.

Justification for criteria are listed below:

Criterion 1 – (*Contains representative/rare/unique wetland type in appropriate biogeographic region*).

The site is an excellent, regionally representative example of a coastal estuarine wetland system, and comprises a diverse range of seasonal and permanent marshlands, grass and heathlands, forests and woodlands, many of which support threatened species or communities within the Tasmanian Bioregion and the Bass Strait IMCRA Province. In particular, the site contains excellent, near pristine, representative examples of the following Ramsar wetland types:

- Type E — Sand, shingle or pebble shores;
- Type J — Coastal brackish/saline lagoons;
- Type H – Intertidal marshes;
- Type N — Seasonal/intermittent/irregular rivers/streams/creeks;
- Type Ss – Seasonal/intermittent saline/brackish/alkaline marshes/pools;
- Type Tp – Permanent freshwater marshes/pools;
- Type Ts – Seasonal/intermittent freshwater marshes/pools on inorganic soils; and
- Type W – Shrub-dominated wetlands.

Logan Lagoon, with other lagoons and dunes in the area, provides a representative and outstanding example of the development of Holocene shorelines for Tasmania. Similarly, the Planter Beach Coastal Barrier System is partly within the site. It is a representative and outstanding example of how offshore bars formed with Holocene sea level rise, and how barrier growth has enclosed the coast, forming large lagoons. These two sites are listed on the Tasmanian Geoconservation Database for their conservation significance.

Logan Lagoon is a Tasmanian estuary of critical conservation significance (Edgar *et al.* 1999) and has been assessed as a wetland in near-pristine condition for the Tasmanian Bioregion (Dunn 2002). This criterion was met at designation in 1982 and continues to be met at present.

Criterion 2 – (*supports vulnerable, endangered, or critically endangered species or threatened ecological communities*)

This criterion focuses on species and communities that are threatened at a Commonwealth level, primarily through the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), but also at the international level, such as the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List.

The site supports three nationally threatened wetland-dependent fauna species. The dwarf galaxias (*Galaxiella pusilla*) and fairy tern (*Sternula nereis nereis*) are listed as Vulnerable under the EPBC Act and IUCN Red List respectively, whilst the Australasian bittern (*Botaurus poiciloptilus)* is listed as Endangered under the EPBC Act and IUCN Red List.

The site supports two nationally threatened wetland-dependent terrestrial flora species, the Swamp fireweed (*Senecio psilocarpus*), which is listed as Vulnerable under the EPBC Act, and the Northern leek-orchid (*Prasophyllum secutum*) which is listed as endangered under the EPBC Act and TSP Act.

This criterion was likely to be met at designation and continues to be met at present.

Criterion 3 – (*Supports populations of plant and animal species important for maintaining the biological diversity of a biogeographic region*)

One regionally threatened 'wetland-dependent' terrestrial species is recorded within the Logan Lagoon Ramsar site boundary:

- Large-fruit seatassel (*Ruppia megacarpa*): listed as rare under the TSP Act.

Three wetland dependent vegetation communities recognised as threatened under Tasmanian legislation have been recorded within the site:

- Saline aquatic herbland – listed as Vulnerable (NC Act) and poorly reserved in Tasmania;
- Freshwater aquatic herbland – listed as Vulnerable (NC Act) in Tasmania;
- Lucustrine herbland – listed as Vulnerable (NC Act) and poorly reserved in Tasmania.

This criterion was likely to be met at designation and continues to be met at present.

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*)

Logan Lagoon provides important resting and feeding areas for waterbirds and migratory shorebirds. In 2002-2003, with severe drought conditions in mainland Australia, a flock of approximately 3000 banded stilts (*Cladorynchus leucocephalus*) arrived at Logan Lagoon and remained in the area for about 8 months. This is the largest number of stilts ever recorded in Tasmania (Olsen and Weston 2004; Woehler and Park 1997).

The 1998-1999 Shorebird Survey (Bryant 2002) for Tasmania found that Logan Lagoon and Cameron Inlet have high migratory and shorebird diversity and are priority sites for resident species. The area provides

breeding habitat for the little tern (*Sterna albifrons*), a beach nesting shorebird listed as endangered under the Tasmanian *Threatened Species Protection Act 1995.* The survey also recorded large numbers of two migratory species; curlew sandpiper (*Calidris ferruginea*), 1000 birds and red-necked stint (*Calidris ruficollis*), 4000 birds. Logan Lagoon is listed as an important site for these two species under the East Asian - Australasian Shorebird Site Network (Bamford *et al*. 2008). For these reasons, the lagoon is not only important on a local scale, but also nationally and internationally.

A total of 21 migratory wader species have been recorded at the site and all of these, with the exception of the double-banded plover (*Charadrius bicinctus*), breed in the Arctic region during the northern hemisphere summer. Double-banded plovers breed in New Zealand and some of the population over-winters in Australia.

Many of the migratory bird species that use the site during migration are listed on international agreements such as CMS, CAMBA, JAMBA, or ROKAMBA. These species are:

- cattle egret (*Ardea ibis*), CAMBA
- ruddy turnstone (*Arenaria interpres*), CMS , JAMBA, CAMBA, ROKAMBA
- sharp-tailed sandpiper (*Calidris acuminata*), CMS, JAMBA, CAMBA, ROKAMBA
- sanderling (*Calidris alba*), CMS, JAMBA, CAMBA
- lesser sand plover (*Charadrius mongolus*), CMS, JAMBA, CAMBA, ROKAMBA
- Latham's snipe (*Gallinago hardwickii*), CMS, JAMBA, CAMBA, ROKAMBA
- Caspian tern (*Hydroprogne caspia*), JAMBA, CAMBA
- bar-tailed godwit (*Limosa lapponica*), CMS, JAMBA, CAMBA, ROKAMBA
- satin flycatcher (*Myiagra cyanoleuca*), CMS
- eastern curlew (*Numenius madagascariensis*), CMS, JAMBA, CAMBA, ROKAMBA
- whimbrel (*Numenius phaeopus*), CMS, JAMBA, CAMBA, ROKAMBA
- Pacific golden plover (*Pluvialis fulva*), CMS, JAMBA, CAMBA, ROKAMBA
- little tern (*Sterna albifrons sinensis*), CMS, JAMBA, CAMBA, ROKAMBA
- common greenshank (*Tringia nebularia*), CMS, JAMBA, CAMBA, ROKAMBA

(JAMBA: listed under the Japan – Australia Migratory Birds Agreement; CAMBA: listed under the China – Australia Migratory Birds Agreement; ROKAMBA: listed under the Republic of Korea – Australia Migratory Birds Agreement; CMS: listed under the Convention on Migratory Species)

This criterion was met at designation and continues to be met at present.

Criterion 5 – (*A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds*)

There are no data to demonstrate the site regularly supporting 20,000 waterbirds. Anecdotal information suggests that it doesn't. The site is unlikely to have met this criterion at the time of listing and is also unlikely to meet it now.

Criterion 6 – (*A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of waterbird*)

Using population estimates obtained from the 4th edition of Waterbird Population Estimates (Wetlands International 2006), the site regularly supports 1% of the global or regional population of: hooded plover, fairy Tern, musk duck, and chestnut teal. This is based on survey data obtained from annual waterfowl counts and shorebird surveys carried out in 1998/1999 (Bryant 2002) and 2008 (Woehler 2008). Given the

ephemeral nature of the lagoon, it is difficult to determine whether the site meets the Ramsar criteria for 'regular' use. However, existing information does indicate that the site periodically supports 1% of the population of these species. It is likely that this criterion was met at designation and continues to be met at present.

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*).

There is insufficient data to demonstrate the site regularly supporting a significant proportion of indigenous fish. However, historical observations suggests that the dwarf galaxias *(Galaxiella pusilla)*, which is of conservation significance regionally and nationally (see Criterion 2), has been observed at the site. All known populations in Tasmania are important, as the species has declined throughout its geographic range, has a patchy distribution and existing populations are fragmented (TSS 2006b). Logan Lagoon, if found to have a significant population of dwarf galaxias, will represent one of the few reserved locations in the Tasmania Bioregion. Additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would suggest that it was met at the time of listing.

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*).

There are no data to demonstrate the site provides an important source of food for fish, a spawning ground, or is utilised by migratory fish. However, when the lagoon mouth is open to the ocean, marine species may visit the lagoon for feeding, spawning, or as a nursery. Additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would suggest that it was met at the time of listing.

Criterion 9 – (*A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species*).

There are no data to demonstrate the site supports 1 percent of a population of any wetland-dependent non-avian animal species. Only the dwarf galaxias (*Galaxiella pusilla*) meets the description of a wetland-dependent non-avian animal species that is considered internationally important. Historical information suggests that this species is present at the site; however, additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would also suggest that it was also met at the time of listing.

Ecological Character

The key ecological characteristics and processes that are central to maintaining the ecological character of Logan Lagoon are poorly understood. This ECD is the first description of the components, processes, benefits and services of the site and how they are linked. The components and processes for the wetland determine the habitats, ecological communities and species that are found at the site and the criteria for which it is listed. A summary of the ecosystem components and processes is provided in Table 1. The relationships among the ecosystem components and services are simplified as a conceptual model (Figure 2).

Table 1. Summary of ecosystem components (C) and processes (P) for the Logan Lagoon Ramsar site.

Component	Description
Climate (C/P)	There are four climate processes (P) that broadly affect the wetland ecology of Logan Lagoon: rainfall (P); temperature (P); wind (P), and; evaporation (P). Climate (C) fundamentally affects the hydrology and geomorphology at the site – e.g. modification of the landscape by wind (P).
Geomorphology (C)	Logan Lagoon is part of an extensive eastern Flinders Island parallel dune – coastal barrier system. Site of geoconservation significance - site contains a number of old, slightly higher than present, strand lines suggesting recent uplift (or higher mid-Holocene sea levels). Lagoon isolated from the sea by a large sand bar which is rarely breached under natural conditions, but has a history of forced opening by locals.
Wetland Soils (C)	Site is predominantly sands, occurring in dunes or sandy plains. Inorganic soils are a feature of a range of wetland types at the site, each of which supports vegetation communities that are of conservation significance in the Tasmanian Bioregion. Site contains Hydrosols - seasonally or permanently wet soils and subaqueous materials.
Hydrology (C)	Highly seasonal freshwater inflows from direct precipitation (P) and drainage channels via Pot Boil Creek. Limited tidal exchange (P) with ocean waters – the sand bar at the lagoon entrance is rarely breached under natural conditions. Groundwater discharge (P) from the uppermost aquifer beneath the lagoon.
Water Quality (P)	Elevated levels (P) of nutrients, including fertilisers, from the surrounding catchment. Surface water quality is influenced by seasonal factors, including rainfall recharge (P), inflows from Pot Boil Creek, evaporation (P), and interaction (P) with groundwater and adjacent marine waters. Periodic opening of the lagoon, under natural circumstances, to ocean waters would quickly modify (P) the water quality. The water quality of the lagoon may change rapidly depending on the influence of climatic conditions (C) or physical modifications at the site (e.g. from fresh to saline conditions following breaching of the sand bar at the lagoon entrance).

Component	Description
Vegetation (C)	A mosaic of vegetation communities including Lowland sedgy heathland, Saline aquatic herbland, Saline sedgeland and rushland, Fresh water aquatic herbland, Lowland *Poa labillardierei* grassland, and *Melaleuca squarrosa* scrub. Wetland-dependent vegetation which is of conservation significance and poorly reserved in Tasmania. Remnant patches of pre-European forest vegetation, including some threatened flora communities. Unknown assemblages of aquatic plant species.
Fauna (C)	High diversity and abundance of birds, including 127 recorded species. A total of 21 migratory wader species has been recorded at the site. Endangered freshwater species, the dwarf galaxias, has been recorded at the site. During prolonged opening of the Logan Lagoon entrance to the ocean, other marine species may use the lagoon for foraging, breeding, or as a habitat refuge. Six frog species occur on Flinders Island and all are likely to inhabit Logan Lagoon, including the threatened green and gold frog *Litoria raniformis*. Unknown assemblages of benthic fauna in the estuarine and the intertidal zones. Similar estuarine lagoons have a range of endemic microfauna and flora.

Defining the critical components and processes is important for understanding the characteristics of the site that contribute to the site's listing under various Ramsar criteria. The critical components and processes for the Logan Lagoon Ramsar site are:

- climate
- geomorphology
- hydrological regime
- water quality
- vegetation
- bird species.

Each of these components and processes meet the DEWHA (2008a) indicative criteria for identifying critical components, processes and services, as they: are important in determining the site's unique character; are important in supporting criteria under which the site was listed; are reasonably likely to change in the next 100 years; and changes to them could cause significant negative consequences. A description of why these components and processes were selected is detailed below and a conceptual model that illustrates the relationships between them is illustrated in Figure 2.

Ecosystem Benefits and Services

The Ramsar definition of ecosystem services is "the benefit that people receive from ecosystems". In many cases the benefits people receive from ecosystems (economic, social, and cultural) rely on the underlying ecological components and processes of the wetland. The benefits and services most relevant for Logan Lagoon are grouped into supporting services, regulating services and cultural services. There were no provisioning services identified.

Supporting Services: Logan Lagoon maintains regional biodiversity by: supporting a number of representative, rare or unique wetland types; supporting regionally, nationally and internationally threatened species and communities; providing habitat for plant and animal species that contribute to the biodiversity of the Tasmanian bioregion; supporting critical life stages or provides refuge; and supporting migratory and resident waterbirds.

Alluvial processes occurring within Logan Lagoon contribute to the formation of geological features such as shorelines and sand dunes via the deposition of sediments. Accumulation of organic matter provides nutrients for flora communities which help to stabilise the dune systems. The lagoon facilitates storage, recycling, processing and acquisition of nutrients for use by other organisms inhabiting or using the site.

Regulating services: Logan Lagoon maintains and regulates the hydrological cycles and regimes including: groundwater recharge from surrounding impermeable granite catchments; flood control and erosion protection; retention, recovery and removal of excess nutrients and pollutants; and the maintenance of natural ecosystems in the lagoon.

Scientific and educational: The site has education value in serving as a demonstration of a near-pristine wetland, particularly the coastal dune systems that are of geoconservation significance on a regional scale. The monitoring of bird numbers at the site provides important information on the long term status of some threatened birds.

The benefits and services listed above contribute to the maintenance of the site's ecological character. However, not all are critical for supporting the components and processes that contribute to the ecological character. The critical benefits and services for maintaining the components and processes are:

- supports representative, rare or unique wetland types;
- supports threatened species and communities;
- provides habitat for flora and fauna that contribute to the biodiversity of the Tasmanian bioregion;
- supports critical life stages or provides refuge; and
- supports migratory and resident waterbirds.

These critical services have been selected based on the criteria that define a wetland of international importance (Section 3.4.2) and the components and processes (Section 4.1) that support them. Each of the services meet the DEWHA (2008a) indicative criteria for identifying critical components, processes and services, as they: are important in determining the site's unique character; are important in supporting criteria under which the site was listed; are reasonably likely to change in the next 100 years; and changes to them could cause significant negative consequences.

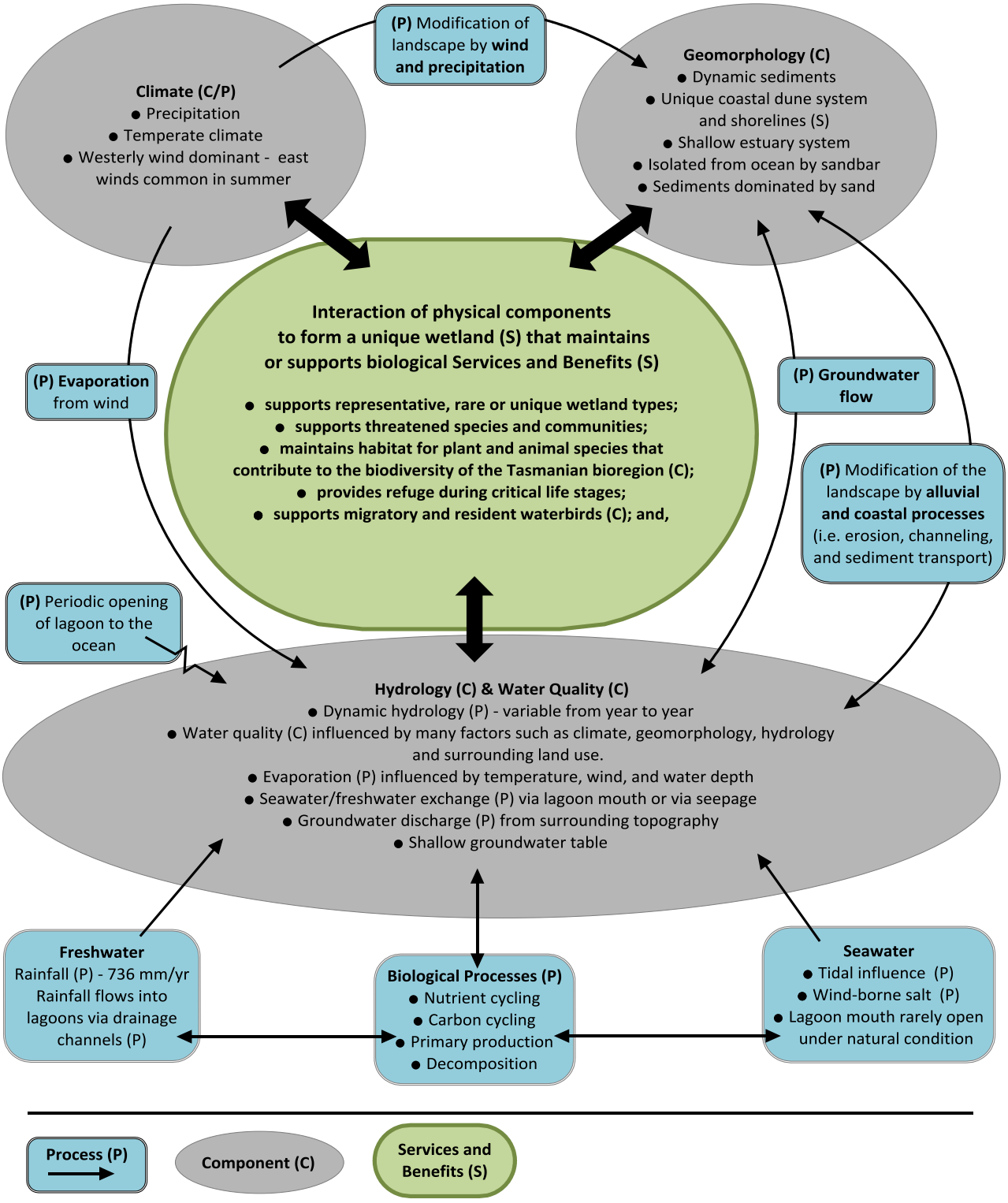

Figure 2. A conceptual model of the Logan Lagoon Ramsar site illustrating the relationships among the various components, processes, and services. Note that some features may be considered as components or processes as well as ecosystem services or benefits (Created by Elgin Associates May 2011).

Conceptually, it is the components and processes and the interactions between them that characterise each of the critical ecological services. Each of the critical benefits and services relate directly to a critical component or process. Consequently, identifying changes in the components and processes will be adequate for identifying changes in the critical services. A description of why these services are critical, the

criteria for which they are selected, and the components and processes to which they relate is detailed in Table 13. A more comprehensive description of each benefit / service is described in Sections 5.2.1 to 5.2.5.

Limits of acceptable change

The 'Limits of Acceptable Change' (LAC) are the range of variation of the components, processes and benefits or services that can occur without causing a change in the ecological character of the site. These limits make it easier to determine when the ecological character is likely to change, or when it has changed as a result of technological development, pollution or other human interference. Establishing these limits for Logan Lagoon is difficult because there is an overall paucity of scientific data and information, including any long-term monitoring datasets (except for birds). Where adequate baseline and supporting evidence permit, a LAC has been defined for the critical components, processes and services. Given the lack of available data, these measures will benefit from future revisions as more data becomes available. Some of this data may be gathered in relatively short time frames (2 years), whilst other data will require regular and long-term monitoring (>10 years).

Table 2. Limits of acceptable change for critical components and processes of the Logan Lagoon Ramsar site.

Component / Process / Service	**Baseline / supporting evidence**	**Limit of acceptable change**
Climate: Understanding the interactions between the physical conditions at the site and its subsequent use by flora and fauna is important. For example, waterbirds may use the site for breeding only in years when water levels are moderate and there is adequate area for nesting on the shores.		
Climate	The particular attributes of climate that are important in maintaining the ecological character of the site are rainfall, temperature, wind and evaporation. Climate predictions for north-eastern Tasmania suggest a generally warmer climate which is wetter in all seasons. Mean daily temperatures are projected to be warmer (both minimum and maximum temperatures) with increased solar radiation, relative humidity in summer, and increased evaporation (ACE CRC 2010).	The links between climatic conditions, the hydrological responses to such conditions, and their impact on the biological components are poorly understood and should be further investigated. No LAC can be determined due to a lack of understanding of the impact of climatic processes on other critical components, processes and services, such as, hydrology, geomorphology, flora and fauna.

Geomorphology: Protecting the geological features, including the integrity and structure of the dunes, is important for the purposes of geoconservation and maintaining the ecological character which contributes to the site's listing under Criterion 1.		
Holocene Shorelines and dune systems	There are approximately 54 hectares of shorelines, spits and dune systems that are important for maintaining the geoconservation value of the site under Criterion 1. The area of shorelines, spits and dunes defined in the TASVEG mapping layers require ground-truthing.	Currently there are 54 hectares of high quality shorelines, dune systems and spits mapped within the site. In the absence of studies detailing impacts from human disturbance, a common-sense approach has been adopted, setting a limit of acceptable change at not more than 3 hectares (2 percent) of the area of the Holocene shoreline and dune systems showing evidence of human disturbance through vehicle use or foot traffic. Because the wetland map was made without proper ground-truthing, verification of areas will be required.
Hydrology: The hydrological regime is a major driver in the vegetation communities at the site, particularly for wetland-dependent communities. The availability of water plays a key role in the attractiveness of the site for resting and breeding of resident and migratory fauna, especially birds.		
Surface water flow	Flow regimes are poorly understood: Historically, the lagoon mouth has been artificially breached by local landowners. Alterations to the natural hydrological regime impacts on other components such as geomorphology, water quality, vegetation and fauna. Surrounding farmland drains into the lagoon via a series of channels. High water levels in the lagoon have previously been blamed for inundated pasture on surrounding farms. The link between climate and hydrology is poorly understood. For example, the amount of rainfall required to maintain the natural hydrology.	No unnatural opening of the lagoon mouth. Site observations indicate that fluvial inflows are a significant input of surface water to the lagoon. Whilst this inflow is beneficial in maintaining water in the lagoon, poor water quality in inflow waters could offset this benefit. Site specific hydrology data and further water quality data is therefore required before LAC can be set that takes into account these factors.
Tidal exchange	Historical information on lagoon mouth opening is anecdotal. Future monitoring should include the status of the lagoon entrance (open/closed) because parameters such as salinity may be highly variable when the lagoon is open to the ocean.	No unnatural opening of the lagoon mouth. The lagoon is rarely open to the ocean. However, when the hydrological regime shifts to a marine system, advice on appropriate parameters should be sought.

Water Quality: provides suitable water quality to support the persistence of wetland dependent flora and fauna. The ecological character of the site currently depends on the quality of water entering and being retained within the lagoon. Baselines need to be set before LAC can be set.		
Water quality	Only two water samples recorded from the site. pH: Limited data indicates pH of 7.2-7.7 in Logan Lagoon waters. Potential for acid sulphate soils to impact on pH of lagoon waters. Salinity: Limited data indicates salinity (as Total Dissolved Solids) ranging between 2,600-35,700 mg/L: Salinity highly variable depending on seasonal climatic and hydrological processes. Dissolved Oxygen: No data available. Turbidity: Limited data indicates range between 0.5 and 4.9 NTU: Turbidity varies with freshwater inflows, wind and tidal influences. Nutrients: Limited site data indicates Total P (0.09 – 0.2 mg/L and Total N (1.4-1.5 mg/L).	Cannot determine LAC due to insufficient data.
Vegetation: the hydrology, climate, water quality and soil quality of Logan Lagoon influence the vegetation that is supported at the site. The threatened wetland-dependent vegetation communities contribute to the regional biodiversity and selection of Criterion 1 and 3.		
Threatened plant species	There are currently three threatened wetland-dependent plant species mapped at the site.	In the absence of accurate mapping, a common sense approach has been adopted, setting a limit of acceptable change as the persistence of the following threatened species within the Logan Lagoon boundary: • Swamp fireweed (*Senecio psilocarpus*) • Large-fruit seatassel (*Ruppia megacarpa*) • Northern leek orchid (*Prasophyllum secutum*) These three species are cryptic and therefore seasonally specific surveying will be required to identify them. Species should be observed during two out of every three surveys.

Threatened plant communities	Poor quality information on the current distribution and abundance of threatened plant communities because maps based on TASVEG Mapping Layers have not been ground-truthed. The areas of threatened wetland-dependent vegetation communities are: • Saline aquatic herbland = 9.23 hectares • Freshwater aquatic herbland = 1.28 hectares • Lacustrine herbland = 3.71 hectares.	There are 14.22 hectares of threatened wetland-dependent vegetation communities at the site. Common sense would suggest no loss greater than 10 percent for each wetland type based on TASVEG mapping layers. Because the wetland map was made without proper ground-truthing, verification of areas will be required. Based on current estimates made for this ECD, the maximum areas of threatened wetland vegetation that could be lost before causing unacceptable change to the site are: • Saline aquatic herbland: 0.9 hectares • Freshwater aquatic herbland: 0.5 hectares • Lacustrine herbland: 4 hectares.
Fauna: Logan Lagoon supports and large number of birds, many with conservation significance locally, nationally, and internationally which justifies the selection of Ramsar criteria 3, 4 and 6.		
Number of waterbird species counted at the site annually	Annual counts of waterfowl carried out at Logan Lagoon during February 1985 - 2009, excluding 1987, 1989, 1994 and 2008. The area counted varied among years and data are not comparable, making it difficult to detect population trends.	No LAC can be determined due to insufficient data. To be defined once population trends for waterfowl are clear from systematic annual counts.
Number of shorebirds recorded in annual surveys	There has been no systematic, long term monitoring of shorebirds within the Ramsar site to enable a numerical baseline to be set, although Birds Tasmania conducted counts along the ocean coastline of the site in 2008 and 2010, and is planning future work.	No LAC can be determined due to insufficient data. To be defined once population trends for shorebirds are clear from systematic annual counts.
Threatened mammals, reptiles, amphibians	Very little systematic data. Poor information on the current distribution and abundance of threatened species.	No LAC can be determined due to insufficient data. To be defined once systematic surveys undertaken for a range of species.

Threats

There are several threats which could adversely impact on the ecological character of the Logan Lagoon Ramsar site, comprising:

- Inappropriate fire regime: frequent and extensive firing has dramatically altered some of the vegetation within the Logan Lagoon Ramsar site. The vegetation on the western windward side of the lagoon is conducive to fire, containing areas of tussock grasslands, sedgeland, heath and scrub;

- Inappropriate use of recreational vehicles at the site: access to the site in off-road vehicles and motorbikes is common. Off-road vehicle use is associated with a range of impacts to some of the Ramsar site's key natural values and may cause erosion, vegetation damage, contribute to the spread of introduced plants, disturb coastal breeding birds and destroy their eggs;
- Alteration to drainage regime, including artificial opening of the lagoon mouth and modifications of the natural flow into the lagoon Human interference in the natural hydrological processes of Logan Lagoon, such as artificially opening the mouth, may be detrimental to many of the species inhabiting the lagoon ecosystem, including, aquatic plant and algal species, fish, amphibians, birds, crustaceans and gastropods;
- Introduction of animal and plant pests: Introduced animal species have established wild (feral) populations on Flinders Island and in the Logan Lagoon Ramsar site. These feral animals pose varying threats to the native fauna and flora. Similarly, a number of introduced plant species as well as the root-rot fungus *Phytophthora cinnamomi* has been introduced to the lagoon site;
- Surrounding land use/agriculture: Most of the water that enters the Logan Lagoon site originates in or flows through land that is subject to agricultural activities, particularly pasture improvement for grazing. Runoff and leaching of fertilisers and other toxicants into the water system may indirectly have a significant impact on the natural properties of the lagoon; and
- Climate change via changed rainfall patterns, changed temperature and wind regimes, more frequent and severe weather events, sea level rise and/or coastal retreat: Changes associated with such a climate may potentially impact the hydrology, geomorphology, vegetation, habitat and species at Logan Lagoon.

Key knowledge gaps

There are a range of critical components, processes and services for which there is insufficient information to define a limit of acceptable change. Change in ecological character can be positive or negative; however, for the purpose of notification under the Ramsar Convention, change is defined as 'human-induced adverse alteration'. Obtaining information on the knowledge gaps detailed in Table 2 will allow the ecological character to be assessed or monitored within rigorous and defensible limits of acceptable change.

Table 3. Key knowledge gaps that require research in order to allow accurate description of the ecological character of the Logan Lagoon Ramsar site.

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP
Climate	
Climatic processes (High)	The relationship between climatic conditions (rainfall, temperature, wind and evaporation) and the hydrological responses to such conditions, and the requirements for maintaining the natural hydrology of the site, are poorly understood.
Geomorphology	
Geomorphic features (Medium)	Geomorphic landforms, materials processes, ages and stability of the site are poorly described (in the literature).

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP
Soils (Medium)	Potential acid sulphate soils: The effect of disturbance on acid sulphate soils has not been investigated at the site.
Hydrology	
Hydrological processes (Medium)	There is no systematic information on the water levels within Pot Boil Creek or the lagoon. No information on the flow of groundwater through the system.
Water Quality	
Water Quality (High)	There is no comprehensive data on water quality, particularly the influence of surrounding land practices, or changes during different hydrological conditions (e.g. opening of the lagoon to the ocean).
Vegetation	
Wetland-dependent vegetation (High)	All vegetation was mapped using 1:42 000 aerial photos taken in 1999. There was no ground-truthing in the area. The distribution of Ramsar wetland types, including threatened wetland-dependent communities, has not been established and there is evidence that the area of some types may be expanded (Section 4.8). There is no recent information on the community composition, distribution and temporal patterns of aquatic communities within the estuary.
Littoral vegetation (High)	There is very little current information on the extent and condition of threatened species or communities. The distribution and impacts of exotic plant species and *Phytophthora* within the site. The impact of fire on the current extent and condition of vegetation types is unknown.
Fauna	
Mammals, Reptiles, and Amphibians (High)	There are limited fauna observations at the site, particularly for threatened species such as New Holland mouse, common wombat (Bass Strait), and Green and Gold frog. The presence of frogs infected with chytrid fungus has not been confirmed but poses a significant threat to frog populations at the site.
Fish (Medium)	There is very little current information on the community composition and abundance of fish communities.
Birds	
Waterfowl (High)	There has been no systematic survey and reporting of abundance and species composition and there are insufficient data to determine spatial and temporal trends or habitat usage.

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP
Shorebirds (High)	Shorebird surveys of Logan Lagoon have been mainly limited to the immediate coastline. Standardised methodologies have been used over time to permit limited and preliminary determination of spatial and temporal trends or habitat usage by some species.

Monitoring needs

The monitoring programs currently in place are restricted to counts of birds. Additional monitoring and interpretation of data is required before changes in ecological character can be assessed against the limits of acceptable change. A management plan (Parks and Wildlife Service 2007) is in place which will act as a guide for decision makers and stakeholders in the region and includes recommendations for monitoring priorities in Logan Lagoon. However, the monitoring prescribed in the management plan would benefit from augmentation with the actions prescribed in this ECD, including recognition of the limits of acceptable change and identified knowledge gaps.

The key monitoring needs for Logan Lagoon are:

- Hydrology – water quality testing and quantifying water flow under different hydrological regimes;
- Littoral and aquatic vegetation – identification of species composition, distribution, and confirmation of threatened vegetation;
- Fauna - ground-truthing the presence/absence and distribution of species of mammals, reptiles, and amphibians, particularly those listed as threatened;
- Fish – species composition and abundance, particularly threatened species such as the dwarf galaxiid; and
- Birds – review the methodology used for annual counts of waterfowl and shorebirds and design statistically rigorous survey designs.

In addition to the required monitoring described above, there are areas where considerable investment and research investigation are desirable for understanding and maintaining the ecological character. These include:

1. Establishing the distribution and abundance of feral animals;
2. Assessing the damage caused by off road vehicles, including the erosion of dune systems, and the disturbance of potential acid sulphate sediments; and
3. Assessing the impact of the surrounding land use on the condition of the wetland.

Communication and Education

There are many opportunities for wetland-related activities involving members of the local Flinders Island community, interested groups and visitors. Logan Lagoon has the potential to be an important educational resource for natural science, especially given its relatively pristine condition, its role as a sanctuary for migratory birds and its geological values. Logan Lagoon has outstanding and representative ecological features on local, bioregional and global scales. However, many of its features are poorly understood and there has been a history of damage from recreational activities at the site.

There is a number of communication and education messages that could be prioritised which may help facilitate this process, including:

- The importance of responsible driving of vehicles – how to minimise disturbance to foreshores and biota;
- Emphasising the effect of disturbance on migratory birds – the importance of energy conservation for migratory birds and steps the community can take to minimise shorebird disturbance by walking, boating, recreational vehicles and domestic pets;
- The importance of privacy for nesting birds - the impact of disturbance on nesting birds (particularly species such as pelicans, hooded plovers, fairy and little terns, that nest on easily accessible beaches) and ways in which the community can undertake recreational activities while minimising disturbance to nests;
- The significance of the values of the Ramsar site - this would include promoting the international significance of the site and threats to the values of the site, particularly in relation to land use management and feral animals;
- The need to obtain essential data to assist in more effective management of the Ramsar site; and
- Educating local community members on how to record and report sightings of flora and fauna at the site. One particularly useful outcome of this process would be increased information on the occurrence and distribution of feral animals, such as pigs and cats. Establishing the usage of the site by these animals may help managers plan for their future eradication.

The 2007 Logan Lagoon Management Plan was developed in consultation with community, landowners, site managers, local council, state government departments and other stakeholders. The Plan provides a range of detailed management prescriptions that address issues such as access to the site, monitoring and research requirements, managing development and community involvement. The finalised plan was released publicly in 2009 and some of the prescriptions were being planned at the time of writing this ECD (e.g. season closure of the tracks by Parks and Wildlife Service rangers to prevent damage to vegetation and substrate).

Many of the suggestions for community education could be implemented within the framework of the Management Plan. In general, the plan proposes actions that are in line with the Ramsar Convention's 'wise use' policy, such as protection of the outstanding natural and cultural values and the provision for an appropriate range of recreational opportunities.

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2. INTRODUCTION

2.1. Context / Site details

The Logan Lagoon Ramsar site (Logan Lagoon) was designated a 'Wetland of International Importance' under the Convention on Wetlands (Ramsar Convention) in November 1982. There are 159 Contracting Parties with a total of 1886 designated sites on the Ramsar List worldwide, 64 of which are in Australia (Ramsar Convention Secretariat 2010). 10 of these are in Tasmania. When countries become signatories to the Convention, they are enlisting in an international effort to ensure the conservation and wise use of wetlands. The Ramsar Convention includes four main commitments that the Contracting Parties have agreed to:

- Listing Sites - designate at least one wetland at the time of accession for inclusion in the List of Wetlands of International Importance;
- Wise Use – through their national land-use planning commit to promote, as far as possible, "the wise use of wetlands in their territory";
- Reserves and Training - establish nature reserves in wetlands, and promote training in the fields of wetland research, management and wardening; and
- Cooperation - consult with other Contracting Parties about implementation of the Convention, especially in regard to transboundary wetlands, shared water systems, and shared species.

Under Article 3.2 of the Convention, parties are expected to report to the Secretariat any changes or threats to the ecological character of their listed wetlands (Ramsar Convention Secretariat 2010).

Understanding and documenting ecological character is central to maintaining and protecting the values of internationally and nationally important wetlands. Australian Ramsar site managers seek to maintain the ecological character of each site, remain informed of any changes to the ecological character of Ramsar sites and notify the Ramsar Secretariat of any changes at the earliest opportunity.

An ECD provides the baseline description of a wetland at a given point in time and can be used to assess changes in the ecological character of these sites. This is the first ECD to be prepared for Logan Lagoon since its listing in 1982.

Logan Lagoon is one of three large estuarine lagoons which make up a coastal lagoon system that extends along the eastern coastline of Flinders Island. The 2257 hectare Ramsar site is located in the south-east corner of Flinders Island in Bass Strait, Tasmania, approximately six kilometres north-east of the township of Lady Barron. The site is bounded by the sea to the east and south, by vacant Crown Land to the north, and private property along approximately two-thirds of the western boundary. It is enclosed within the Logan Lagoon Conservation Area which is managed by the Tasmanian Parks and Wildlife Service (Figure 3).

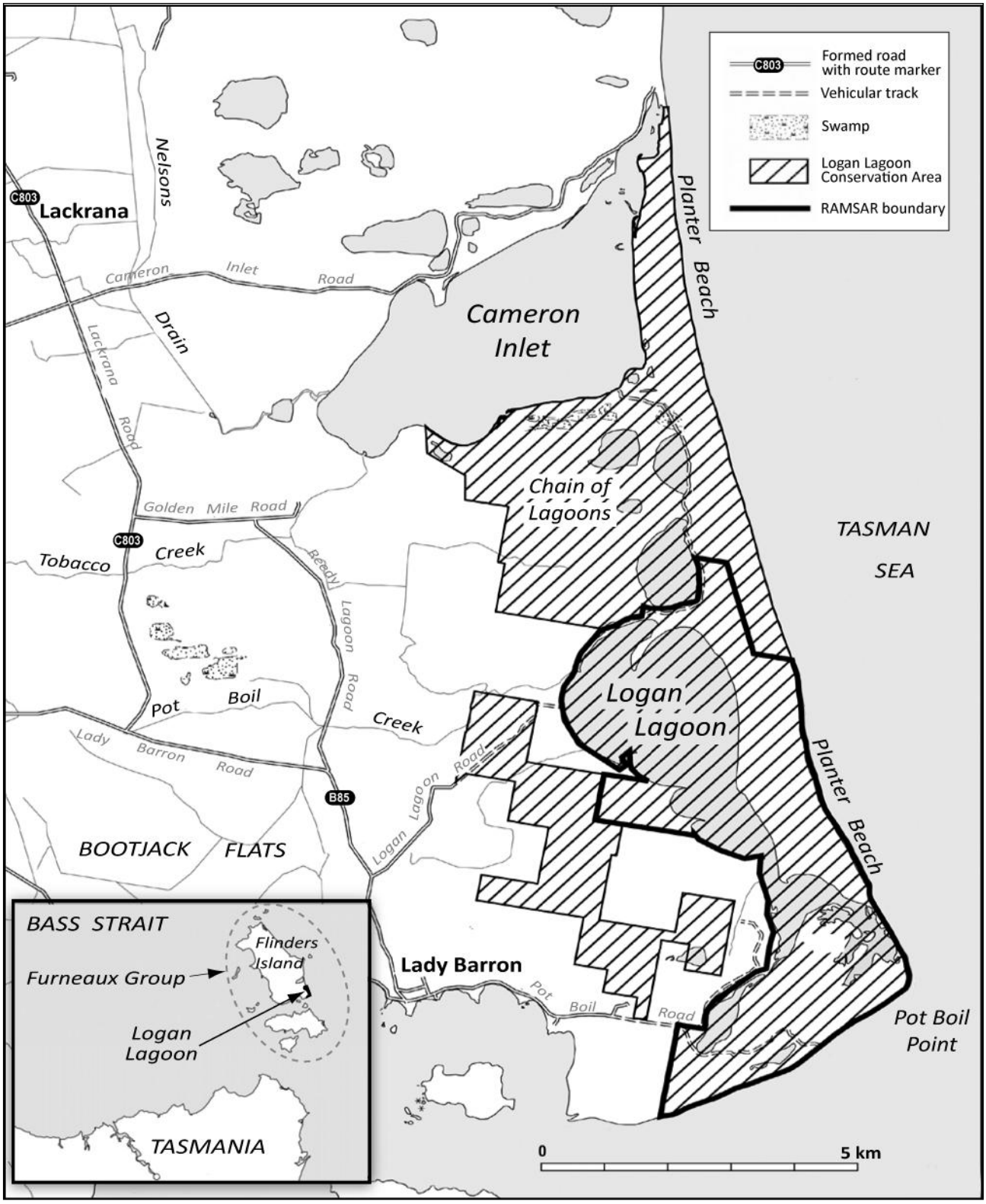


Figure 3. Location of Logan Lagoon Ramsar site in relation to Flinders Island, the Furneaux Group, Bass Strait and Tasmania (modified from Parks and Wildlife Service 2007 by Elgin Associates 2010).

Table 4. Site description of the Logan Lagoon Ramsar site.

Site descriptor	Site details
Name	Logan Lagoon

Site descriptor	Site details
Location in coordinates	Latitude: 40° 11' 00"S; Longitude: 148° 18' 00"E
General location	Logan Lagoon is situated on the south-east corner of Flinders Island, Bass Strait, Tasmania, approximately six kilometres north-east of the township of Lady Barron.
Area	2257 hectares
Date of Ramsar site designation	16 November 1982
Ramsar listing criteria	1, 2, 3, 4 and 6
Management authority	Director, National Parks and Wildlife Service GPO Box 1751, HOBART, 7001 Tasmania
Date the ecological character description applies	16 November 1982
Status of description	This is the first Ecological Character Description for Logan Lagoon.
Date of compilation	May 2011
Name(s) of compiler(s)	Dr Luke Finley, Mr Andrew Roberts and Dr Nicholas Yee of Elgin Associates Pty Ltd, [PO Box 3134, West Hobart, TAS, 7000] and Ms Katrina Jensz and Mr Barry Baker of Latitude 42 Environmental Consultants Pty Ltd [114 Watsons Road, Kettering, TAS, 7155].
References to the Ramsar Information Sheet (RIS)	Ramsar Information Sheet (RIS) prepared by DPIWE June 2005 Ramsar Site Number: 252 Wetlands International Site Reference Number: 5AU004
References to the management plan	Parks and Wildlife Service 2007, Logan Lagoon Ramsar Site (part of the Logan Lagoon Conservation Area) Management Plan 2004. Department of Tourism, Arts and the Environment, Hobart.

2.2. Purpose of Ecological Character Descriptions

The Ramsar Convention defines (1) "*ecological character*" as the combination of the ecosystem components, processes and benefits and services that characterise the wetland at a given point in time, (2) the "*change in ecological character of wetlands*" as the human-induced adverse alteration of any ecosystem component, process, and/or ecosystem benefit and service, and (3) the "*wise use of wetlands*" as the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development (Ramsar Convention Secretariat 2005a).

The key basis for understanding the overall processes of detecting, reporting and responding to change in ecological character is Article 3.2 of the Ramsar Convention, which states that:

> "Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any listed wetland in its territory has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference. Information on such changes shall be passed without delay to the organization or government responsible for the continuing bureau duties [*i.e.* the Ramsar Convention Secretariat]…".

An Ecological Character Description (ECD) should contain all relevant information that helps establish the range of natural variation in components, processes and services at each site within a given time frame. The condition of a Ramsar site can then be assessed against a baseline, together with any information which has been received subsequently, enabling managers to report whether there have been significant changes to the ecological character.

The aims of an ECD were originally detailed by McGrath (2006) and now form the basis for 'The Statement of Purpose' which originates from the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands: Module 2 of the National Guidelines for Ramsar Wetlands — Implementing the Ramsar Convention in Australia* (DEWHA 2008a). The information which follows describes the values, components and processes of the Logan Lagoon Ramsar site and threats to its ecological character. The purpose of this document is:

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 Logan Lagoon; and

b) to formulate and implement planning that promotes:

- conservation of the wetland; and
- 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 (RIS) 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 *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), particularly:

- 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
- 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.

2.3. Objective of the Logan Lagoon Ecological Character Description

The objective of the ECD for Logan Lagoon is to produce a comprehensive description of the ecological character that aims to:

1. Describe the critical components, processes and benefits/services of the wetland found at Logan Lagoon at the time of listing (1982) and the relationships among them;

2. Describe the current condition (2010) of critical components, processes and benefits/services of the wetland found at Logan Lagoon and the relationships among them;

3. Develop a conceptual model for Logan Lagoon that displays the 'ecological character' in terms of components, processes and benefits/services and the relationships among them;

4. Quantify the limits of acceptable change for the critical components, processes and benefits and services of the wetland;

5. Identify actual or likely threats/risks to the ecological components, processes or services of the Logan Lagoon site.

2.4. Relevant legislation and policies

This section provides a summary of the international, national and state level legislation and policy that is relevant to the listing and management of the Logan Lagoon Ramsar site.

2.4.1. International Treaties

Ramsar convention

The Convention on Wetlands (Ramsar, Iran, 1971), otherwise known as the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia was one of the first 18 countries to become a signatory to the Convention in 1975. The Ramsar Convention Bureau maintains a List of Wetlands of International Importance that includes 64 Australian sites (10 in Tasmania); which total over 8 million hectares (DEWHA 2010c).

The Ramsar criteria for listing wetlands of international importance include sites containing representative, rare or unique wetland types within their bioregion; and sites of international importance for conserving biological diversity.

Migratory bird bilateral agreements and conventions

The East Asian-Australasian Flyway

The geographical routes that migratory waterbirds traverse on an annual basis are known as 'flyways'. Ten of these flyways are recognised around the planet. The East Asian-Australasian Flyway extends from the Russian Far East and Alaska, southwards through East Asia and South-east Asia, to Australia and New Zealand and encompasses 22 countries. During migration, waterbirds rely on a chain of productive wetlands and coastal areas to rest and feed, building up sufficient energy to fuel the next phase of their journey. International cooperation throughout their migratory range is therefore essential to conserve and protect migratory waterbirds and the habitats on which they depend.

The East Asian-Australasian Shorebird Site Network is an initiative under the Asia Pacific Migratory Waterbird Conservation Strategy 2001 – 2005 and the Action Plan for the Conservation of Migratory Shorebirds in the East Asian-Australasian Flyway 2001-2005. These frameworks enable all sectors of the Asia – Pacific region to come together to promote the conservation of wetlands and waterbirds. The Network comprises 95 sites from 14 countries including 2 sites in Tasmania (Logan Lagoon on Flinders Island and Pitt Water-Orielton Lagoon in the Derwent region).

Tasmania's geographical position represents the southern extremity of the range for Palaearctic migratory shorebirds. Tasmania therefore serves as the final resting and feeding site for many individuals before they return to their northern hemisphere breeding grounds. While Tasmania, compared to some other Australian States, has a smaller complement of migratory visitors, it is the stronghold for several species and is likely to become increasingly important if other areas become unavailable. Logan Lagoon has been identified as a site of international importance for migratory shorebirds across the East Asian-Australasian Flyway for the curlew sandpiper (*Calidris ferruginea*) and the red-necked stint (*Calidris ruficollis*) (Bamford *et al.* 2008).

For over 30 years, Australia has played an important role in international cooperation to conserve migratory birds in the East Asian-Australasian Flyway, entering into bilateral migratory bird agreements with Japan in 1974 (JAMBA), China in 1986 (CAMBA) and the Republic of Korea in July 2007 (ROKAMBA). Each of these agreements provides for the protection of migratory birds from take or trade except under limited circumstances, the protection and conservation of habitats, the exchange of information and building cooperative relationships.

JAMBA - The agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment, 1974.

CAMBA - The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment, 1986.

ROKAMBA - The Agreement between the Government of Australia and the Republic of Korea for the Protection of Migratory Birds and their Environment, 2006.

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) adopts a framework in which countries with jurisdiction over any part of the range of a particular species co-operate to prevent migratory species becoming endangered. For Australian purposes, many of the species listed under this agreement are migratory birds.

2.4.2. National legislation

***The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (DEWHA 2010a). Under the EPBC Act, actions that are likely to have a significant impact on matters of national environmental significance (NES) are subject to a rigorous assessment and approval process. Matters of NES are defined as:

- world heritage sites
- national heritage places
- wetlands of international importance (Ramsar wetlands)
- nationally threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- nuclear actions.

The EPBC Act establishes a framework for managing Ramsar wetlands, through the Australian Ramsar Management Principles established under the Environment Protection and Biodiversity Conservation Regulations 2000. These principles are intended to promote national standards of management, planning, environmental impact assessment, community involvement and monitoring, for all of Australia's Ramsar wetlands in a way that is consistent with Australia's obligations under the Ramsar Convention. A description of ecological character is a requirement under the Ramsar Convention and the Australian Ramsar Management Principles. The *National framework and guidance for describing the ecological character of Australian Ramsar Wetlands* (DEWHA 2008a) outlines a nationally agreed framework for describing the ecological character of Australia's Ramsar-listed wetlands.

All species listed under the international treaties of JAMBA, CAMBA, ROKAMBA and Bonn Convention are covered by the EPBC Act. Threatened species and communities listed under the EPBC Act may also occur, or have habitat in, a Ramsar site. The Regulations also cover matters relevant to the preparation of management plans, environmental assessment of actions that may affect the site, and the community consultation process (DEWHA 2010a)

2.4.3. Tasmanian State legislation

The Tasmanian legislation of most relevance to the site comprises:

***Threatened Species Protection Act 1995* (TSP Act)**

The TSP Act provides for the conservation of threatened species and management of threatening processes. In addition to a range of voluntary mechanisms and options, the TSP Act provides for a number of formal instruments to conserve threatened species. These include the identification of critical habitat, imposing of interim protection orders, the making of land management plans, recovery plans and threat abatement plans, public authority management agreements and for the issuing of permits. The TSP Act has effect over all land tenures in Tasmania.

***Nature Conservation Act 2002 (NC Act) and National Parks and Reserves Management Act 2002* (NPRM Act)**

Threatened vegetation communities at the site and elsewhere in Tasmania are protected through more recent amendments to the NC Act and the *Forest Practices Act 1985*:

- Nature Conservation Amendment (Threatened Native Vegetation Communities) Act 2006; and
- Forest Practices Amendment (Threatened Native Vegetation Communities) Act 2006.

This legislation establishes a list of threatened communities under the NC Act, and provides measures to protect these communities from clearance and conversion under the *Forest Practices Act 1985*.

Reserves are declared under the NC Act, which sets out the values and purposes of each reserve class and are managed under the NPRM Act according to management objectives for each class. Under the *Nature Conservation Act 2002*, for an area to be declared in the reserve class of 'conservation area', that area must predominantly be in a natural state, with its purpose to protect and maintain the natural and cultural values of the area of land and the sustainable use of its natural resources. Under the NPRM Act the sustainable use of natural resources can include activities such as mining and hunting. Under Section 29 of the NPRM Act, the Director of National Parks and Wildlife is the managing authority for the conservation area. The NPRM Act also outlines processes for developing statutory management plans for reserves as well as establishing regulations for reserve management.

Inland Fisheries Act 1995

The Inland Fisheries Act 1995 details fishing regulations and license requirements, as well as prohibited actions in relation to impacts on fish in waterways, which are relevant to the site.

Aboriginal Relics Act 1975

The *Aboriginal Relics Act 1975* protects "relics" created before 1876. It is an offence to damage, destroy, interfere with, disturb or conceal relics without a Ministerial permit.

Aboriginal Lands Act 1995

The Aboriginal Lands Act 1995 promotes reconciliation with the Tasmanian Aboriginal community by granting to Aboriginal people certain parcels of land of historic or cultural significance.

Living Marine Resources Management Act 1995

The *Living Marine Resources Management Act 1995* promotes the sustainable management of living marine resources, to provide for management plans relating to fish resources, and to protect marine habitats.

Environmental Management and Pollution Control Act 1994

The *Environmental Management and Pollution Control Act 1994* provides for the management of the environment and the control of pollution in the State. The fundamental basis of the Act is the prevention, reduction and remediation of environmental harm.

Water Management Act 1999

The *Water Management Act 1999* is part of the State's integrated Resource Management and Planning System and provides for the use and management of Tasmania's freshwater resources.

Rivers and Water Supply Commission Act 1999

The *Rivers and Water Supply Commission Act 1999* provides for the Commission to: administer water districts in accordance with section 5(2); of the *Water Management Act 1999*; manage property of the Crown or the Commission and other property related to the administration of water districts; provide

project management and development services in the commercial water industry and related industries, and; undertake the necessary duties of a Government Business Enterprise (DPIPWE 2009e).

Land Use Planning and Approvals Act 1993

The *Land Use Planning and Approvals Act 1993* is the principal land use planning instrument in Tasmania. It is the cornerstone of Tasmania's Resource Management and Planning System (RMPS) which contains a suite of legislation covering the use of land in Tasmania.

Tasmanian Weed Management Act 1999

The *Weed Management Act 1999* provides for the control and eradication of weeds having regard to the need to: (a) minimise the deleterious effects of weeds on the sustainability of Tasmania's productive capacity and natural ecosystems; (b) promote a strategic and sustainable approach to weed management; (c) encourage community involvement in weed management; and (d) promote the sharing of responsibility for weed management between the different spheres of government, natural resource managers, the community and industry in Tasmania.

2.4.4. Management planning, policies and projects

Logan Lagoon Management Plan 2004

The Management Plan for Logan Lagoon Ramsar Site (Parks and Wildlife Service 2007) has been prepared in accordance with the requirements of the *National Parks and Reserves Management Act 2002*. The objectives of the Management Plan are to ensure that the Logan Lagoon Ramsar Site will be managed to protect its outstanding natural and cultural values, and provide for an appropriate range of recreational opportunities.

State Policy on Water Quality Management 1997

Under this Policy, protected environmental values must be set for all Tasmanian groundwater and surface waters, including estuarine and coastal waters. Protected environmental values (the current uses, qualities and values of the water body) have been documented in a consultative process and water quality objectives have been set that will protect the environmental values of the waterway (TPC 1997).

State Coastal Policy 1996

The principles of this policy are that natural and cultural values of the coast are protected, that the coast shall be used and developed in a sustainable manner, and that integrated management and protection of the coastal zone is a shared responsibility (DPIPWE 2009a). The coastal zone includes wetlands and lagoons immediately inland of the coast and Logan Lagoon would therefore be protected under this policy.

Climate Futures for Tasmania Project

The Tasmanian Government, CSIRO and Hydro Tasmania are cooperatively funding a research collaboration which will provide likely future climate information at local scales around Tasmania. Previously, national scale projections have been relied upon which has sometimes limited their use at local levels. The Climate Futures for Tasmania Project will provide projections that can be used for local decision-making, and importantly, to involve a broad cross section of the community promoting a more holistic approach to climate change adaptations.

Flinders Planning Scheme 1994

The Flinders Island Planning Scheme applies to the lands and water under the jurisdiction of the Flinders Council. This includes land defined as environmental management and recreation zones and the scheme aims to provide for the sustainable management of the natural and physical resources found on Crown lands and other lands whilst providing opportunities for public recreation at suitable sites. One of the aims of the scheme is to ensure that land use or development and management practices shall be environmentally appropriate and shall avoid contamination or despoliation of the land, ground water, water courses, shorelines, lagoons and marshes. Sand-dunes, coastal vegetation and ecologically important areas shall be protected from degradation.

Ramsar Strategic Plan 2009-2015

The Ramsar Strategic Plan (Ramsar Convention Secretariat 2009a) aims to ensure the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.

2.5. Methodology and Approach

The compilers of this ECD met with members of the Logan Lagoon Ramsar site ECD Steering Committee on Flinders Island in July 2009. The meeting allowed participants to become familiar with Flinders Island, the Logan Lagoon Ramsar site, local issues, and discuss the requirements of the project in general. They also met with key stakeholders including adjoining private landowners, the Flinders Island Council, NRM North, Furneaux Field and Game Association, the Flinders Island Aboriginal Association Incorporated, Flinders Island Museum and the local community.

The development of the ECD followed the steps outlined in the *National Framework and Guidance for describing the ecological character of Australian Ramsar wetlands* (DEWHA 2008a). This included the compilation of all relevant and up-to-date information (both published and unpublished where available) regarding the ecological character of Logan Lagoon, with an emphasis given to those critical processes, components and ecosystem services that support the Ramsar criteria for which it was listed. This framework was used to identify the actual and potential threats to the ecological character of the site and determine acceptable levels of change.

There was an overall paucity of general and scientific information for the site, particularly records for the distribution and abundance of flora and fauna. Consequently, online databases were interrogated for much of the information in this ECD. Sources of information include: climatic data recorded by the Bureau of Meteorology (BoM 2009), recent and historical aerial photographs, TASVEG 2.0 database (TASVEG 2009), Geoconservation database (DPIPWE 2009b), Natural Values Atlas (DPIPWE 2009c), The List (DPIPWE 2009d), Atlas of Australian Birds (AAB 2009), published literature, research studies, informal surveys, herbarium records, websites and personal communications. A more detailed description of these databases, their function, and a discussion of limitations associated with interpreting resulting data, is in Section 2.6 and Appendix A.

2.6. Limitations of database searches

There are limitations when species lists are derived from database searches such as those described in Section 2.5 above. In particular, searches may:

- Include species that have been recorded in the specified buffer zone (e.g. a six kilometre radius) on only one or two occasions;
- Include species that are vagrant and have been recorded at the site but are not normally resident;

- Include species that are now locally extinct but still appear because these databases are historic records;
- Include species that have specific habitat requirements that may be present in the surrounding region but not on the actual site;
- Include species that have complex life histories or are not well understood, so that deciding whether they frequent the site or are vagrants is difficult;
- Result in database lists that are underwritten by observations from spatially or temporally limited surveys, such that unsubstantiated observations can appear as fact; or
- Result in an amalgamation of long-term observations so that an area can appear to have a more diverse fauna than is actually present from year to year.

As a consequence of the above limitations, some species included in the lists produced from database searches may not be present on the site. However, in the absence of data obtained from systematic surveys of species at the site, database searches are an invaluable tool for producing species lists for a particular location. No systematic on-ground surveys across the entire site, which could validate the database records, have been undertaken.

3. OVERVIEW OF THE LOGAN LAGOON RAMSAR SITE

3.1. Location

Logan Lagoon is situated on the south-east corner of Flinders Island in Bass Strait, Tasmania, Australia, approximately six kilometres north-east of the township of Lady Barron (Figure 2). Logan Lagoon is part of a coastal lagoon system that comprises three large estuarine lagoons along the eastern coastline of Flinders Island (Figure 4).

The site extends from the southern shore of South Chain Lagoon in the north down to Wilsons Lagoon in the south (Figure 2). Flinders Island falls within the Flinders municipality, which had a population of approximately 864 in 2006 (Australian Bureau of Statistics 2010). The site is visited by locals and visitors for a range of activities, some of which may impact the conservation value of the site.

3.2. Land tenure

The 2257 hectare site is enclosed within the Logan Lagoon Conservation Area which is managed by the Tasmanian Parks and Wildlife Service. The site is bounded by sea to the east and south, Logan Lagoon Conservation Area to the north, with private property along approximately two-thirds of the western and north-western boundary (Figure 5; Figure 6). With the exception of the areas immediately to the west and north-west of the entrance to Pot Boil Creek, the majority of the Logan Lagoon Conservation Area is covered with native vegetation.

The catchment of Logan Lagoon is approximately 7500 hectares – comprised of Crown Land, conservation reserve and some privately owned land. The clearance, drainage and reclamation of low-lying areas on the east coast of Flinders Island between the 1930s (Bootjack Flats area) and 1950s (east coast swamps) has increased the area of the catchment from its pre-settlement state. The majority of the land was reclaimed by soldiers who were granted settlement rights in return for their labour in clearing and draining some of the more inhospitable portions of the island. These areas are now agricultural farms (mostly for grazing cattle) which regularly use fertilisers to increase productivity of pastures. The runoff associated with these farms discharges into the catchment's main tributary, Pot Boil Creek - from as far away as Bootjack Flats - which subsequently feeds into the northern end of the lagoon. Agricultural runoff poses a risk to the ecological character of the site.

Prior to clearing by settlers, the natural vegetation comprised scrubby coastal heathlands and grasslands, of which only remnant patches remain. Soils within the site are dominated by uniform sandy deposits. The Planter Beach Dune System protects the lagoon from coastal processes and is recognised as a feature of conservation significance in the Tasmanian Bioregion. The beaches are composed of undifferentiated, calcareous sand and are highly susceptible to wind and wave erosion. The coastal waters to the south of the site, known as Vansittart (or Pot Boil) Shoal are treacherous; comprising shallow, shifting sand bars.

Inland the soils consist of a surface layer of organic materials and the Holocene shorelines that incorporate the lagoon are representative and outstanding geomorphological examples for the Tasmanian Bioregion (Parks and Wildlife Service 2007).

Figure 4. Photograph of the south-east coast of Flinders Island. Logan Lagoon is part of a chain of wetlands that extend along the east coast from Pot Boil Point in the south (far right) to Sellars Point midway up the east coast (top left) (Photograph: Luke Finley, Elgin Associates, July 2009).

Figure 5. Photograph of cleared agricultural land adjacent to the western boundary of Logan Lagoon Conservation Area Ramsar site. Note the drainage channel that flows into the Chain of Lagoons area in the bottom right of the image (Photograph: Luke Finley, Elgin Associates, July 2009).

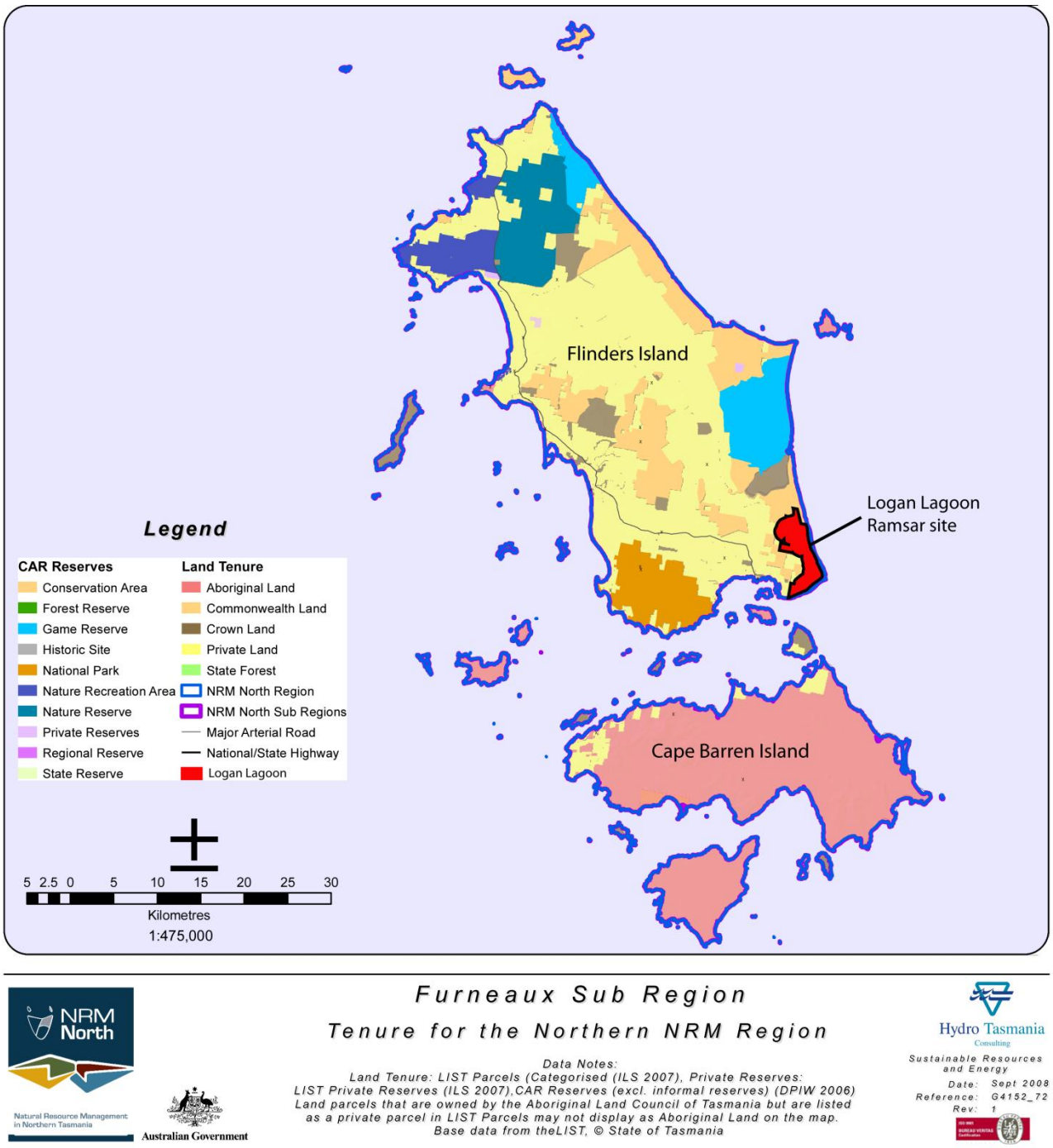


Figure 6. Land tenure of Flinders Island. The Logan Lagoon Ramsar site is shaded red (Source: NRM North; Produced by Hydro Tasmania Consulting, September 2008; modified by Elgin Associates, May 2010).

3.3. History of the site

Flinders Island

The Furneaux Group of islands, of which Flinders Island is part, was first occupied by Aboriginals at least 35,000 years ago. A lowering of sea level during the last ice age formed a land bridge between mainland Australia and Tasmania. This bridge, that included the land mass of Flinders Island, enabled foot passage across Bass Strait, and subsequent population of the Tasmanian region. It is believed that a population remained on Flinders Island until about 4500 years ago, when it died out due to unknown reasons. Flinders Island then remained free from human occupation until the arrival of sealers circa 1800.

Flinders Island was first identified by European explorers on 19 March 1773 by Captain Tobias Furneaux, the commander of Captain Cook's support ship the *HMS Adventure*, when it became separated from the *Endeavour* in heavy fog. Captain Cook named the Furneaux Group of island in 1773 in honour of Captain Furneaux. However, Flinders Island was not named until 1802 - after Matthew Flinders, for his discovery of Bass Strait. The first official European settlement on Flinders Island commenced in 1831, with the relocation of G. A. Robinson's Aboriginal station from Gun Carriage (Vansittart) Island to The Lagoons on the south-west coast of Flinders Island. The settlement later moved north to Wybalenna, finally closing in October 1847.

Following the settlement's closure, the whole of Flinders Island was leased from 1850 to 1861 by Captain Malcolm Smith, a former Commandant of Wybalenna. Tin was discovered at Killiecrankie in 1883 and in 1888 the island was opened for land selection. George Boyes, who took up land at Palana in 1889, is credited with being the first official landowner in this period. By the turn of the century a bustling community had developed at Whitemark and in 1910–1911 the wharf at Lady Barron was constructed.

No systematic surveys for historic heritage have been carried out within the boundaries of the Ramsar site. The Tasmanian Historic Places Inventory does not contain any entries for the area (Parks and Wildlife Service 2007).

Logan Lagoon Conservation Area and Logan Lagoon Ramsar site

The Logan Lagoon Conservation Area (Figure 3) was declared *'a sanctuary with respect to animals and birds'* on 6 August, 1968, under the *Animals and Birds Protection Act 1928.* Following the passing of the *National Parks and Wildlife Act 1970,* the area became a wildlife sanctuary. In 1974, two blocks on the north-east corner and one block on the eastern edge of the sanctuary were acquired and added to the conservation area. A further block on the western edge was acquired in May 1977. Under Section 17 of the *Regional Forest Agreement (Land Classification) Act 1998*, the wildlife sanctuary is declared to be reserved land in the class of Conservation Area and is taken to have been so declared under the *National Parks and Reserves Management Act 2002* (Parks and Wildlife Service 2007). The boundary of this original conservation area now forms the boundary of the Ramsar site (see below).

A major extension to the reserve occurred in 2002, flowing from the recommendations of an inquiry into unallocated Crown Land on Flinders Island conducted by the Resource Planning and Development Commission (RPDC). This inquiry recommended that Logan Lagoon Conservation Area be extended to include land to the north between Cameron Inlet and Chain of Lagoons and land to the west. The extension was proclaimed by Statutory Rule 2002, No 172, gazetted on 25 December 2002 (Parks and Wildlife Service 2007). The extension adds approximately 2607 hectares to the Logan Lagoon Conservation Area, bringing the total area to approximately 4864 hectares (Figure 3).

Shorebird Site Network

Logan Lagoon was declared a Shorebird Network Site on the East Asian – Australasian Shorebird Site Network in 1996 because of the presence of a significant number of the curlew sandpiper (*Calidris ferruginea*) and the red-necked stint (*Calidris ruficollis*).

3.4. Ramsar criteria

3.4.1. Criteria under which the site was designated (16 November 1982)

Logan Lagoon was listed as an internationally important wetland under the Ramsar Convention in 1982, meeting three of the thirteen pre-1999 Ramsar criteria. The criteria at the time of listing were:

1(a) It is a particularly good representative example of a natural, or near-natural, wetland, characteristic of the appropriate biogeographical region;

2(c) It is of special value as the habitat of plants or animals at a critical stage of their biological cycle;

3(b) It regularly supports substantial numbers of individuals from particular groups of waterbirds, indicative of wetland values, productivity or diversity.

Table 5 .Ramsar Criteria for which Logan Lagoon was designated under the pre-1999 and how they compare to the current criteria.

Pre 1999 Criteria and Description		**Current Criteria (2005) and Description**	
Criterion 1(a)	It is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region	Criterion 1	A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Criterion 2(c)	It is of special value as the habitat of plants or animals at a critical stage of their biological cycle.	Criterion 4	A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 3(b)	It regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity.	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.

3.4.2. Current situation and additional criteria met

The Ramsar criteria for identifying wetlands of international importance have been reviewed in the period since the site was first designated. Under the current criteria, Logan Lagoon meets a fourth and fifth criterion in addition to the original three criteria for which the site was listed (Table 6).

Table 6. Criteria for Identifying Wetlands of International Importance (Adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties). Criteria for which Logan Lagoon Ramsar site currently qualifies are highlighted in blue.

Number	Basis	Description
Group A: Sites containing representative, rare or unique wetland types		
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.
Group B: Sites of international importance for conserving biological diversity		
Criterion 2	Species and ecological communities	A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 3	Species and ecological communities	A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
Criterion 4	Species and ecological communities	A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criterion 5	Waterbirds	A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
Criterion 6	Waterbirds	A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of waterbird.
Criterion 7	Fish	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.
Criterion 8	Fish	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.
Criterion 9	Other taxa	A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Justification for criterion listed above:

Criterion 1 – (*contains representative/rare/unique wetland type in appropriate biogeographic region*)

The site is an excellent, regionally representative example of a coastal estuarine wetland system, and comprises a diverse range of seasonal and permanent marshlands, grass and heathlands, forests and woodlands, many of which support threatened species of communities within the Tasmanian Bioregion and the Bass Strait IMCRA Province. In particular, the site contains excellent, near pristine, representative examples of the following Ramsar wetland types:

- Type E — Sand, shingle or pebble shores;
- Type J — Coastal brackish/saline lagoons;
- Type H – Intertidal marshes;
- Type N — Seasonal/intermittent/irregular rivers/streams/creeks;
- Type Ss – Seasonal/intermittent saline/brackish/alkaline marshes/pools;
- Type Tp – Permanent freshwater marshes/pools;
- Type Ts – Seasonal/intermittent freshwater marshes/pools on inorganic soils; and
- Type W – Shrub-dominated wetlands.

Logan Lagoon, with other lagoons and dunes in the area, provides a representative and outstanding example of the development of Holocene shorelines for Tasmania. Similarly, the Planter Beach Coastal Barrier System is partly within the site. It is a representative and outstanding example of how offshore bars formed with Holocene sea level rise, and how barrier growth has enclosed the coast, forming large lagoons. These two sites are listed on the Tasmanian Geoconservation Database for their conservation significance. Logan Lagoon is a Tasmanian estuary of critical conservation significance (Edgar *et al.* 1999) and has been assessed as a wetland in near-pristine condition for the Tasmanian Bioregion (Dunn 2002). This criterion was met at designation in 1982 and continues to be met at present.

Criterion 2 – (*supports vulnerable, endangered, or critically endangered species or threatened ecological communities*)

This criterion focuses on species and communities that are threatened at a Commonwealth level, primarily through the EPBC Act, but also at the international level, such as the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List.

The site supports three nationally threatened wetland-dependent fauna species. The dwarf galaxias (*Galaxiella pusilla*) and fairy tern (*Sternula nereis nereis*) are listed as Vulnerable under the EPBC Act and IUCN Red List respectively, whilst the Australasian bittern (*Botaurus poiciloptilus)* is listed as Endangered under the EPBC Act and IUCN Red List.

The site supports two nationally threatened wetland-dependent terrestrial flora species, the Swamp fireweed (*Senecio psilocarpus*) which is listed as vulnerable under the EPBC Act, and the Northern leek-orchid (*Prasophyllum secutum*) which is listed as endangered under the EPBC Act and TSP Act.

This criterion was likely to be met at designation and continues to be met at present.

Criterion 3 – (*Supports populations of plant and animal species important for maintaining the biological diversity of a biogeographic region*)

One regionally threatened 'wetland-dependent' terrestrial species is recorded within the Logan Lagoon boundary:

- Large-fruit seatassel (*Ruppia megacarpa*): listed as rare under the TSP Act.

Three wetland dependent vegetation communities recognised as Vulnerable under Tasmanian legislation have been recorded within the site:

- Saline aquatic herbland – listed as Vulnerable (NC Act) and poorly reserved in Tasmania;
- Freshwater aquatic herbland – listed as Vulnerable (NC Act) in Tasmania;
- Lucustrine herbland – listed as Vulnerable (NC Act) and poorly reserved in Tasmania.

This criterion was likely to be met at designation in 1982 and continues to be met at present.

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*)

Logan Lagoon provides important resting and feeding areas for waterbirds and migratory shorebirds. In 2002-2003, with severe drought conditions in mainland Australia, a flock of approximately 3000 banded stilts (*Cladorynchus leucocephalus*) arrived at Logan Lagoon and remained in the area for approximately 8 months. This is the largest number of stilts ever recorded in Tasmania (Olsen and Weston 2004; Woehler and Park 1997).

The 1998-1999 Shorebird Survey (Bryant 2002) for Tasmania found that Logan Lagoon and Cameron Inlet have high migratory and shorebird diversity and are priority sites for resident species. The area provides breeding habitat for the little tern (*Sterna albifrons*), a beach nesting shorebird listed as Endangered under the Tasmanian *Threatened Species Protection Act 1995.* The survey also recorded large numbers of two migratory species; curlew sandpiper (*Calidris ferruginea*), 1000 birds and red-necked stint (*Calidris ruficollis*), 4000 birds. Logan Lagoon is listed as an important site for these two species under the East Asian - Australasian Shorebird Site Network (Bamford *et al*. 2008). For these reasons, the site is not only important on a local scale, but also nationally and internationally.

A total of 21 migratory wader species have been recorded at the site and all of these, with the exception of the double-banded plover (*Charadrius bicinctus*), breed in the Arctic region during the northern hemisphere summer. Double-banded plovers breed in New Zealand and some of the population over-winters in Australia.

Many of the migratory bird species that use the site during migration are listed on international agreements such as CMS, CAMBA, JAMBA, or ROKAMBA. These species are:

- cattle egret (*Ardea ibis*), CAMBA
- ruddy turnstone (*Arenaria interpres*), CMS , JAMBA, CAMBA, ROKAMBA
- sharp-tailed sandpiper (*Calidris acuminata*), CMS, JAMBA, CAMBA, ROKAMBA
- sanderling (*Calidris alba*), CMS, JAMBA, CAMBA
- lesser sand plover (*Charadrius mongolus*), CMS, JAMBA, CAMBA, ROKAMBA
- Latham's snipe (*Gallinago hardwickii*), CMS, JAMBA, CAMBA, ROKAMBA
- Caspian tern (*Hydroprogne caspia*), JAMBA, CAMBA

- bar-tailed godwit (*Limosa lapponica*), CMS, JAMBA, CAMBA, ROKAMBA
- satin flycatcher (*Myiagra cyanoleuca*), CMS
- eastern curlew (*Numenius madagascariensis*), CMS, JAMBA, CAMBA, ROKAMBA
- whimbrel (*Numenius phaeopus*), CMS, JAMBA, CAMBA, ROKAMBA
- Pacific golden plover (*Pluvialis fulva*), CMS, JAMBA, CAMBA, ROKAMBA
- little tern (*Sterna albifrons sinensis*), CMS, JAMBA, CAMBA, ROKAMBA
- common greenshank (*Tringia nebularia*), CMS, JAMBA, CAMBA, ROKAMBA

(JAMBA: listed under the Japan – Australia Migratory Birds Agreement; CAMBA: listed under the China – Australia Migratory Birds Agreement; ROKAMBA: listed under the Republic of Korea – Australia Migratory Birds Agreement; CMS: listed under the Convention on Migratory Species)

This criterion was met at designation and continues to be met at present.

Criterion 5 – (*A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds*)

There are no data to demonstrate the site regularly supporting 20,000 waterbirds. Anecdotal information suggests that it doesn't. The site is unlikely to have met this criterion at the time of listing and is also unlikely to meet it now.

Criterion 6 – (*A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of waterbird*)

Using population estimates obtained from the 4th edition of Waterbird Population Estimates (Wetlands International 2006), the site regularly supports 1 percent of the global or regional populations of: hooded plover, fairy Tern, musk duck, and chestnut teal. This is based on survey data obtained from annual waterfowl counts and shorebird surveys carried out in 1998/1999 (Bryant 2002) and 2008 (Woehler 2008). Given the ephemeral nature of the lagoon, it is difficult to determine whether the site meets the Ramsar criteria for 'regular' use. However, existing information indicates that the site periodically supports 1 percent of the population of these species. It is likely that this criterion was met at designation and continues to be met at present.

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*).

There is insufficient data to demonstrate the site regularly supporting a significant proportion of indigenous fish. However, historical observations suggests that the dwarf galaxias *(Galaxiella pusilla)*, which is of conservation significance regionally and nationally (see Criterion 2), has been observed at the site. All known populations in Tasmania are important, as the species has declined throughout its geographic range, has a patchy distribution and existing populations are fragmented (TSS 2006b). Logan Lagoon, if found to have a significant population of dwarf galaxias, will represent one of the few reserved locations in the Tasmania Bioregion. Additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would suggest that it was met at the time of listing.

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*)

There are no data to demonstrate the site provides an important source of food for fish, a spawning ground, or is utilised by migratory fish. However, when the lagoon mouth is open to the ocean, marine species may visit the lagoon for feeding, spawning, or as a nursery. Additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would suggest that it was met at the time of listing.

Criterion 9 – (*A wetland should be considered internationally important if it regularly supports 1 percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species*)

There are no data to demonstrate the site supports 1 percent of a population of any wetland-dependent non-avian animal species. Only the dwarf galaxias (*Galaxiella pusilla*) meets the description of a wetland-dependent non-avian animal species that is considered internationally important. Historical information suggests that this species is present at the site; however, additional surveys are required to establish whether Logan Lagoon meets this criterion at present, and confirmation would suggest that it was met at the time of listing.

3.5. Wetland types

Logan Lagoon contains a range of wetland types. At the time of listing, the site was identified as having three wetland types (E, J, N). Under the Ramsar classification system, two Marine/Coastal wetland types (from a possible 12; Table 7) and one inland wetland type (from a possible 20; Table 7) were initially recorded as occurring at the site. Several additional wetland types have been identified and should be added to this list (Table 7 and Table 8). Although some of these wetland types represent small areas (Figure 19; Table 12), they support communities that have conservation significance in the Tasmanian Bioregion. The process used to identify the additional wetland types, and the species and communities associated with these wetland types, is discussed in Section 4.7 (see also Table 12).

Marine/Coastal:

Type E — **Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

Type J — **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.

One additional Marine/Coastal wetland type has been identified and should be added:

Type H – **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes brackish and freshwater marshes.

Table 7. Marine / Coastal wetland types (shaded boxes identify the wetland types present at the site. Types in **bold** are newly added).

Saline water	Permanent	Depth < 6 metres	A
		Underwater vegetation	B
		Coral reefs	C
	Shores	Rocky	D
		Sand, shingle or pebble	E
Saline or brackish water	Intertidal	Flats (mud, sand or salt)	G
		Marshes	**H**
		Forested	I
	Lagoons		J
	Estuarine waters		F
Saline, brackish or fresh water	Subterranean		Zk(a)
Fresh water	Lagoons		K

Inland:

Type N — **Seasonal/intermittent/irregular rivers/streams/creeks**.

Four additional Inland wetland types have been identified and should be added:

Type Ss – **Seasonal/intermittent saline/brackish/alkaline marshes/pools**.

Type Tp – **Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils**; with emergent vegetation water-logged for at least most of the growing season.

Type Ts – **Seasonal/intermittent freshwater marshes/pools on inorganic soils**; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

Type W – **Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.

Table 8. Inland wetland types (shaded boxes identify the wetland types present at the site. Types in bold are newly added).

Fresh water	Flowing water	Permanent	Rivers, streams, creeks	M
			Deltas	L
			Springs, oases	Y
		Seasonal/intermittent	Rivers, streams, creeks	N
	Lakes and pools	Permanent	> 8 ha	O
			< 8 ha	Tp
		Seasonal/intermittent	> 8 ha	P
			< 8 ha	Ts
	Marshes on inorganic soils	Permanent	Herb-dominated	**Tp**
		Permanent/ Seasonal/intermittent	Shrub-dominated	**W**
			Tree-dominated	Xf
		Seasonal/intermittent	Herb-dominated	**Ts**
	Marshes on peat soils	Permanent	Non-forested	U
			Forested	Xp
	Marshes on inorganic or peat soils	High altitude (alpine)		Va
		Tundra		Vt
Saline, brackish or alkaline water	Lakes	Permanent		Q
		Seasonal/intermittent		R
	Marshes and pools	Permanent		Sp
		Seasonal/intermittent		**Ss**
Fresh, saline, brackish or alkaline water	Geothermal			Zg
	Subterranean			Zk(b)

4. ECOLOGICAL CHARACTER OF THE LOGAN LAGOON RAMSAR SITE: COMPONENTS, PROCESSES AND SERVICES

4.1. Summary of the components and processes

This chapter provides a general description of the ecosystem components, processes, benefits and services that define the ecological character of the Logan Lagoon site. Ecosystem components are physical, chemical and biological parts of a wetland, from small-scale to large-scale (e.g. genes, species and habitat). Ecosystem processes are the dynamic forces operating within an ecosystem such as those that occur within and between populations and communities, including interactions with the surrounding physical environment.

There is a paucity of information on the site's ecosystem components and processes before and since the time of listing (1982), and quantifying changes to the site's ecological character since the time of listing is difficult. This ECD utilises various studies and reports from research conducted at the site and surrounding area undertaken since listing, interpreted to infer the conditions at the time of listing as accurately as possible (see Section 2.5).

A full description of the ecosystem components and processes of Logan Lagoon is provided in Section 4.3 below. A detailed description of the critical components and processes is described in Section 5.1.

Table 9. Summary of ecosystem components (C) and processes (P) of the Logan Lagoon Ramsar site.

Component	Description
Climate (C/P)	There are four climate processes (P) that broadly affect the wetland ecology of Logan Lagoon: rainfall (P); temperature (P); wind (P); evaporation (P). Climate (C) fundamentally affects the hydrology and geomorphology at the site – e.g. modification of the landscape by wind (P).
Geomorphology (C)	Logan Lagoon is part of an extensive eastern Flinders Island parallel dune – coastal barrier system. Site of geoconservation significance - site contains a number of old, slightly higher than present strand lines, suggesting recent uplift (or higher mid-Holocene sea levels). Lagoon isolated from the sea by a large sand bar which is rarely breached under natural conditions, but has a history of forced opening by locals.

Component	Description
Wetland Soils (C)	Site is predominantly sands, occurring in dunes or sandy plains. Inorganic soils are a feature of a range of wetland types at the site, each of which supports wetland vegetation communities that are of conservation significance in the Tasmanian Bioregion. Site contains Hydrosols - seasonally or permanently wet soils and subaqueous materials- there are areas within the site that have High to Very High risk of Potential Acid Sulphate Soils (PASS).
Hydrology (C)	Highly seasonal freshwater inflows from direct precipitation (P) and drainage channels via Pot Boil Creek. Limited tidal exchange (P) with ocean waters – the sand bar at the lagoon entrance is rarely breached under natural conditions. Groundwater discharge (P) from the uppermost aquifer beneath the lagoon.
Water Quality (P)	Elevated levels (P) of nutrients, including fertilisers, from the surrounding catchment. Surface water quality is influenced by seasonal factors, including rainfall recharge (P), inflows from Pot Boil Creek, evaporation (P), and interaction (P) with groundwater and adjacent marine waters. Periodic opening of the lagoon, under natural circumstances, to ocean waters would quickly modify (P) the water quality. The water quality of the lagoon may change rapidly depending on the influence of climatic conditions (C) or physical modifications at the site (e.g. from fresh to saline conditions following breaching of the sand bar at the lagoon entrance).
Vegetation (C)	A mosaic of wetland-dependent vegetation communities including Lowland sedgy heathland, Saline aquatic herbland, Saline sedgeland and rushland, Fresh water aquatic herbland, Lowland *Poa labillardierei* grassland, and *Melaleuca squarrosa* scrub Wetland-dependent vegetation which is of conservation significance and poorly reserved in Tasmania. Remnant patches of pre-European forest vegetation, including some threatened flora communities. Unknown assemblages of aquatic plant species.
Fauna (C)	High diversity and abundance of birds, including 129 recorded species. A total of 21 migratory wader species have been recorded at the site. Endangered freshwater species, the dwarf galaxias, has been recorded at the site. During prolonged opening of the entrance to the ocean, other marine species may use the lagoon for foraging, breeding, or as a habitat refuge. Six frog species occur on Flinders Island and all are likely to inhabit Logan Lagoon, including the threatened green and gold frog *Litoria raniformis*. Unknown assemblages of benthic fauna in the estuarine and the intertidal zones. Similar estuarine lagoons have a range of endemic microfauna and flora.

4.2. Summary of the ecosystem benefits and services

Ecosystem benefits and services are defined in accordance with the Millennium Ecosystem Assessment (MEA) definition of ecosystem services as 'the benefits that people receive from ecosystems' (Ramsar Convention Secretariat 2005a). In many cases the benefits people receive from ecosystems (economic, social and cultural) rely on the underlying ecological components and processes in the wetland. These are very important, even though they may not benefit humans directly.

The MEA (Millennium Ecosystem Assessment 2005) identifies four main categories of ecosystem benefits and services:

1. Provisioning services — the products obtained from the ecosystem such as food, fuel and fresh water
2. Regulating services — the benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation
3. Cultural services — the benefits people obtain through spiritual enrichment, recreation, education and aesthetics
4. Supporting services — the services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit over a long period of time.

A detailed description of the critical benefits and services is described in Section 5.2.

Table 10. The ecosystem benefits and services of the Logan Lagoon Ramsar site.

Ecosystem service	**Benefit**
Provisioning services	
None identified	None identified
Supporting services	
Biodiversity	Logan Lagoon provides a wide range of biodiversity values such as: • support for a number of regionally, nationally and internationally threatened species; • supports a series of representative, rare or unique wetland types, • as an important site for migratory seabirds; • supports critical life stages or provides refuge; and • provides habitat for plant and animal species that contribute to the biodiversity of the Tasmanian Bioregion.
Soil formation	Sediment retention and stabilisation of coastal dunes system. Accumulation of organic matter which provides nutrients for flora and fauna.
Nutrient cycling	Storage, recycling, processing and acquisition of nutrients. Control of nutrients from overland flow and groundwater, outflow seepage through barrier dunes and occasionally by tidal flows when the entrance is breached.

Regulating services	
Maintenance and regulation of hydrological cycles and regimes	Recharge of groundwater systems by runoff from surrounding impermeable granite catchments which drain into sand aquifers, flowing underground, generally eastwards. Maintenance of natural hydrological regimes that support the ecosystems in the lagoon.
Erosion protection	Prevention of physical changes such as coastal erosion and storm damage by vegetation cover.
Pollution control and detoxification	Retention, recovery and removal of excess nutrients and pollutants from upstream land uses. Extraction of excess nutrients and chemicals by aquatic plants.
Climate regulation	No data – Possible regulation of greenhouse gases, temperature precipitation and other climatic processes.
Biological control of pests and diseases	No data – Support of predators of agricultural pests.
Flood control	The site buffers drainage water from the surrounding agricultural land during periods of high flow. Protection of coastal dunes system and surrounding low-lying land from inundation during rough seas.
Cultural services	
Recreation and tourism	Recreational fishing occurs on the ocean beach. Water sports such as canoeing and kayaking occur on the lagoon. Surfers access the areas to the East and South via the site. Visits by walkers and nature observers such as amateur bird watchers. Visits by nature-based tourism operators.
Spiritual and inspirational	Appreciation of natural features through photography. Cultural heritage (historical and archaeological). Spiritual and religious significance. Sense of place. Existence value.
Scientific and educational	Some areas have education value in serving as a demonstration of a near-pristine wetland. The coastal dune system is recognised as being of geoconservation significance on a regional scale. Long-term monitoring of waterbird numbers at Logan Lagoon are counted annually and other bird numbers are counted periodically.

4.3. Detailed description of the ecosystem components, processes and services

4.3.1. Climate

Climatic information has been collected at Flinders Island Airport near Whitemark since 1940 (Appendix B). The climate of Flinders Island is classified as temperate maritime, with the island surrounded by the waters of Bass Strait and the Tasman Sea. The surrounding marine waters have a stabilising effect on the climatic conditions because the sea temperature only varies by 6 to 7 degrees Celsius throughout the year. Summers are mild with up to 15 hours of daylight in midsummer, compared to approximately 9 hours of daylight in midwinter (BoM 2009).

The four aspects of climate that are most likely to affect the wetland ecology of Logan Lagoon are rainfall, temperature, wind and evaporation. These factors fundamentally affect the hydrology and geomorphology at the site and thus contribute to the site's ecological character. The climatic data suggests that there has been a shift to warmer and drier conditions in the 25 years since listing in 1982. The implications of climate change on the site are a threat but are poorly understood: however, climate change predictions for south-eastern Australia suggest a generally warmer climate with less rainfall and rising sea levels (DCC 2009). Changes associated with such a climate may potentially impact the hydrology, geomorphology, vegetation, habitat and species at Logan Lagoon (see threats Section 8.7).

4.3.2. Rainfall

Flinders Island Airport receives an annual average rainfall of 736 millimetres, ranging from 374.1 millimetres (2006) to 1164.9 millimetres (1956) (Figure 7; Appendix B). The long term average was six percent higher (777 millimetres) during the 25 years leading up to Ramsar listing (1957-1982). In contrast, annual rainfall (687 millimetres) was 7 percent below the long term average in the 25 years since Ramsar listing (1983-2008) (Appendix B).

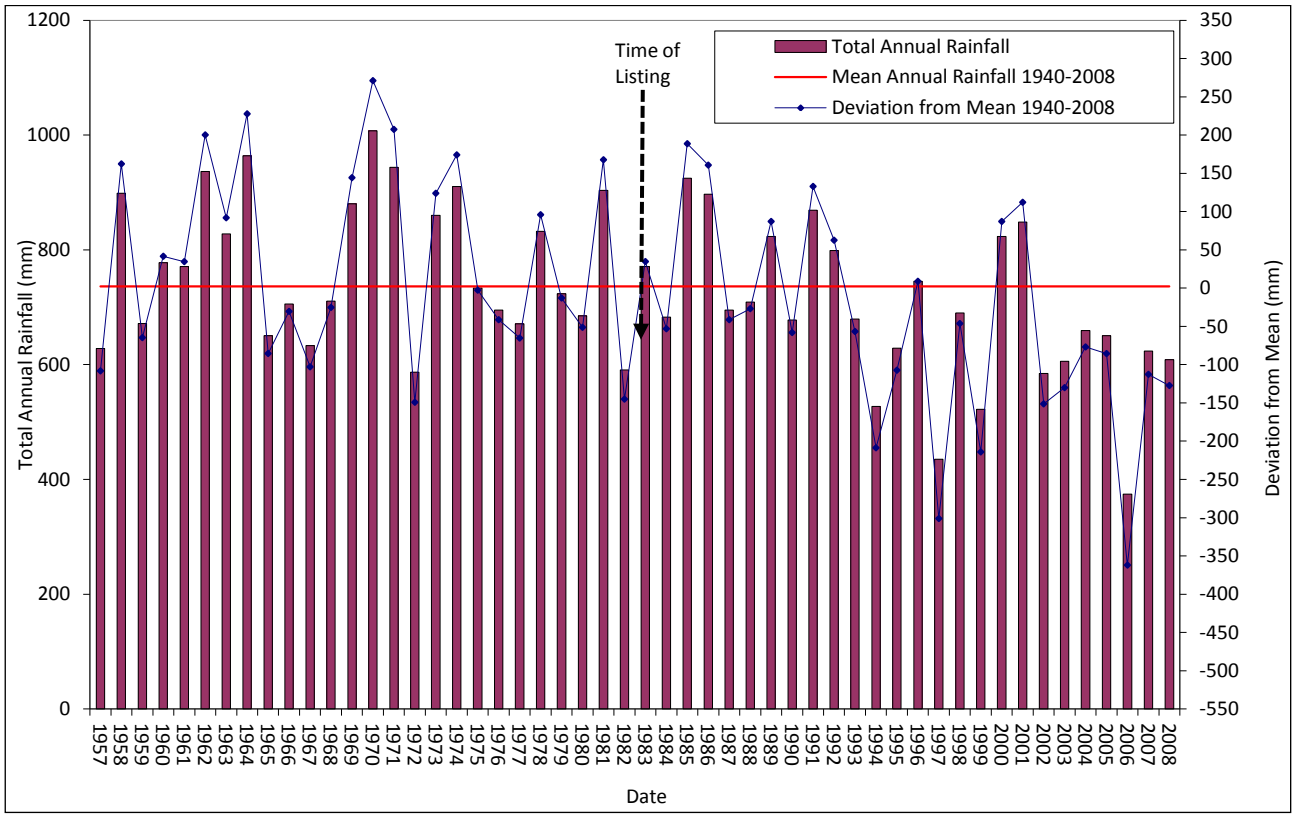


Figure 7. Annual rainfall data from Flinders Island Airport from 1940 - 2008 (BoM 2009; Created by Elgin Associates 2009).

Flinders Island receives most rainfall in winter and early spring, coinciding with the persistent westerly winds. The months of January and February are the driest, whereas July and August are the wettest (Figure 8). The reduction in annual rainfall following listing (1982) is also apparent in the average monthly rainfall. With the exception of January, June and November, average monthly rainfall totals declined in the 25 years between 1983 and 2008 (compared with 1957 to 1982). Large decreases (greater than 20 percent) in monthly average rainfall are evident for February (40 percent), May (30 percent), March (27 percent) and July (20 percent) (Figure 8; Appendix B).

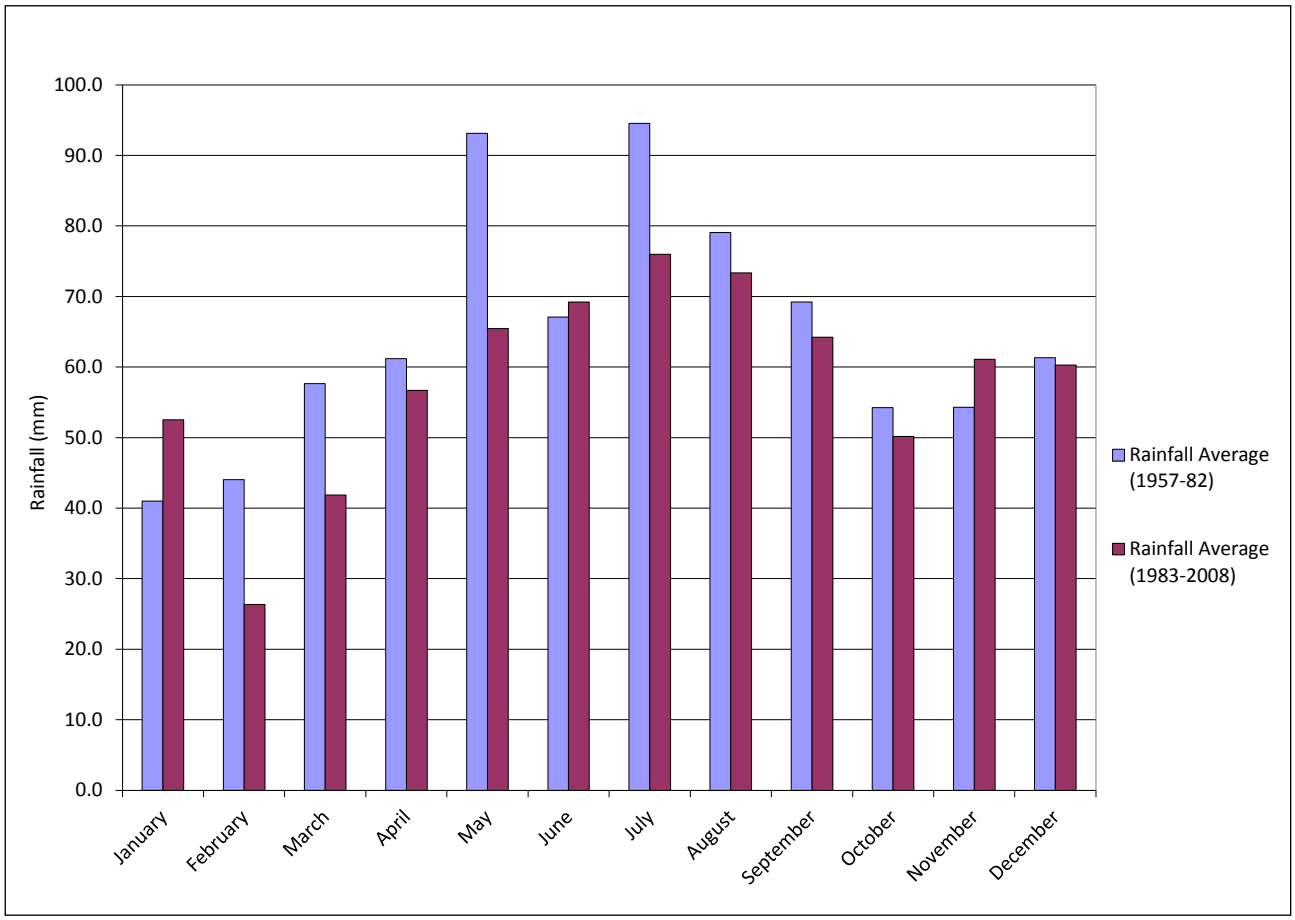


Figure 8. Monthly average rainfall data for the periods 1957-1982 and 1983-2008 (BoM 2009; Created by Elgin Associates 2009).

4.3.3. Temperature

July is the coldest month of the year, with mean temperatures ranging from 6 to 13 degrees Celsius. February is the warmest month, with mean temperatures ranging from 13.5 degrees Celsius to 22.4 degrees Celsius (Figure 9; Appendix B).

The reduction observed in rainfall in the 25 years since listing appears to be accompanied by increases in the mean monthly minima and maxima temperatures. Monthly minima temperatures for the later period (1983 – 2008) increased by between +0.1 degrees Celsius (April) and +0.6 degrees Celsius (January, May and July) for all months except March (-0.2 degrees Celsius) (Figure 9; Appendix B). Similarly, the average monthly maxima increased between 0.1 degrees Celsius (February, April and October) and 0.5 degrees Celsius (July) for all months except January (no change) (Figure 9; Appendix B).

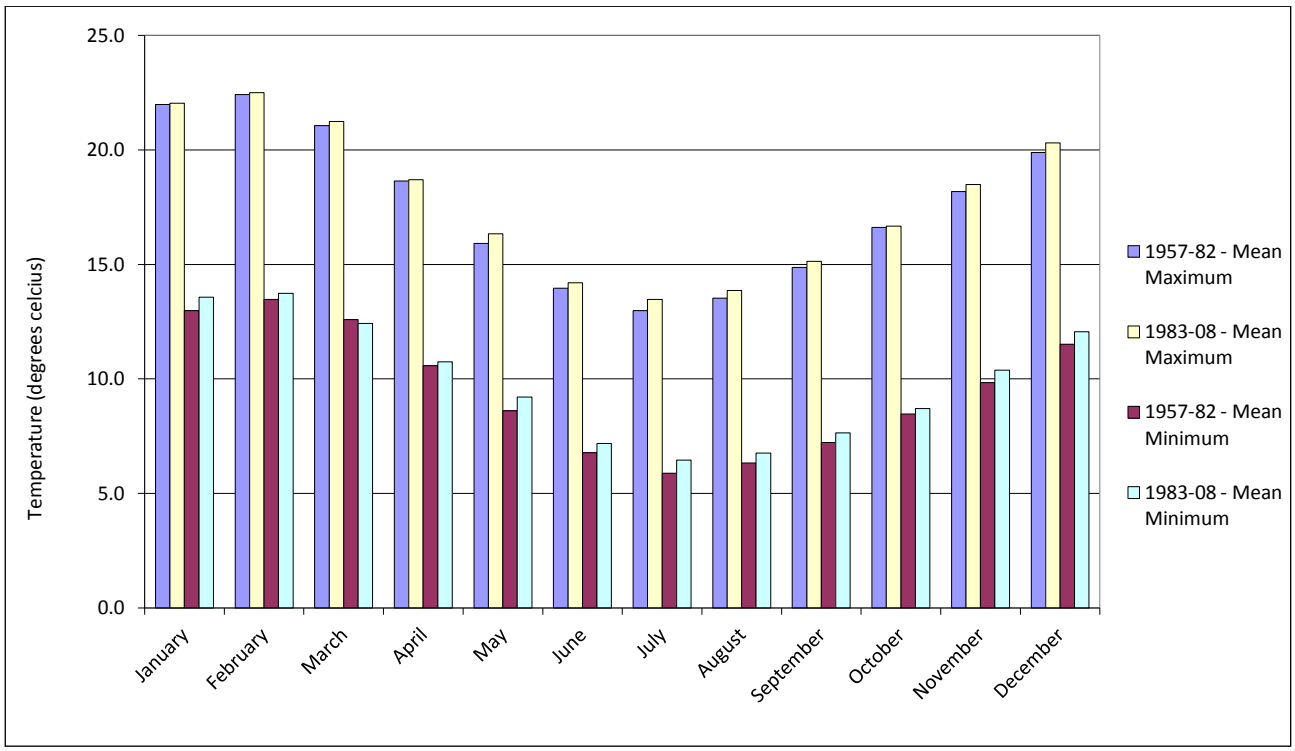


Figure 9. Mean monthly maxima and minima temperatures for the 25 year period leading up to Ramsar listing (1957-82) and subsequent 25 year period (1983-2008) (BoM 2009; Created by Elgin Associates 2009).

4.3.4. Wind

Flinders Island is located between latitudes' 39° 40'S and 40° 20'S, a region known as the "roaring forties" for its prevailing westerly winds. These winds persist throughout the year and have a strong influence on the level of cloudiness and rainfall over Flinders Island. Wind is most dominant from the westerly quadrant from autumn to spring, with east and north-easterly winds also common in the summer months (Figure 11).

Wind speeds are lowest in late Autumn/early Winter (May-July) and reach their maximum average velocity in late Spring/early Summer (October-December) (Figure 10).

Conditions are rarely calm, with only 7 percent of mornings (9 am) and 2 percent of afternoon (3 pm) observations being calm (Figure 11).

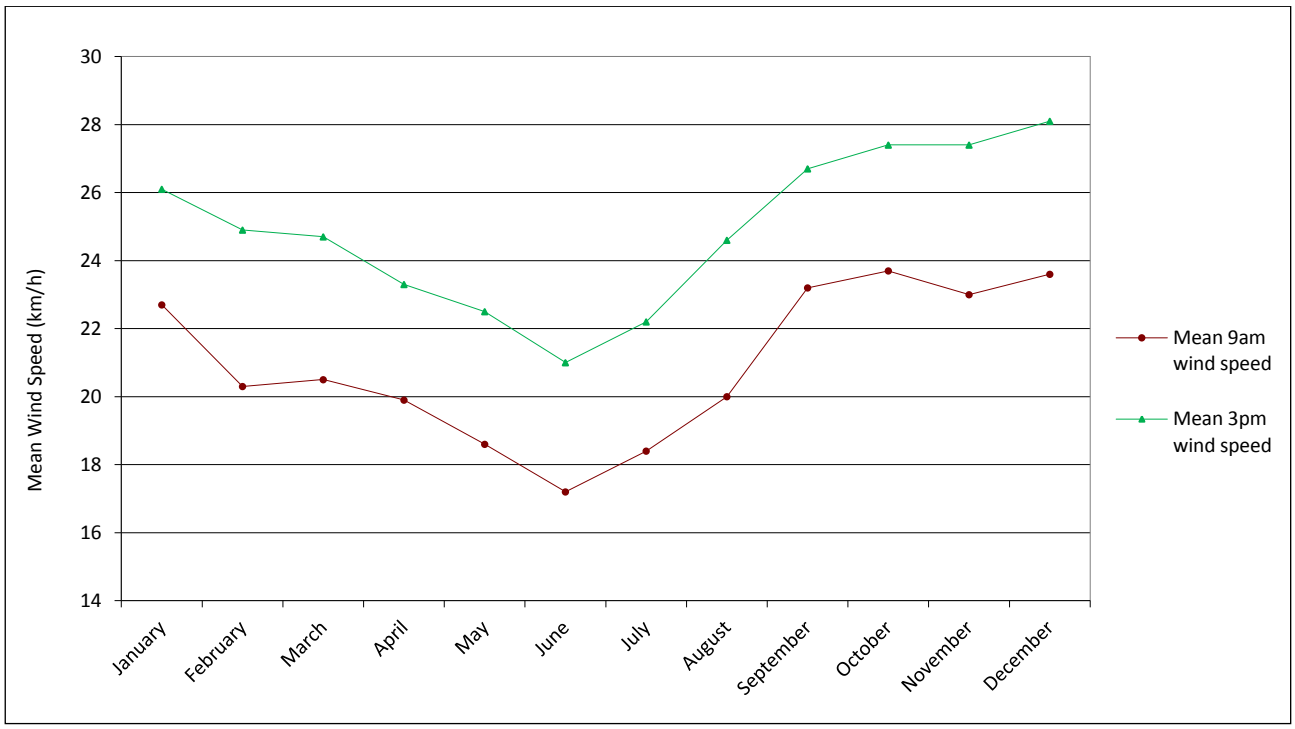


Figure 10. Mean wind speeds for 9 am and 3 pm at Flinders Island (1962-2006) (BoM 2009; Created by Elgin Associates 2009).

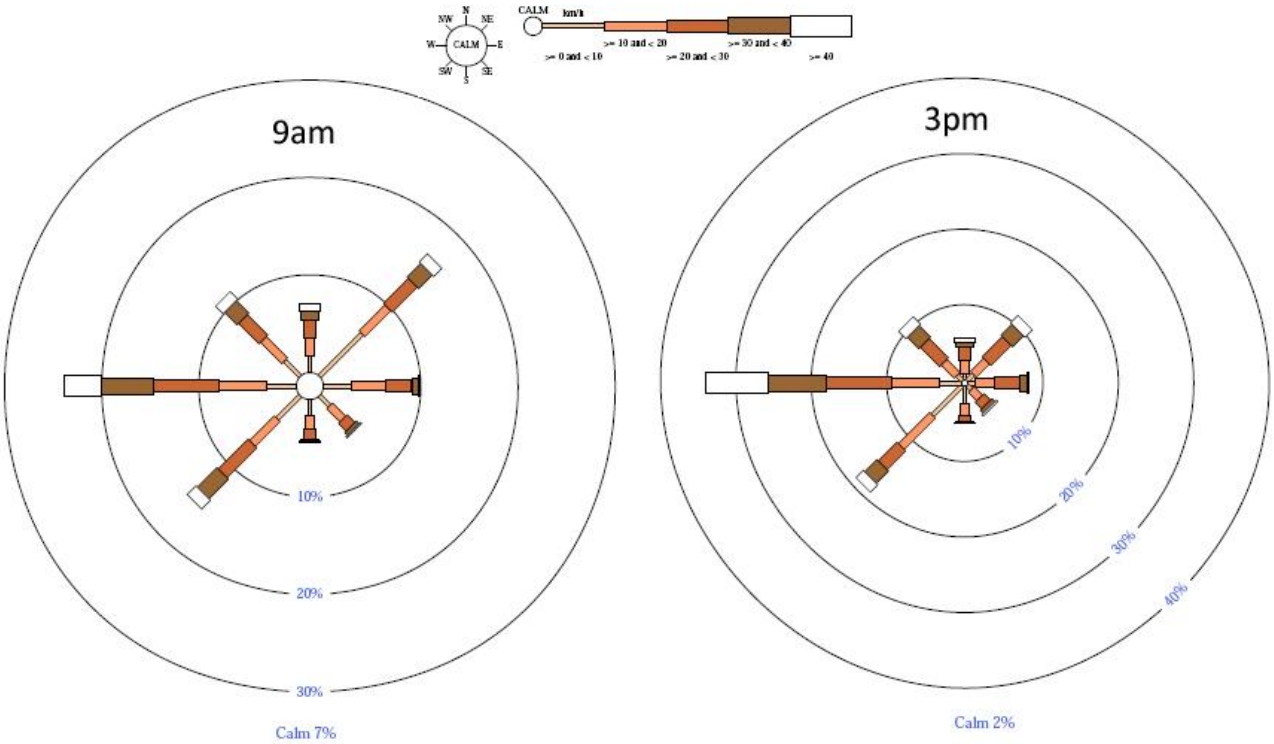


Figure 11. Wind direction and wind speed in kilometres per hour at Flinders Island Airport (01 Jan 1962 to 31 Dec 2006) for observations at (a) 9am (n=13880) and (b) 3pm (n=11885) (Copyright © Commonwealth of Australia 2007. Prepared on 29 Mar 2007).

4.3.5. Evaporation

Evaporation on Flinders Island is greatest between late spring and summer, when temperatures are higher and days are longer (Figure 12). There was little difference in evaporation between the 25 year periods (1957-1982 and 1983-2008). The persistent winds, elevated summer water temperatures and shallow waters at Logan Lagoon are likely to contribute to a higher evaporation rate than those estimated from the weather station.

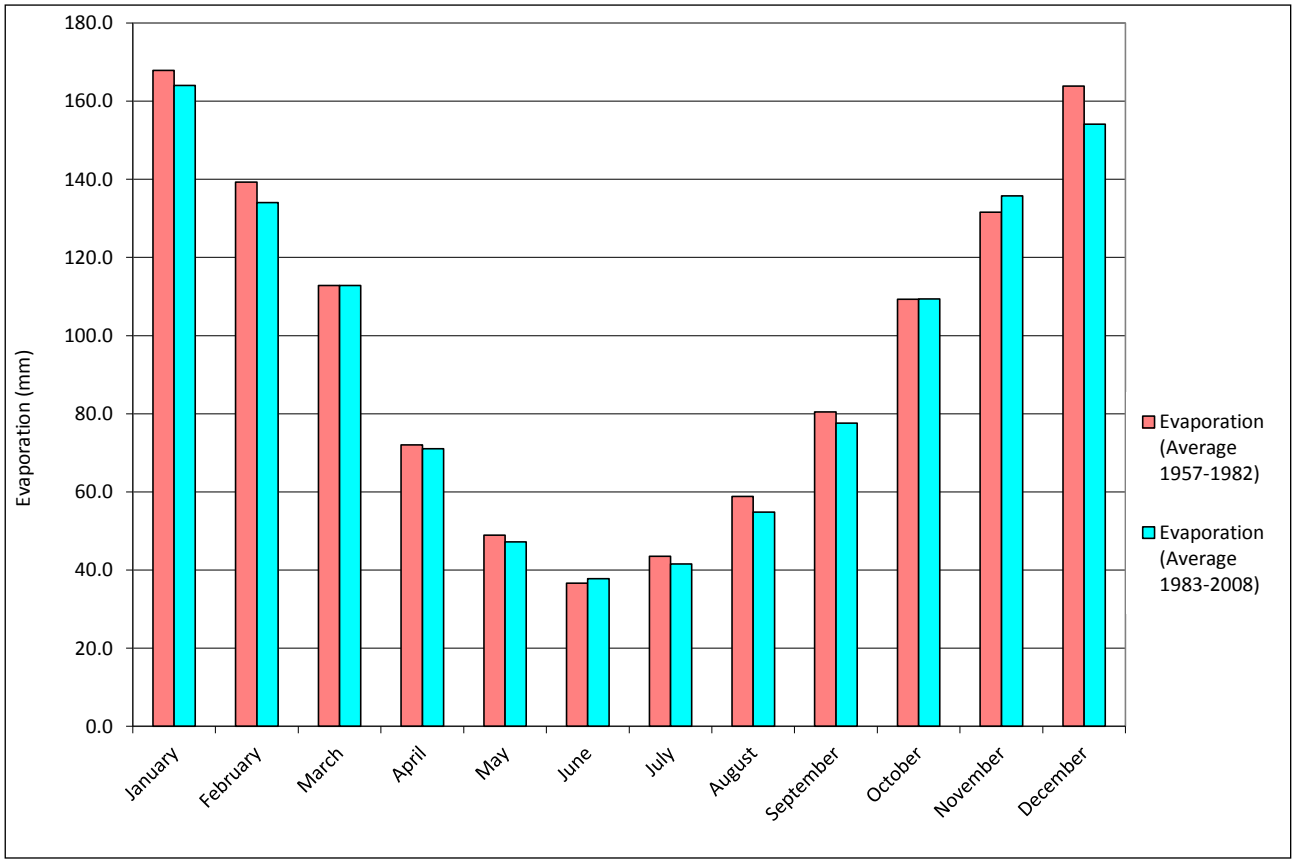


Figure 12. Average Monthly Evaporation at Flinders Island Airport for the periods 1957-1982 and 1983-2008 (BOM 2009; Created by Elgin Associates 2009).

4.4. Geomorphology

Logan Lagoon is located in a dune and coastal lagoon system which extends along the east coast of Flinders Island. Early development of the system occurred in the Pleistocene and was associated with extensive dune building, with the deposition of sediments on top of older Cainozoic sediments and Palaeozoic bedrock (Dixon 1996). The bedrock consists of Ordovician to Devonian turbidites intruded by Devonian granite, which are overlain by Tertiary marine limestone and minor basalt. The granite is likely the ultimate source of much of the siliceous component of the sands found at the site (J Bradbury, DPIPWE, *personal communication,* 17 Dec 2009).

The current lagoon system is Holocene in age and was formed as a result of the Late Quaternary marine transgression of 18,000 to 6,000 years ago, when water released from melting ice and snow resulted in a worldwide sea level rise. Before the transgression, sea levels were about 140 metres lower than they are today, with Bass Strait a coastal plain and watercourses extending across the plain to the lowered coastline (Bird 2000). This lowered coastline would have been located at the edge of the continental shelf some 50 kilometres to the east of Flinders Island.

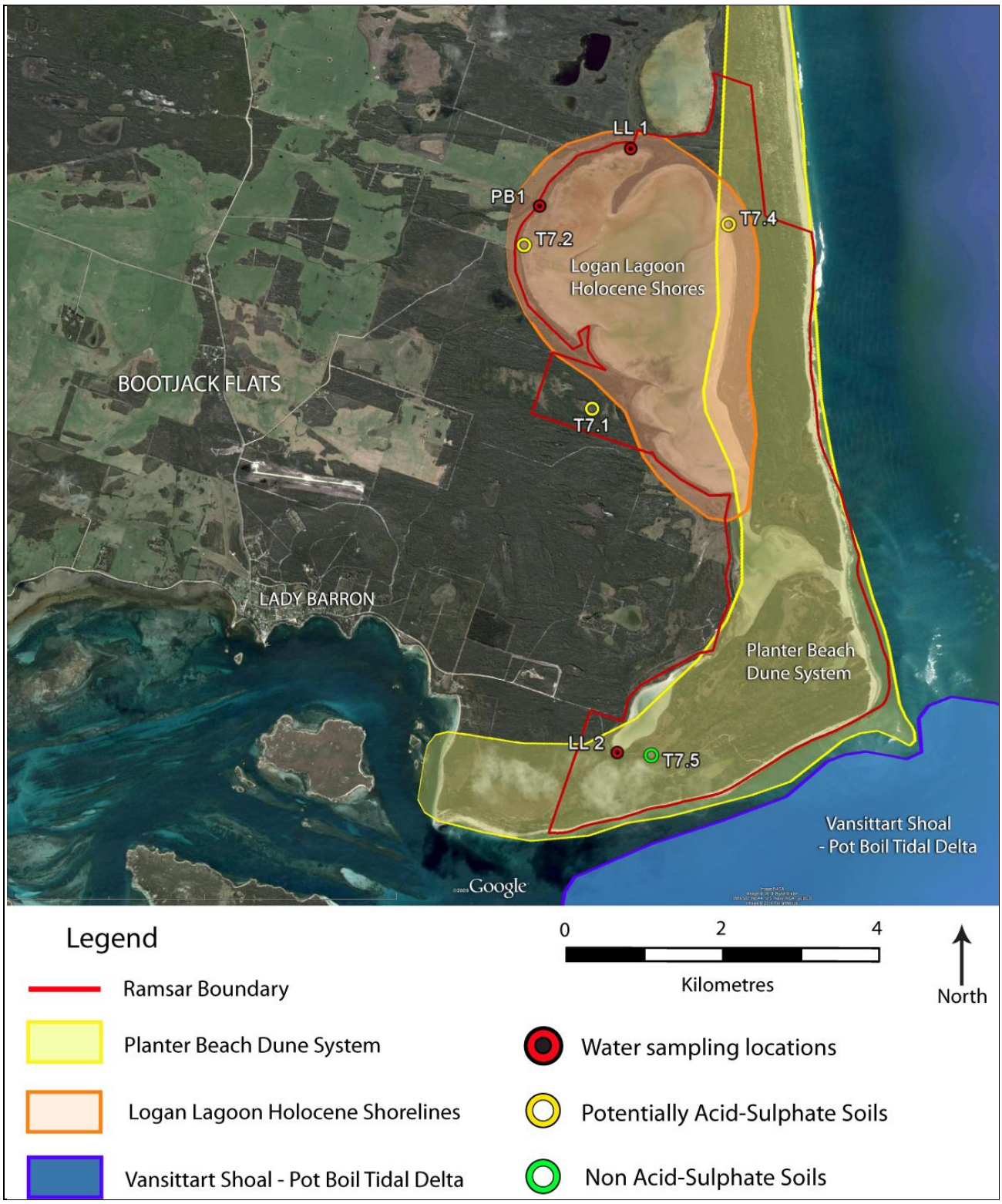


Figure 13. Tasmanian sites of geoconservation significance near Logan Lagoon Ramsar site (DPIPWE 2009b) and the sampling locations described in later sections (Water quality – Section 4.4; Soils – Section 4.5) (Created by Elgin Associates, June 2010).

Sea level rise during the transgression was rapid with an average rise of over a metre percentury, and resulted in shoreward deposition of sea-floor sediments. In southeast Australia, the conclusion of the transgression around 6,000 years ago was marked by higher sea levels before they receded slightly and then stabilized at approximately the present sea level (Bird 2000). Development of barriers to the sea ensued as bay mouth spits impeded drainage and enclosed a series of lagoons within the flooded

longitudinal dune system (Dixon 1996). Examples of the inland lagoon and barrier dune systems that were formed include Logan Lagoon and adjacent Planter Beach. These sites are recognised for their geoconservation significance as outstanding examples of Holocene landforms, listed on the Tasmanian Geoconservation Database (DPIPWE 2009b) as the Logan Lagoon Holocene Shorelines and Planter Beach Coastal Barrier System (Figure 13). An additional site, the Vansittart Shoal – Pot Boil Tidal Delta, is located in marine waters to the south of Logan Lagoon and is also recognised as a site of geoconservation significance in Tasmania.

The present Logan Lagoon system consists of a series of interconnected lagoons in a former embayment that covers an area of 9.7 square kilometres and a perimeter of 32.3 kilometres. The lagoons are shallow with depths of one to two metres, with the deeper sections located in the southernmost part of Logan Lagoon. The areas to the west, north and south of the site are areas of marshland, cleared land and other smaller lagoons. The Planter Beach barrier dune system (Figure 13) is adjacent to the east and consists of a series of parallel dunes with an approximate elevation of five to ten metres Australian Height Datum (AHD). Exchange of lagoon water with ocean waters has been via a channel in the southeast corner of the lagoon in an area of a partly terrestrialised washover (Figure 14) (J. Bradbury, DPIPWE, *personal communication,* 17 Dec 2009). The present entrance to the sea is only open on an infrequent basis and generally a sand bar extends from the lagoon to the beach. During periods when the bar is open, there can be an outflow of lagoon water or an inflow of seawater into the lagoon, with the extent of seawater exchange being dependent on factors such as lagoon water levels, tides, extent of bar erosion and storm activity.

Figure 14. The current ocean entrance of Logan Lagoon is via a channel in the southeast corner of the lagoon which passes through an area of a partly terrestrialised washover, with its inferred extent shown by the dotted red line. Arrows indicate two recurved spits on the western shoreline (Created by J. Bradbury, DPIPWE, December 2009).

Physical processes within the lagoon are apparent by landforms that include a series of recurved spits along the former western shoreline (Figure 14), and a linear island in the northwest corner. As barriers developed to enclose the lagoon, the effects of sea waves reduce as other processes dominate, including tidal currents,

fluvial inflow and winds blowing over the lagoon generating local waves and currents. These processes have displaced and moved sediments up and down the lagoon shoreline, resulting in the erosion of embayments and growth of landforms such as the spits and linear island observed at the site.

Sediments of fluvial origin are present in the lagoon, washed in from subcatchment watercourses such as Pot Boil Creek. Considering the extensive land clearing that has occurred in the subcatchment since European settlement, the rate of fluvial deposition of sediments into Logan Lagoon from land runoff is likely to have increased since this time. Lagoonal sediments originating mostly from the breakdown of organic matter in the lagoon would be expected to have a high organic content. Wind-borne deposition of sands into the lagoon from nearby beaches and dunes is likely; especially given the persistent winds that occur on the island (refer Section 4.3.4). Limited exchange of lagoon water during periods when the entrance is closed leads to long water residence times, which in turn prevents the transport of sediments out of the lagoon system.

The ongoing deposition of sediments to the coastal lagoon system over the past 6000 years has resulted in growth, or progradation, of the east coast of Flinders Island. Progradation is evident by the formation of the parallel dune systems and the nearby sand shoals from sea floor sand drift, east of Vansittart Island (Bird 2000) and deposition rates are faster than other parts of the sandy Tasmanian east coast (Parks and Wildlife Service 2007). The subsequent colonisation of newly formed dunes by terrestrial vegetation stabilises the dunes and prevents erosion. Consequently, maintaining vegetation health is important for dune stability.

4.4.1. General soil types

The soil types of Logan Lagoon, including the probability of occurrence of acid sulphate soils, have been characterised and mapped by the Land Conservation Branch of DPIPWE (Appendix C) as part of the Australian Soil Resource Information System (ASRIS) (CSIRO 2009). Soils at the site include:

- Hydrosols, as seasonally or permanently wet soils and subaqueous materials; and
- Sands, occurring in dunes or sandy plains at the site.

Hydrosols occur within the lagoon perimeter and are also dominant to the west, southwest and north of the lagoon. Sandy soil types are the dominant soil types to the east and south of the lagoon, as well as some areas to the west of the lagoon.

4.4.2. Acid Sulphate Soils

Acid sulphate soils are naturally occurring soils or sediments that contain mineral sulphides which can undergo oxidation to generate sulphuric acid. Acid sulphate soils can be potential, actual or post-active and can occur in coastal, estuarine or swamp environments where mineral sulphides form in waterlogged, reducing conditions. Oxidation and acid generation generally results from exposure to air through mechanisms such as soil disturbance or water drainage (Qld EPA 2009).

A reconnaissance survey by the Geological Survey of Tasmania in 2001 (Mineral Resources Tasmania 2001) identified the potential for acid sulphate soils on the east coast of Flinders Island where Holocene sediments are most extensive. Back swamps and remnant coastal lagoons were identified as ideal environments for the formation of potential acid sulphate soils (PASS).

The potential for acid sulphate soils at the site and surrounding areas has been mapped by DPIPWE in 2009 for inclusion in the Australian Soil Resource Information System (ASRIS). The majority of Logan Lagoon has a low probability (6-70 percent chance) or extremely low probability (1-5 percent chance) of PASS, however, there are some small localised areas with a high probability (>70 percent chance) across the site.

In 2009, the Land Conservation Branch of DPIPWE conducted soil sampling at Logan Lagoon and surrounding areas to obtain analytical data (Moreton *et al.* 2009) on PASS. The sampling included soil boring to depths of up to 1.18 metres at five locations, identified as T7.1 to T7.5. Sampling locations were on or adjacent to Logan Lagoon shorelines on the western (T7.1, T7.2), southern (T7.5) and eastern (T7.3) sides. Location T7.4 was from the northern shoreline of South Chain Lagoon to the north of Logan Lagoon (Table 11; Figure 13).

Table 11. Tasmanian Acid Sulphate Soils Information (TASSI) Project – Site Summary. Risk Categories are based upon depth of AASS/PASS material from surface where the shallower the depth, the greater the likelihood of disturbance/impacts.

Site	Non-Acid Sulphate Soil (NASS)	Potential Acid Sulphate Soil (PASS)	Actual Acid Sulphate Soil (AASS)	Very High Risk PASS or AASS 0 - 0.5m	High Risk PASS or AASS 0.5 - 1m	Moderate Risk PASS or AASS 1 - 1.5m	Low Risk PASS or AASS 1.5 - 2m	Cumulative depth of Acid Sulphate Horizons (cm)	ANC exceeding acidity produced from Sulphate
T7.1		**X**			**X**			26	
T7.2		**X**			**X**			23	**X**
T7.3		**X**		**X**				94	**X**
T7.4		**X**			**X**			90	**X**
T7.5	**X**								

(Note - Acid neutralising capacity (ANC) applies to a single core sample from each site and should not be seen as indicative of ANC in areas adjacent to site).

The results of soil sampling by DPIPWE (Moreton *et al.* 2009) identified PASS at four of the five locations (T7.1-7.4), with non-acid sulphate soils (NASS) identified at location T7.5. Actual acid sulphate soils (AASS) were not identified in soil samples collected from the site. The PASS at location T7.3 were classified as 'very high risk' due to their occurrence in shallow soils from 0-0.5 metres depth where there is a greater likelihood of disturbance or impacts. PASS at the other locations (T7.1, T7.1 and T7.4) occurred in the 0.5-1.0 metres depth interval and were therefore classified as 'high risk' by DPIPWE (Moreton *et al.* 2009).

4.5. Hydrology

Logan Lagoon Ramsar site is located in the Logan Lagoon subcatchment, which comprises an area of 75 square kilometres (Parks and Wildlife Service 2007) in the southeast of Flinders Island. The subcatchment beyond the boundary of the Ramsar site is undulating and includes a number of watercourses (mostly man-made drains) that extend several kilometres to the west of the lagoon (Figure 5). A number of these watercourses are tributaries of Pot Boil Creek, which is the only natural watercourse that enters Logan Lagoon (Parks and Wildlife Service 2007). Land use in the subcatchment is mostly cleared land for grazing agricultural purposes (Figure 4). There is potential for runoff of sediments, fertilisers and other toxicants into the lagoon via the subcatchment watercourses (Parks and Wildlife Service 2007). These inputs are a threat to the ecological character of the lagoon (see Section 8.6).

The lagoon has a perimeter of 32.3 kilometres with an area of 9.7 square kilometres (Edgar *et al.* 1999), or approximately 14 percent of the sub-catchment, and is shallow with depths of generally one to two metres (Parks and Wildlife Service 2007). The lagoon is isolated from the sea by a sand bar that is open on an infrequent basis (Parks and Wildlife Service 2007). Water levels in the lagoon are influenced by several seasonal factors including direct rainfall recharge, surface water inflows, evaporation and interaction with groundwater and adjacent marine waters. Major outflows include evaporation, seepage to groundwater during periods of lowered water table and discharge to sea via the lagoon entrance during periods of opening.

Figure 15. A photograph of Pot Boil Creek at its discharge point to the northern shoreline of Logan Lagoon, illustrating high water flows in the creek observed in July 2009 (Photograph: Luke Finley, Elgin Associates, July 2009).

The highest rates of surface water recharge are anticipated during winter and spring when direct rainfall recharge, groundwater discharge and freshwater inflows from Pot Boil Creek (Figure 15) are at a maximum, resulting in increased water levels in the lagoon (Figure 16). In the drier summer and autumn months, with less rainfall and higher rates of evaporation, the lateral extent and volume of water in the lagoon decreases. Inflows from Pot Boil Creek can be nil during dry periods, with anecdotal accounts indicating that the creek is intermittent and often dries out for extended periods (D Bailey, adjacent landowner, *personal communication*, July 2009).

Evaporation during summer is a significant outflow of water from the lagoon, with persistent winds, warm temperatures and long periods of daylight contributing to high evaporation rates. During extended dry weather, the lagoon dries out and water is restricted to the deeper sections of the lagoon, or it may dry out completely for periods of several years at a time (Edgar *et al*. 1999). Extended dry periods are known from 1995-1996, 1997 (Edgar *et al.* 1999) and 1998-2000, where water was contained only in the southernmost section of the lagoon (Parks and Wildlife Service 2007).

The uppermost aquifer beneath the lagoon and its sub-catchment is unconfined and occurs in the quaternary sediments (REM and Aquaterra 2008), with a groundwater flow system that is likely to be similar to that described by DPIPWE (Lynch 2007) for lagoon systems north of Cameron's Inlet. Regional groundwater flow in this part of Flinders Island is inferred to be radial outwards towards the coast with a general west to east flow anticipated beneath Logan Lagoon, and eventual discharge to seawater in the beach zone (REM and Aquaterra 2008). The water table occurs very close to the soil surface (Parks and Wildlife Service 2007) and fluctuates according to seasonal variation. Thus in winter (coinciding with high rainfall), the water table occurs very close to the ground surface and only recedes to one to two metres below ground surface during summer (Lynch 2007). During periods of an elevated water table, groundwater discharge to the lagoon surface waters occurs resulting in a net inflow of water into the lagoon. Conversely, during periods of a lowered water table (such as during summer), there is potential for a net loss via vertical migration of lagoon surface waters to the underlying groundwater, with subsequent discharge to sea in the beach zone.

Figure 16. An aerial photograph of the northern end of Logan Lagoon, illustrating the entry of Pot Boil Creek into the lagoon, Pot Boil Road, and the adjacent farmland - July 2009 (Photograph: Luke Finley, Elgin Associates, July 2009).

Inflows of seawater and outflow of lagoon water may also occur during the infrequent periods when the lagoon entrance is open to the sea, and depends on factors that include lagoon water levels, tides, extent of bar erosion and storm activity. Breaching of the lagoon entrance can result in rapid outflow of lagoon water and/or an influx of seawater into the lagoon, with a net inflow or outflow of water via the lagoon entrance dependent on the above factors. Natural breaching of the entrance is more likely during wet periods (such as winter/spring) due to overflow from elevated water levels (Parks and Wildlife Service 2007). Easterly storms, which are more common in summer, can also result in breaching of the lagoon entrance (Parks and Wildlife Service 2007). Available information indicates that the lagoon mouth was open naturally for much of 1998, 1999 and 2000 (Parks and Wildlife Service 2007).

There is a history of man-made breaches of the lagoon by local landholders attempting to reduce inundation of nearby agricultural land by lowering the water level in the lagoon (Parks and Wildlife Service 2007). Records also indicate that artificial breaching of the lagoon mouth occurred on a regular basis in the 50 years prior to 1987 (Municipality of Flinders 1987).

4.6. Surface Water Quality

Surface water quality in Logan Lagoon is influenced by seasonal factors that affect water levels in the lagoon, including: rainfall recharge; inflows from Pot Boil Creek and its tributaries; evaporation; interaction with groundwater; and adjacent marine waters. Information on the water quality of the site is discussed for two hydrological features: water in Logan Lagoon in 1982 and 2009 (Section 4.6.1); and water flowing from Pot Boil Creek in 2009 (Section 4.6.2).

During winter and spring periods when rainfall and freshwater inflows are at their highest, mixing and dilution of lagoon waters is expected to result in decreased lagoon water salinities. Higher levels of runoff are also anticipated into sub-catchment watercourses during these periods, resulting in greater potential

for sediments, nutrients and contaminants to enter Logan Lagoon. In the drier summer and autumn months - with less rainfall, higher rates of evaporation and a decrease in the extent of the lagoon waters - salinity is expected to increase through concentration.

Groundwater discharge to the lagoon is likely when the water table is above or close to the lagoon surface. Available groundwater data for lagoon systems to the north of Camerons Inlet (REM and Aquaterra 2008) indicates that groundwater electrical conductivity in the uppermost aquifer beneath Logan Lagoon is likely to range from 1500 - 4500 µS/cm (approximate Total Dissolved Solids of 1000 - 2900 mg/L), which is slightly brackish.

Flinders Island receives large quantities of salt loading from rainwater and seaspray. Data collected by a CSIRO scientist in the Darling Range to the west of the lagoon, estimated that approximately 175 kilograms per hectare per year were contributed (Edgecombe 2007). This amount of salt is likely to influence water quality in the lagoon by raising the salinity level.

Salinity levels in the lagoon change when the lagoon entrance is open to the sea, resulting in tidal flushing of outgoing lagoon water and/or influx of seawater. The lagoon entrance is located in the southeast corner of the lagoon and when the entrance is open the lower reaches will be highly saline, whereas in the upper reaches, freshwater inputs from Pot Boil Creek may cause brackish conditions.

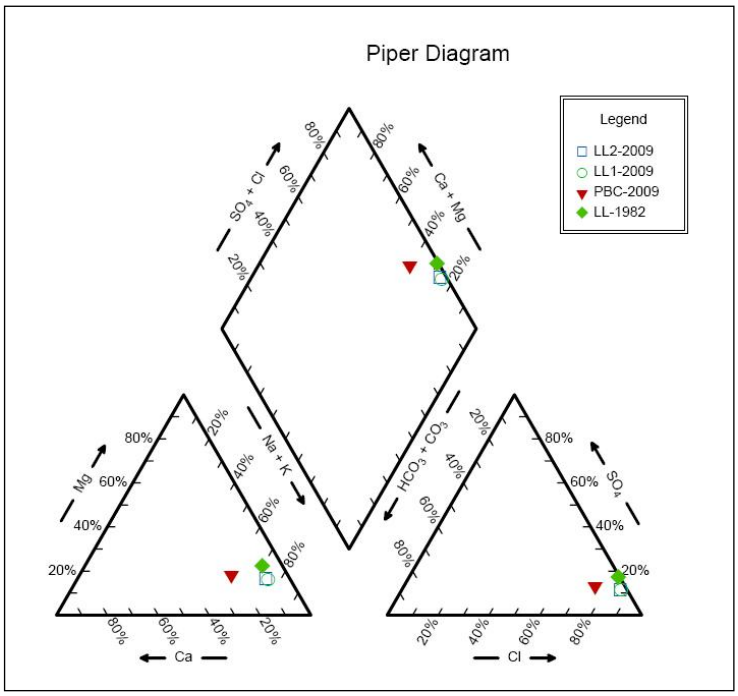


Figure 17. Piper plot showing major ion composition of water samples collected from Logan Lagoon in 1982 and 2009, and from Pot Boil Creek in 2009 (Created by Elgin Associates 2009).

Water quality data from the lagoon waters was available for two sampling events: in 1982 by Bowling and Tyler (1984), and in 2009 by Elgin Associates (Appendix D; Table D2). These samples represent a snapshot of the water quality at the time of listing, and the second at the time of preparation of this ECD. The analysis at these two sampling events had several parameters in common, including: pH, total dissolved solids/salinity, turbidity, major cations and anions, and nutrients (Appendix D).

The water samples collected from Logan Lagoon were dominated by sodium and chloride ions between 1982 and 2009, illustrated in a Piper plot (Figure 17) which compares the ion composition of the water. The Piper plot shows that the composition of lagoon water samples were almost identical. The ion composition of Pot Boil Creek was also dominated by sodium chloride-type water, although the creek water has higher

proportions of other major ions, such as carbonate and calcium than the lagoon samples. The similarities in major ion composition between Pot Boil Creek and Logan Lagoon, and other parameters (pH, turbidity, nutrients), suggests that creek waters are influential on water chemistry in the lagoon.

4.6.1. Logan Lagoon Water Quality at Time of Ramsar Listing (1982)

The water in Logan Lagoon at time of listing (1982) was similar in salinity to seawater and was dominated by sodium and chloride ions (Appendix D; Table D1). This likely reflects the marine setting of the lagoon and either a concentration of salts by high rates of evaporation during dry weather, or an influx of seawater into the lagoon. Other factors for elevated salinity include the dissolution of salts from lagoon surficial geology (also indicated by the presence of silicates), salts in discharging groundwater and deposition of salts from seaspray from adjacent marine waters. The water exhibited neutral pH conditions.

Turbidity measures the attenuation of light in the water column, or how 'clear' the water is. The level was 'low' when considered against draft indicator level for Tasmanian estuaries, indicating relatively clear water. Phosphorus data indicated that it may be acting as a stressor nutrient on the system, and there is potential for nutrient enrichment of lagoon waters and eutrophic conditions.

4.6.2. Logan Lagoon Water Quality at Time of this ECD (2009)

The August 2009 sample (Appendix D; Table D2) provides a snapshot of the lagoon water quality in winter, when rainfall and freshwater inflow are at their highest, and evaporation lowest. The lagoon waters were brackish, with total dissolved solids (TDS) much lower than the 1982 results, particularly close to Pot Boil Creek, probably reflecting a high level of freshwater runoff from the catchment. Major cations and anions were dominated by sodium and chloride with a near neutral pH. Turbidity ranged from 'low' to 'medium', indicating an increase in suspended particulates from runoff, probably due to the high rainfall in the month prior to sampling.

Nitrogen was detected in lagoon waters as organic nitrogen, and may be attributed to the high level of organic matter that typically occurs in wetland environments (Chapman 1996). Ammonia was detected at LL2 at levels typical for surface waters (Chapman 1996) and may reflect breakdown of organic matter in this part of the lagoon (Appendix D; Table D2). Concentrations of nitrogen oxides, or NOx (nitrate and nitrite) were 'low' when considered against draft indicator level for Tasmanian estuaries. Similar to the 1982 results, the total phosphorus concentrations were 'very high', indicating nutrient enrichment of lagoon waters and the potential for eutrophic conditions. There was no evidence of Organochlorine or Organophosphorus pesticides in the lagoon water samples.

4.6.3. Surface Water Inflow Quality – Pot Boil Creek 2009

The sub-catchment contains a number of creeks and drains which discharge into Logan Lagoon via Pot Boil Creek. To test the water discharging into the lagoon from the sub-catchment, two water samples (one each in July and August 2009) were collected from Pot Boil Creek, just upstream of its discharge into the lagoon (Appendix D; Table D3).

The water inflow into the lagoon from Pot Boil Creek was brackish in July 2009 but was fresher by a factor of four in August 2009, indicating the dilution effect from high rainfall between the sampling events. Salts in the creek water were dominated by sodium and chloride ions, with a near-neutral pH. The turbidity level was 'medium' in July and 'high' in August, indicating an increase in suspended load from runoff due to winter rainfall at the time of the sampling events (Appendix D; Table D3). Nitrogen was present mainly in the organic form, with a minor nitrate component in the July sampling event (Appendix D; Table D3). The 'very high' total phosphorus and reactive phosphorus concentration in July indicated that reactive

phosphorus, more readily available for uptake, comprises a significant proportion (40%) of total phosphorus in creek waters discharging to the lagoon.

4.7. Vegetation

4.7.1. General description

Logan Lagoon Ramsar site and the Flinders Island east coast plain have good examples of native coastal vegetation, including communities of wetland-dependent species, and also remnant patches of pre-European forest and scrub vegetation. Most of the site is in relatively natural condition except for some cleared and drained agricultural land on the western shore. A total of 342 plant taxa have been recorded in the general vicinity of Logan Lagoon Conservation Area. Of these, 102 were recorded within the boundary of the site (Appendix E; Table E1) and seven are threatened plant species (see Section 4.9).

On the eastern side of the lagoon there is dense coastal shrubbery of coast wattle (*Acacia longifolia)* and coast tea tree (*Leptospermum laevigatum)* interspersed with patches of wetland dependent grassland and herbland. North of Logan Lagoon there is forest and scrub which experiences a higher fire frequency than the vegetation on the leeward side - the prevailing wind direction is from the west and north-west. The lagoons act as a fire break protecting the vegetation to the east from fire. This vegetation is dominated by Western peppermint (*Eucalyptus nitida)*, coast tea tree *(L. laevigatum)*, silver banksia (*Banksia marginata)* and Oyster Bay pine (*Callitris rhomboidea)*. Although not strictly wetland-dependent, these remnant communities are of conservation significance (Harris 1989) and three successive fires, with intervals of less than eight years, will cause local extinction of the Oyster Bay pine (*C. rhomboidea)* in this area (Parks and Wildlife Service 2007).

On the windward side of Logan Lagoon, and in the southern part of the conservation area, Western peppermint (*E. nitida)* and *Allocasuarina spp.* scrub is dominant with a heath understorey, which in many places has been converted to a predominantly bracken understorey by the high fire frequency (Section 8.1; Figure 23). Some white gum (*Eucalyptus viminalis)* occurs on the dune ridges (Parks and Wildlife Service 2007).

In poorly drained swales and along drainage channels, coast paperbark (*Melaleuca ericifolia)* thickets occur. The lagoon is fringed with *Juncus* reed beds (Saline sedgeland and rushland) and there are pockets of coast speargrass (Austrostipa *stipoides)* grassland and coastal tussockgrass (*Poa poiformis)* grassland. Samphire (*Sarcocornia quinqueflora)* is scattered on the fringes of the lagoon on the flats which are subject to periodic inundation. These are recognised as 'succulent saline herbfield' community, TASVEG Code ASS, although the TASVEG mapping layers do not match observations of Samphire around the edge of Logan Lagoon made in July 2009. These communities are generally at the water edge and therefore subject to the most disturbance due to water level fluctuations. Extended periods of inundation, or prolonged exposure to arid conditions, will prevent the persistence of these communities.

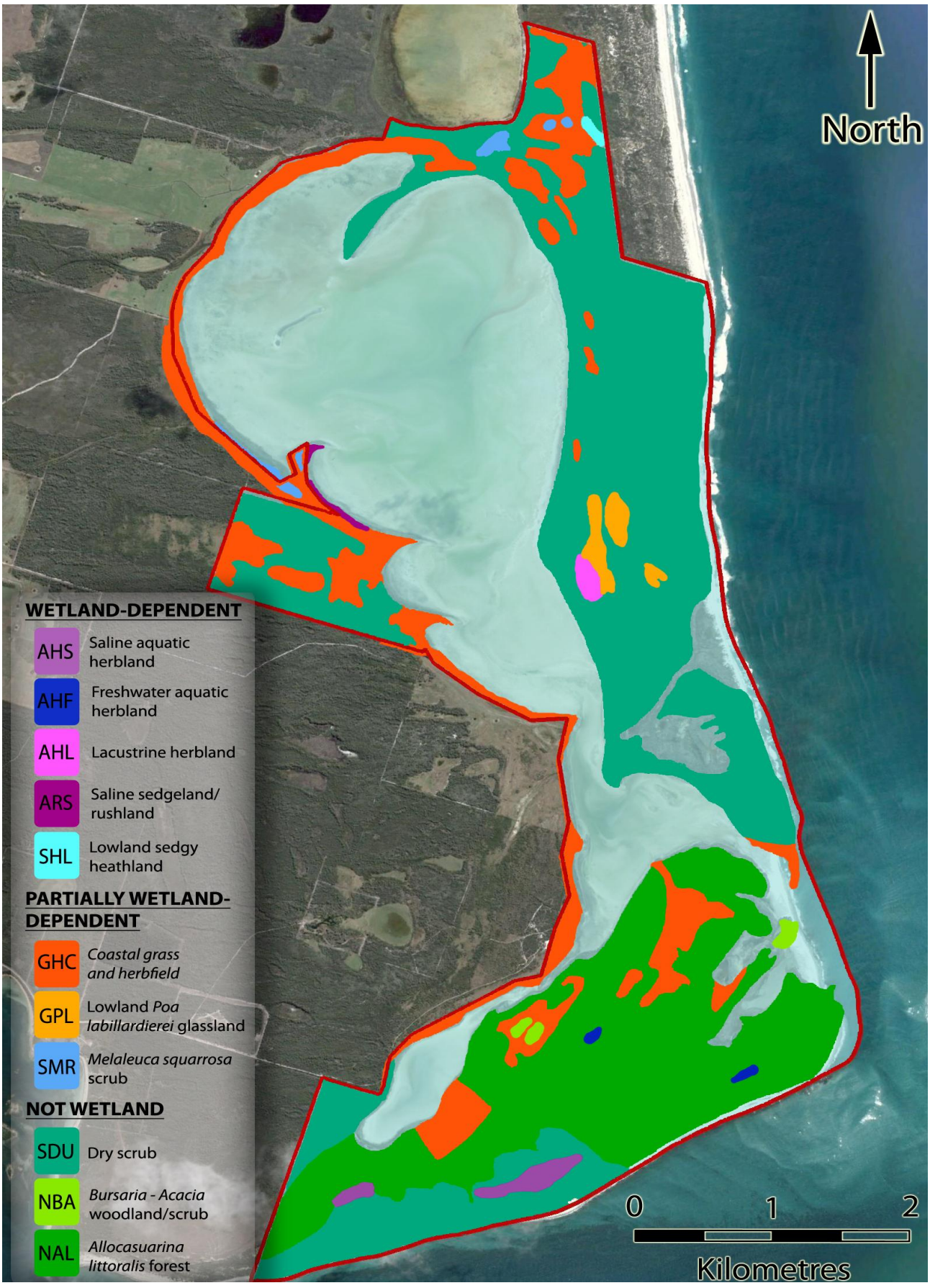


Figure 18. Spatial distribution of vegetation community types at Logan Lagoon Ramsar wetland site showing vegetation communities data based on TASVEG 2.0 classification (TASVEG 2009) and exported from LISTmap 1.2 (DPIPWE 2009d). See also Figure 19 for an indicative map of Ramsar wetland types (Created by Elgin Associates 2010).

4.7.2. Vegetation Communities

Based on TASVEG mapping, the site supports at least twelve vegetation communities (Figure 18), including four wetland community types, two types of grassland, three types of scrub/heathland and three forest/woodland communities. Of these twelve communities, five are considered wetland-dependent, three are partially wetland-dependent, two are 'other' wetland types; and three are not wetland communities (M Visoiu, DPIPWE, *personal communication*, 3 June 2010).

A comparison of the TASVEG 2.0 communities with the Ramsar wetland types identified an additional five wetland types that had not been identified previously (Table 12). An indicative distribution of the eight Ramsar wetland types is shown in Figure 19. The wetland-dependent vegetation, although only comprising a relatively small area of the site, contains communities that are threatened and poorly reserved in Tasmania.

The remaining areas contain non-wetland-dependent vegetation comprised of scrub and heathland (TASVEG Codes: SMR, SDU and SHL), forest or woodland (TASVEG Codes: NBA, NAL, and NCR) communities, (Figure 18), some of which are of conservation significance and contribute to the selection of Criterion 1 in Section 3.4.2. The wetland types for sand (OSM) and water (OAG) are well represented throughout the site, although sand does not map at the site using the TASVEG data layers (Figure 18) (note: the distribution of sand in Figure 19 was inferred from photographs taken during a visit to the site).

4.8. Wetland-dependent vegetation

The term '*wetland-dependent*' refers to plants or animals that are adapted to, and dependent on, living in wet conditions for at least part of their life cycle. There are four threatened wetland-dependent terrestrial species recorded within the Logan Lagoon Ramsar site boundary, including:

- Swamp fireweed (*Senecio psilocarpus*): as Vulnerable under the EPBC Act and rare under the TSP Act; observed within the Logan Lagoon Ramsar boundary;
- Large-fruit seatassel (*Ruppia megacarpa*): listed as rare under the TSP Act; observed within the Logan Lagoon Ramsar boundary;
- Prickly arrowgrass (*Triglochin mucronatum*): listed as endangered under the TSP Act; observed within the Logan Lagoon Ramsar boundary;
- Northern leek-orchid (*Prasophyllum secutum):* listed as endangered under both the EPBC Act and the TSP Act; subject to recovery plan (TSS 2006a); observed within the Logan Lagoon Ramsar boundary.

Swamp fireweed is known from six locations in Tasmania; including one observation from Pot Boil Point in the Logan Lagoon Ramsar site (Wapstra, 2010). There is limited information on the distribution of this species in Tasmania. Populations are characteristically small and diffuse, and therefore often overlooked. Identification of this species at the site would require seasonally specific surveying.

Large-fruit seatassel grows in brackish to hypersaline coastal lagoons, estuaries and inland lakes in Tasmania (TSS 2003a). This plant has been collected at Logan Lagoon by a fire trail off Logan Lagoon Road in 1977. Identification of this cryptic species at the site would require targeted surveying.

The prickly arrowgrass is listed as known from Vansittart Island and Flinders Island. This species is quite inconspicuous, and grows in herbfields on damp saline soils of salt-flats and coastal saltmarshes (TSS 2009). This plant has been recorded near the mouth of Cameron's Inlet (the Ramsar boundary) and with targeted seasonally specific surveying is likely to be found in other areas of the site.

The Northern leek-orchid is endemic to Tasmania where it is uncommon and localised along the north coast of the state, on the west coast at Ocean Beach and on Flinders Island (TSS 2008a). The area of South Logan Lagoon represents an important location for the species as it is one of the few locations where it is known to exist, protected by reservation status. The orchid is dependent on fire to trigger emergence and good flowering. It was last observed at Logan Lagoon in 1992 where it was recorded among Dry scrub (SDU) vegetation community. This species is currently subject to a recovery plan (TSS 2006a). Identification of this cryptic species at the site would require targeted seasonally specific surveying.

Approximately 940 Hectares of the Logan Lagoon Ramsar site is mapped as estuarine water, making the lagoon the most dominant feature. The low-lying areas surrounding the lagoon, much of which is inundated periodically, comprise a range of wetland-dependent vegetation types. Although restricted to a few small areas within the site (Figure 18 and Figure 19), the wetland types described here are of conservation significance to Tasmania, and justify the selection of Criterion 2 (Section 3.4.2).

The categorisation of vegetation communities is largely determined by their position along a hydrological gradient. For example, the vegetation community Lowland *Poa labillardierei* grassland (TASVEG Code GPL) is usually considered a terrestrial community and therefore not wetland-dependent. However, around Logan Lagoon it is defined as a partially wetland-dependent species because it is found in areas of the lagoon that are intermittently inundated. The intermittent inundation allows a more diverse range of species to persist, such that:

- Terrestrial species persist because they are able to tolerate inundation for limited periods, but permanent inundation will kill them; or
- Partially wetland-dependent species persist because they are periodically inundated, but persistent arid conditions will kill them.

The Ramsar Type *Ss* wetlands are characterised by 'Seasonal/intermittent saline/brackish/alkaline marshes/pools'. This wetland type is equivalent with the TASVEG community 'Saline aquatic herblands' (AHS) which is listed as threatened under the NC Act (Table 12). These communities occur in areas of permanent or semi-permanent brackish to hyper-saline water that is commonly found in small pools in saltmarshes and along the edges of estuaries. Saline aquatic wetlands are typically the most species poor of all wetland community types with one or two and rarely more than five species in this community. Species such as Lake water milfoil (*Myriophyllum salsugineum)* may occur sparsely with *Lepilaena sp.* and *Ruppia spp*. When the wetland dries out for extended periods the aquatic species are reduced to vegetative tubers that survive in the wetland soil. Some taxa can persist for many years in the absence of water, such as *Myriophyllum spp.* (Harris and Kitchener 2005). At Logan Lagoon, Ss wetland is mapped in two patches in the south west corner of the Ramsar site and in a small area along the west edge of the lagoon (Figure 19).

The *Ss* wetland type is recognised because Half Way Lagoon and Wilsons Lagoon in the far south of the site meet this description. The listing of Type *Ss* wetlands is encouraged by the Ramsar Convention to secure the sustainable use of temporary pools, and to identify and designate temporary pools as Ramsar sites. It has been recognised that temporary ponds are often undervalued as wetlands because of their generally small size and seasonal or ephemeral nature, yet such wetlands can be of critical importance for the maintenance of biodiversity, particularly in ephemeral wetlands.

The Ramsar Type *Tp* (permanent freshwater wetlands) is equivalent to TASVEG community 'Freshwater aquatic herbland' (AHF) which is listed as threatened in Tasmania (NC Act) (Table 12). Freshwater aquatic herbland (AHF) is mapped in two very small patches west of Pot Boil Point (Figure 18). Freshwater aquatic herbland is characterised by the presence of standing permanent or semi-permanent freshwater that

supports aquatic and/or emergent herbaceous vegetation and can occur in water from a few centimetres to several metres in depth (Harris and Kitchener 2005).

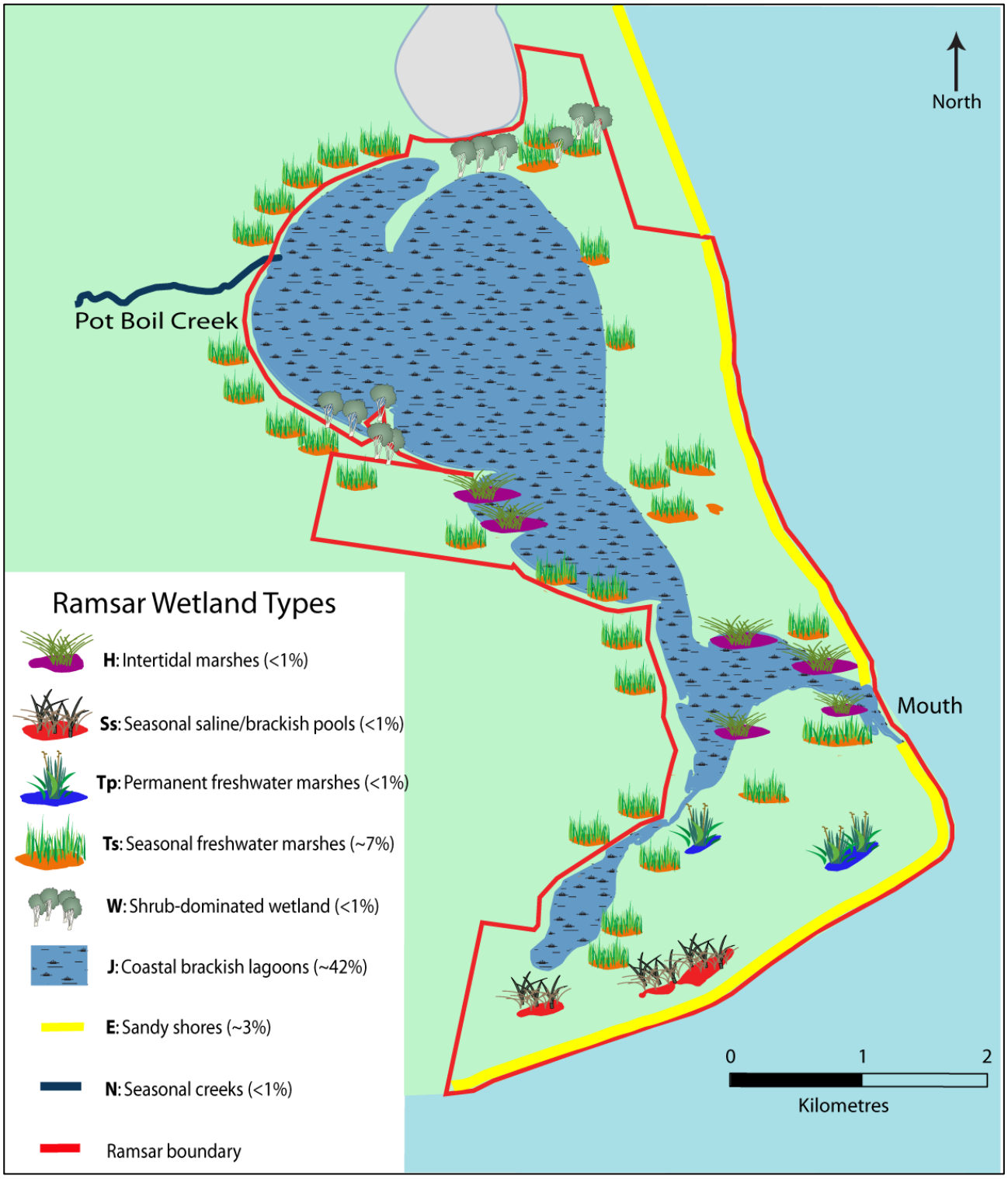


Figure 19. Estimated distribution of Ramsar wetland types across the Logan Lagoon Ramsar site. Additional detail on the mapping of wetland types is provided in Section 4.7 and a map derived from TASVEG mapping data (Figure 18) (Created by Elgin Associates 2010).

Areas with clear water support the most species-diverse communities, while silty and tannin stained water support sparser and less diverse communities. The composition and structure of the community are heavily

dependent on the water depth, water quality, chemistry, temperature and flow of the water and on mechanical disturbance such as animal grazing.

The Ramsar Type *Ts* (Seasonal freshwater wetlands) is equivalent to TASVEG communities 'Lacustrine herbland' (AHL), listed as threatened in Tasmania (NC Act) (Table 12). At Logan Lagoon the Ts wetland type is found in one small patch east of the lagoon (Figure 19). The community is characterised by a single, low-growing vegetation layer (generally less than 20 centimetres in height), which is fairly species-diverse. Lacustrine herblands are largely confined to the margins of wetlands, and species are therefore semiaquatic (Harris and Kitchener 2005). Grazing pressure often keeps the community less than five centimetres in height. Dominant species may include Scarce centrolepis *(Centrolepis strigosa) and* Mossy Pennywort *(Hydrocotyle muscosa).* The species diversity in herbfield communities generally increases as salinity decreases.

The Ramsar Type H wetland consists of intertidal marshes, including salt marshes and is equivalent to the TASVEG community 'Saline sedgeland / rushland' (ARS). This community is mapped in one small location on the western edge of the lagoon (Figure 18 and Figure 19). It is a coastal community frequently dominated by *sea rush (Juncus kraussii)* or, sometimes, other species such as *Gahnia filum.* Some succulent species may be interspersed but they do not define the community (Harris and Kitchener 2005).

There are areas of the lagoon shorelines with vegetation types which were not identified using TASVEG mapping layers. A site visit in July 2009 by Elgin Associates included a walk to the mouth of the lagoon, where large expanses of low-lying sand flats are covered with samphire or beaded glasswort *(Sarcocornia quinqueflora)* (Figure 25). These habitats are important for molluscs, crabs, isopods and amphipods as well as several bird species (Harris and Kitchener 2005). The observed vegetation most likely represents TASVEG community type 'Succulent saline herbland' (ASS) - Ramsar wetland Type *H* (Intertidal Marshes) - although it appears to be mapped on the TASVEG data layers as water (OAG) (Figure 18).

Further surveying and/or ground-truthing of the vegetation at Logan Lagoon is required. This would help to confirm the TASVEG mapping layers and presence of the Ramsar wetland types described above. There are possibly more wetland types that could be added, or the range of existing communities may be extended.

4.9. Other vegetation of conservation significance

The Lowland *Poa labillardierei* grassland (or 'Lowland Native Grasslands of Tasmania') is listed as a critically endangered ecological community under the EPBC Act (DEWHA 2010b) and is extensive throughout the site. Threatened species associated with this community include the wedge-tailed eagle (*Aquila audax fleayi*), listed as Endangered (EPBC Act and TSP Act) and common wombat (Bass Strait) (*Vombatus ursinus*), listed as Vulnerable (IUCN Red List and EPBC Act).

There are several threatened terrestrial species recorded, either within the Ramsar site boundary, or in the surrounding area (which may be identified within the Ramsar boundary subject to further surveys), including:

- Tiny fingers *(Caladenia pusilla):* listed as rare under the TSP Act; subject to recovery plan (TSS 2006a); observed within Ramsar boundary;
- Lance beard heath (*Leucopogon lanceolatus var. lanceolatus*): listed as rare under the TSP Act - observed within Ramsar boundary;
- Australian dusty miller *(Spyridium parvifolium* var*. parvifolium):* listed as rare under the TSP Act; observed within Ramsar boundary;

- Fringed everlasting *(Chrysocephalum baxteri):* listed as rare under the TSP Act; - observed within Ramsar site boundary;
- Rayless starwort *(Stellaria multiflora):* listed as rare under the TSP Act; observed within Ramsar boundary;
- Prickly arrowgrass (*Triglochin mucronatum*); listed as endangered under the TSP Act; observed within the Logan Lagoon Conservation Area, but outside the Ramsar boundary;
- Tunstall's greenhood (*Pterostylis tunstallii):* listed as endangered under the TSP Act; subject to recovery plan (TSS 2006a); observed in surrounding area; and
- Bluestar sun orchid (*Thelymitra holmesii*): listed as rare under the TSP Act (TSS 2000); subject to recovery plan (TSS 2006a); observed in surrounding area.

Further flora surveys should investigate habitats critical to the conservation of these species. Descriptions for the species listed above have been provided in Appendix E; Table E2.

Table 12. Vegetation communities occurring at Logan Lagoon Ramsar wetland site (TASVEG 2009) and Ramsar wetland types associated with these communities. The communities have been categorised into 'wetland-dependent', 'partially wetland-dependent', and 'not wetland-dependent' (M Visoiu, DPIPWE, *personal communication*, 3 June 2010).

TASVEG 2.0 Code	Community	Status EPBC Act	Status NC Act	Ramsar Wetland Type	Area	
					Hectares	Percentage
Saltmarsh, Wetland and Heathland - Wetland-dependent (~1%)						
AHS	Saline aquatic herbland		Threatened	**Type Ss**: Seasonal/intermittent saline/ brackish/ alkaline marshes/ pools.	9.23	0.41
AHF	Fresh water aquatic herbland		Threatened	**Type Tp**: Permanent freshwater marshes/pools; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.	1.28	0.06
AHL	Lacustrine herbland		Threatened	**Type Ts**: Seasonal/intermittent freshwater marshes/pools on inorganic soils.	3.71	0.16
ARS	Saline sedgeland/ rushland			**Type H: Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.	3.68	0.16
SHL	Lowland sedgy heathland			**Type W**: Shrub-dominated wetlands.	1.82	0.08
Scrub, Heathland and Coastal complexes – <u>Partially</u> wetland-dependent (~7%)						
GHC	Coastal grass and herbfield			**Type Ts**: Seasonal/intermittent freshwater marshes/pools on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.	141.06	6.25

TASVEG 2.0 Code	Community	Status EPBC Act	Status NC Act	Ramsar Wetland Type	Area	
					Hectares	Percentage
GPL	Lowland *Poa labillardierei* grassland (Lowland native grasslands of Tasmania)	Critically Endangered		**Type Ts**: Seasonal/intermittent freshwater marshes/pools on inorganic soils.	11.81	0.52
SMR	*Melaleuca squarrosa* scrub			**Type W**: Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.	6.25	0.28
Other –wetland (~45%)						
OSM	Sand/Mud, including beaches, sand dune systems, and mobile sand sheets			**Type E**: Sandy shores including beaches, sand dunes and sand spits.	53.5	2.37
OAG	Water, ocean, including artificial areas, lakes or inlets of the sea			**Type J**: Coastal brackish/saline lagoons with at least one narrow connection to the sea; **Type N**: Seasonal/intermittent/ irregular rivers/ streams/ creeks.	939.84 (<1 Hectare)	41.63 (<1%)
<u>Not</u> wetland (~47%)						
SDU	Dry scrub			**Not wetland**	704.35	31.20
NBA	*Bursaria - Acacia* woodland and scrub			**Not wetland**	4.44	0.20
NAL	*Allocasuarina littoralis* forest		Rare	**Not wetland**	376.39	16.67
NCR**	*Callitris rhomboidea* forest		Rare	**Not wetland**	Unknown	Unknown

4.10. Limnology - Microbiota

Australian coastal lagoons, principally some in Tasmania, have been recognised as strongholds of novel and unique (endemic) Australian freshwater algae (Tyler 1996; Walsh *et al.* 2004). The Bass Strait islands, including Flinders Island, are regarded as a biogeographical stepping stone between Tasmania and mainland Australia. The coastal lagoons of Flinders Island, including Logan Lagoon, contain a relatively rich assemblage of microinvertebrates and some endemic Australian freshwater algae (Walsh *et al.* 2001). Only one water sample has been retrieved from Logan Lagoon and it contained 14 microfauna species, a moderate number compared with other nearby lagoons (which comprised between 2 and 27 species (Walsh *et al.* 2001).

Tyler (1996) states that some of the freshwater algae, particularly the frail endemics, are fastidious in their habitat requirements and only prosper in locations with particular physiochemical conditions, and surrounded with a buffer of native vegetation. Logan Lagoon contains a range of wetland types, but little is known of their physiochemical parameters or microbiota. It is probable that some of the water bodies (particularly the smaller lagoons amongst the remnant vegetation communities) may support rare and endemic species, but further research is required.

4.11. Fauna

The Natural Values Atlas (DPIPWE 2009c) and Protected Matters Search Tool (DEWHA, 2009a) were interrogated for observations of fauna at Logan Lagoon. Fauna lists were also obtained from the Logan Lagoon Conservation Area Management Plan (Parks and Wildlife Service 2007). These three sources represent the majority of available records on the fauna of the Logan Lagoon site but records are very limited. There were three records for threatened fauna recorded on the databases (Appendix F, Table F1).

4.11.1. Mammals

Flinders Island has 14 of the 35 native mammal species present on mainland Tasmania (Appendix F, Table F1). Of these 14, all are likely to occur in the Logan Lagoon site, including the common wombat (Bass Strait), listed as Vulnerable under the EPBC Act, and the New Holland mouse, listed as Vulnerable under the IUCN Red List and Endangered under the TSP Act (Parks and Wildlife Service 2007). Additionally, a number of species now locally extinct on Flinders Island have been recorded from calcified remains in eroded dune deposits including the Tasmanian devil, eastern and spotted-tailed quoll, eastern barred bandicoot, eastern grey kangaroo and three rodent species (Edgecombe 2007).

The common wombat (Bass Strait) is presently found only on Flinders Island (Rounsevell *et al.* 1991); however, it previously occurred on King Island, Cape Barren Island, Deal Island and Clarke Island (Hope 1974). The population on Flinders Island is estimated to be approximately 4000 (Maxwell *et al.* 1996). The common wombat (Bass Strait) inhabits heath, grassy woodlands and pasturelands (with predominantly introduced grass species) (Green and Rainbird 1988; Maxwell *et al.* 1996). It is likely that Logan Lagoon supports a population of, or is visited by, the common wombat (Bass Strait).

The New Holland mouse prefers coastal dry heath on sandy substrates. They have been found in various heath and woodland types that have a dense and floristically diverse understory. There is a strong association between New Holland mouse abundance and distribution of four heath species: *Aotus ericoides*, *Lepidosperma concavum*, *Hypolaena fastigiata* and *Xanthorrhoea* spp (DSE 2009). In Tasmania, the New Holland mouse is restricted to the few remaining patches of dry coastal heathland and open, heathy forest on the north-east coastline. All sites are less than 15 kilometres inland and below 200 metres in altitude (DSE 2009), thus Logan Lagoon is a potential site because of its geographic location and vegetation communities.

There are four feral species present at the site; cats (*Felis catus)*, pigs (*Sus scrofa)*, black rat (*Rattus rattus*) and house mouse (*Mus musculus*) (Appendix F; Table F1). These species threaten the survival of local populations of native animals, via competition, predation or disease. In the case of pigs, they also cause physical damage by turning over large areas of substrate in search of food. The threat to the ecological character by feral fauna is discussed further in Section 8.4

4.11.2. Amphibians

Six of the eleven Tasmanian frog species occur on Flinders Island (Appendix F, Table F1) and all are likely to occur in freshwater lagoons and drains within the Ramsar site. One of these species, the green and gold frog *Litoria raniformis* is listed as Endangered on the IUCN Red List, and Vulnerable on the EPBC Act and TSP Act.

Frogs at Logan Lagoon were recently surveyed for Chytrid fungus (*Batrachochytrium dendrobatidis*), a disease which currently threatens Tasmania's native amphibians. Researchers from DPIPWE swabbed the mouthparts of 20 Limnodynastes tadpoles to determine chytrid status, however, the swabs are unlikely to be analysed due to budgetary constraints. The researchers also conducted a call survey for 20 minutes. Species recorded during this survey were Eastern Banjo Frog (*Limnodynastes dumerili*, between three and ten frogs calling), Brown Tree frog (*Litoria ewingii*, two frogs), and Common froglet (*Crinia signifera*, between three and ten frogs calling) (Annie Phillips, DPIPWE, *personal communication.* 21 Dec 2009).

Green and gold frog (*Litoria raniformis).* The green and gold frog is one of the largest frog species in Australia, reaching up to 104 millimetres in length (Barker *et al.* 1995; Tyler 1978; Tyler and Barrie 1996). They are generally olive to bright emerald green, with irregular gold to black spotting. This species is found mostly amongst emergent vegetation and submerged plants in or at the edges of still or slow-flowing water bodies such as lagoons, swamps, lakes and ponds (Robinson 1993). Submerged vegetation is important habitat for breeding success and grassland provides habitat for foraging, shelter and overwintering sites (Clemann and Gillespie 2004; DEWHA 2009b, Hamer and Organ 2006).

There are no observations of the green and gold frog at Logan Lagoon despite there being suitable habitat available which includes subsidiary streams and smaller lagoons within the site. This species was not located during recent site surveys, possibly due to natural and unnatural draining of the lagoon which creates very saline conditions and reduces available habitat. Protecting the lagoon from artificial draining would increase the value of the site as potential habitat for this species. The nearest reliable observation has been recorded at The Patriarchs to the north of the site (DPIPWE 2009c).

4.11.3. Invertebrates

There is limited information on the invertebrate species at Logan Lagoon, including terrestrial, benthic and estuarine invertebrates. A Tasmania-wide survey of estuarine invertebrates in 1999 included sampling of nearby Cameron Inlet (Logan Lagoon was dry at the time of the survey – 1997) (Edgar *et al.* 1999). Cameron Inlet was found to be hypersaline and only eight invertebrate species were recorded. More generally, the survey concluded that macrofaunal species collected at a given site were primarily correlated with local salinity and biomass of submerged plant material, particularly seagrass. Species richness varied with geographic location for macrofauna, with highest numbers of species occurring in the Furneaux Group, northeastern Tasmania and southeastern Tasmania. It is likely that Logan Lagoon has a diverse assemblage of invertebrates that represent an important source of food for fauna, particularly birds and fish. The site's invertebrate population and its availability as a food source, particularly for birds and fish, should be investigated.

4.11.4. Fish

Nine native freshwater fish species occur on Flinders Island (Appendix F, Table F1), all of which are likely to occur in Logan Lagoon or Pot Boil Creek. The dwarf galaxias (*Galaxiella pusilla*) has been identified at Logan Lagoon (Parks and Wildlife Service 2000) and is listed as Vulnerable on the IUCN Red List and under the EPBC Act, and Rare under the TSP Act. The dwarf galaxias lives in still or slow-flowing waters such as ponds, swamps, drains and backwaters of streams, often containing dense aquatic or emergent plants. Water bodies may be permanent, or temporary waters connected to permanent water. Known Tasmanian sites appear to be associated with Holocene sand, gravel and alluvium deposits (Chilcott and Humphries 1996).

The galaxiid fauna of Tasmania has significant conservation status with 69 percent of species considered 'threatened'. The conservation status of the galaxiid fauna is recognized at State, national and international levels. A recovery plan (TSS 2006b) has been prepared for threatened Tasmanian Galaxiidae which aims to ensure the long-term survival of the species in the wild, by minimising the effects of threatening processes.

4.11.5. Reptiles

Tasmania has 3 snake and 18 lizard species. Seven of the lizards are endemic to Tasmania, including two of the skink species recorded on Flinders Island. 14 species of reptile have been recorded on Flinders Island (Appendix F, Table F1) all of which are likely to occur at Logan Lagoon (Edgecombe, 2007). Tasmanian skinks are diurnal lizards, ranging in size from 100 millimetres (delicate skink) through to 450 millimetres (blotched blue-tongue). Although none of these species are listed as threatened on either the EPBC Act or TSP Act, Bougainville's skink, despite being fairly widespread in south-eastern mainland Australia, is known only in a few locations in Tasmania and is therefore of conservation significance.

4.11.6. Birds

There are 129 bird species (native, migratory and introduced) recorded within a 6 kilometre radius of the Logan Lagoon Ramsar site. Of these, 34 are wetland-dependent bird species (Appendix F, Table F3). For many of these species, Logan Lagoon provides important resting and feeding habitat, particularly for the 42 marine or migratory birds listed as threatened under various international agreements (Appendix F, Table F2 and F3). 18 bird species were identified as threatened under the EPBC Act and TSP Act. However, only the little tern, fairy tern, Australasian bittern and white-fronted tern are wetland-dependent and likely to occur at Logan Lagoon (Appendix F, Table F2).

A total of 21 migratory wader species have been recorded at the site (Appendix F, Table F2) and all but one of these, double-banded plover (*Charadrius bicinctus*), breeds in the Arctic region during the northern hemisphere summer. Double-banded plovers breed in New Zealand and some of the population over-winter in Australia. Over-wintering in Australia by other migratory bird species, typically by juveniles, may also occur (Eric Woehler, Birds Tasmania, *personal communication*, 4 March 2010).

Many of the migratory waders identified at Logan Lagoon are listed under CAMBA, JAMBA, ROKAMBA and the Convention on Migratory Species (Appendix F, Table F2). Logan Lagoon is listed as an important site for the curlew sandpiper (*Calidris ferruginea*) and the red-necked stint (*Calidris ruficollis*) under the East Asian - Australasian Shorebird Site Network (Bamford *et al.* 2008). For these reasons, the lagoon is not only important on a local scale, but also nationally and internationally.

When water is present in Logan Lagoon, the site provides important resting and feeding areas for waterfowl and shorebirds migrating between south-eastern Australia and Tasmania. In 2002-2003, with severe drought conditions in mainland Australia, a flock of approximately 3000 banded stilts (*Cladorynchus leucocephalus*) arrived at Logan Lagoon and remained in the area for approximately eight months. This is the highest number of stilts ever recorded in Tasmania (Olsen and Weston 2004).

The 1998-1999 Shorebird Survey for Tasmania found Logan Lagoon (combined with nearby Cameron Inlet) has high migratory and shorebird diversity and is a priority site for resident species (Bryant 2002). During the survey, Logan Lagoon provided the highest count for the following species; curlew sandpiper (*Calidris ferruginea*) 1000 birds, red-necked stint (*Calirdis ruficollis*) 4000 birds, and fairy tern (*Sternula nereis nereis*) 250 birds. In addition, 2470 curlew sandpipers were recorded at Logan Lagoon in 1984 (Bamford *et al.* 2008). The site provides breeding habitat for two beach-nesting shorebirds listed as Threatened under the Tasmanian Threatened Species Protection Act 1995; fairy tern, listed as Vulnerable and little tern (*S. albifrons*), listed as Endangered and migratory (Bryant 2002). A shorebird survey on Flinders Island in 2008 (Woehler 2008) recorded 68 hooded plovers (*Thinornis rubricollis*) along Logan Lagoon beach between Pot Boil Point to Cameron Inlet, a species known to be decreasing in south-eastern Australia (Bryant 2002).

Four of the duck species recorded at Logan Lagoon – black duck (*Anas superciliosa*), Australian shelduck (*Tadorna tadornoides*), chestnut teal (*Anas castanea*) and grey teal (*Anas gracilis*) - are considered as game species and hunted in Tasmania during an annual duck season (Olsen and Weston 2004, Parks and Wildlife Service 2007). The lagoon is an important refuge for these species, as hunting is not permitted within the Ramsar site. During periods of inundation the area has contained numbers as high as 800 black duck, 1200 Australian shelduck, 1800 chestnut teal and 550 grey teal. The area has also been important for black swan (*Cygnus atratus*) and musk duck (*Biziura lobata*), with maximum numbers of 3850 and 5200 respectively. Concomitant with water levels, numbers for waterfowl species have generally been low in most years over the last decade. Annual counts taken before the duck hunting season by DPIPWE in most years since 1985 were used to assess the importance of Logan Lagoon for waterbirds (Table 13).

Table 13. Annual counts of waterfowl at Logan Lagoon during February 1985 - 2009, excluding 1987, 1989, 1994 and 2008. The area counted varied among years and data do not indicate population trends.

Year	Black swan	Mountain duck	Black duck	Chestnut teal	Grey teal	Blue-billed duck	Musk duck	Cape Barren goose
1985			2					8
1986	885	320	600	1819	550		15	8
1987								
1988	600	400				27	5079	
1989								
1990	350	200	158				5200	
1991							493	
1992	2532	735	823	178		6	1623	
1993	3853	1236	261	750	67		2889	
1994								
1995	21						30	
1996	84	26	170	150		10	104	
1997	1800	200	550	250			378	
1998	186		170	22			50	
1999	1330		70				70	
2000	1		7					
2001	120		230	400			55	
2002	100						2500	

Year	Black swan	Mountain duck	Black duck	Chestnut teal	Grey teal	Blue-billed duck	Musk duck	Cape Barren goose
2003	50	80	50				7	
2004	538	481	346	305				
2005	600		600	1000	50	4	150	
2006								
2007	150		20	100		16		
2008								
2009	150	30	50			25		

Cape Barren geese are considered to be the world's second rarest goose species (Parks and Wildlife Service 2007). The species was nearly hunted to extinction in the mid 1800s to early 1900s by sealers and settlers and was slow to recover until an increase in improved pasture in the Furneaux Islands from the 1960s saw the population increase to an estimated 15,000 (Parks and Wildlife Service 2007). Important in the recovery of this species was management action undertaken during the 1970s which saw areas of the island planted with grass to provide a refuge and food source for the geese to attract them away from pasture on private property.

4.11.7. Threatened birds

A number of threatened shorebirds have been recorded breeding in the Logan Lagoon Ramsar site. These are: the little tern (*Sterna albifrons*), which is listed as endangered under the Threatened Species Protection Act 1995 (TSP Act) and also listed under JAMBA andCAMBA; the fairy tern (*Sternula nereis nereis*) which is listed as Vulnerable on the IUCN Red List and TSP Act; the Australasian Bittern (*Botaurus poiciloptilus),* listed as Endangered under the EPBC Act and IUCN Red List; and the hooded plover (*Thinornis rubricollis*) which is not listed, but has a high conservation significance. One other threatened seabird recorded as occurring in the Logan Lagoon Ramsar site, but not as breeding, is the white-fronted tern (*Sterna striata*) which is listed as vulnerable under the TSP Act.

Two terrestrial species of conservation significance recorded at or near Logan Lagoon are the wedge-tailed eagle (*Aquila audax fleayi*) (Endangered- EPBC Act) and the forty-spotted pardalote.(*Pardalotus quadragintus*) (Endangered - IUCN Red List and EPBC Act).

5. IDENTIFICATION OF THE CRITICAL COMPONENTS, PROCESSES AND SERVICES

To identify the critical components, processes and services for which further exploration of interactions is warranted, guidance was taken from the *National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Sites* (DEWHA, 2008a), which states:

The components, processes and benefits/services should be selected for detailed analysis and description if:

- they are important determinants of the site's unique character;
- they are important for supporting the Ramsar or DIWA criteria under which the site was listed;
- change is reasonably likely to occur over short or medium time scales (<100 years); and
- they will cause significant negative consequences if change occurs.

5.1. Critical components and processes

Defining the critical components and processes is important for understanding the characteristics of the site that contribute to the sites listing under various Ramsar criteria. The critical components and processes for the Logan Lagoon Ramsar site are:

- climate;
- geomorphology;
- hydrological regime;
- water quality;
- vegetation; and
- birds.

Each of these components and processes meet the DEWHA (2008a) indicative criteria for identifying critical components, processes and services, as they: are important in determining the site's unique character; are important in supporting criteria under which the site was listed; are reasonably likely to change in the next 100 years; and changes to them could cause significant negative consequences. A description of why these components and processes were selected is detailed below and conceptual model that illustrates the relationships between them is illustrated in Figure 20.

5.1.1. Climate

The region's temperate climate plays a major role in the ecological character at the site, with precipitation being the major source of freshwater inflow into the site, whether via direct rainfall or via runoff from watercourses in the catchment. Persistent westerly winds contribute to precipitation at the site and, along with temperature, these factors influence the high rates of evaporation recorded in the region. The

temperate climate plays a major role in the seasonal hydrological regime at the site and therefore variability in climate parameters such as temperature, particularly in the last 25 years, led to extended periods when Logan Lagoon was only partially full or even dry,.

It is important to understand that there may be complex interactions between the physical conditions at the site and its subsequent use by flora and fauna. For example, waterbirds may use the site for breeding only in years when water levels are moderate – i.e. there is adequate area for nesting on the shores. Consequently, establishing links between climatic conditions, the hydrological responses to such conditions and the impact on the biological components should be paramount. Currently, these links are poorly understood.

5.1.2. Geomorphology

The ongoing deposition of sediments to the coastal lagoon system over the past 6,000 years has resulted in growth, or progradation, of the east coast of Flinders Island. The resulting Coastal Barrier System is a representative and outstanding example of how offshore bars formed with Holocene sea level rise and barrier growth has enclosed the coast, forming large lagoons. Protecting these geological features, including the integrity and structure of the dunes from erosion, is important for the purposes of geoconservation and maintaining the ecological character of the site's listing under Criterion 1.

The dunes also provide habitat for a range of vegetation communities, some of which are threatened in Tasmania. The colonisation of newly formed dunes by terrestrial vegetation acts to stabilise the dunes and prevents erosion. Consequently, protecting the vegetation communities that colonise these coastal features is also important for maintaining the geomorphological features.

Soil quality plays a critical role in supporting vegetation at the site, with soil nutrients and organic matter important soil properties for vegetation growth. Acidification of soils through disturbance of potential acid sulphate soils or via dryland salinity can have detrimental impacts on soil pH and structure, affecting its ability to support vegetation and increasing the potential for soil erosion.

5.1.3. Hydrological Regime

The hydrological regime has a major influence on the structure of the site, the vegetation it supports and its attraction to fauna, especially birds. Seasonal changes to the hydrology regime have an impact on water quality, where conditions can range from stagnant and hypersaline (no inflow, evaporation), to fresh-brackish (high inflows and rainfall), or be saline during periods of seawater ingress via a breached lagoon-sea entrance. Establishing the status of the lagoon entrance (breached or closed) should be paramount when interpreting the results of any monitoring, regardless of whether it is physical (water quality) or biological (bird counts) monitoring.

Groundwater interaction is poorly understood, yet potentially forms a key part of the hydrology regime at the site. Additional groundwater discharge may occur during periods when the water table is elevated, or when lagoon surface water levels are low during drier periods. Groundwater influx to Logan Lagoon is likely to influence the water quality parameters at the site.

The hydrological regime is also a major process for the significant geomorphic features observed at the site..

The hydrology at the site also contributes to the availability of habitat for the dwarf galaxias, which supports selection of Criterion 2. The dwarf galaxias lives in still or slow-flowing waters such as ponds, swamps, drains and backwaters of streams, often containing dense aquatic or emergent plants. Known Tasmanian sites appear to be associated with Holocene sand, gravel and alluvium deposits, of which Logan Lagoon is representative.

5.1.4. Water Quality

Water quality may affect the features that contribute to the selection of criteria for Ramsar listing, such as the survival of the dwarf galaxias (Criterion 2) or persistence of wetland-dependent flora communities that contribute to the biodiversity of the bioregion (Criterion 1 and 3). Surface water quality of the lagoon is a key determinant of ecological character and the factors that may impact the presence of significant species and communities are salinity, nutrients, turbidity and toxicants.

- *Salinity*: the salinity of lagoon waters in the lagoon will affect the types of vegetation that the wetland can support, where salt tolerant species can establish dominance over less tolerant species if saline lagoon waters persist for extended periods. The salinity of water also affects the attractiveness of the lagoon to fauna (including birds) for breeding and resting purposes.
- *Nutrients:* nutrients are essential for growth of many aquatic species, however they can have detrimental effects if eutrophication develops in the lagoon from excess nutrient levels. Under eutrophic conditions, blooming growth of aquatic vegetation becomes unsustainable resulting in deficient dissolved oxygen levels and smothering of the littoral zone by decaying vegetation or wrack.
- *Turbidity:* elevated turbidity levels, which are usually associated with high suspended solid loads, affect light penetration in the water column and the ability of aquatic vegetation to photosynthesise. Also, excess suspended solids flowing into the lagoon from the catchment can lead to increased sedimentation of lagoon areas.
- *Toxicants:* such as agricultural pesticides/herbicides can cause adverse health effects in ecological communities, and some toxicants can bioaccumulate up the food chain.

5.1.5. Vegetation

The low-lying wetland-dependent vegetation of Logan Lagoon is characteristic of a coastal wetland, comprising submerged macrophytes, saltmarsh, herblands and grasslands. The vegetation is important for migratory and resident birds, providing feed and shelter at different life history stages. The vegetation is also a critical component of the alluvial processes at the site, trapping sediments and contributing to the stabilisation and persistence of geomorphic features such as the Holocene shorelines and dune systems listed under Criterion 1.

Away from the shores of the lagoon the habitat changes to sedgeland, heathland and swampy forests. There are remnant stands of shrub-dominated woodlands and forest to the east which are of conservation significance in Tasmania. A combination of the site's hydrology, climate, water quality and soil quality will influence the vegetation that can be supported at the site. The threatened wetland-dependent vegetation communities contribute to the regional biodiversity and selection of Criterion 1 and 3.

5.1.6. Birds

Logan Lagoon supports a large number of birds, many with conservation significance locally, nationally and internationally which justifies the selection of Ramsar criteria 3, 4 and 6; (Section 4.11.6). A total of 21 migratory wader species have been recorded at the site and all but one of these, the double-banded plover (*Charadrius bicinctus*), breeds in the Arctic region during the northern hemisphere summer. Double-banded plovers breed in New Zealand and some of the population over-winters in Australia. Over-wintering in Australia by other migratory bird species, typically by juveniles, may also occur.

Many of the migratory waders identified at Logan Lagoon are listed under CAMBA, JAMBA, ROKAMBA and the Convention on Migratory Species. When water is present in Logan Lagoon, the site provides important resting and feeding areas for waterfowl and shorebirds migrating between south-eastern Australia and

Tasmania. The site regularly supports 1% of the global or regional population of: hooded plover, fairy Tern, musk duck, and chestnut teal and justifies the selection of Criterion 6. Maintaining counts of bird numbers at the site is required to support the continued justification of these criteria.

5.2. Critical benefits and services

The benefits and services listed in Table 10 contribute to the maintenance of the site's ecological character. However, not all are critical for supporting the components and processes that contribute to the ecological character. Similar to the process for identifying critical components and processes (Section 5.1), the critical services and benefits have been identified in relation to the reasons the site was listed as a wetland of international significance.

The critical benefits and services for maintaining the components and processes are:

- supports representative, rare or unique wetland types;
- supports threatened species and communities;
- provides habitat for plant and animal species that contribute to the biodiversity of the Tasmanian bioregion;
- supports critical life stages or provides refuge; and
- supports migratory and resident waterbirds.

These critical services have been selected based on the criteria that define a wetland of international importance (Section 3.4.2) and the components and processes (Section 4.1) that support them. Each of the services meet the DEWHA (2008a) indicative criteria for identifying critical components, processes and services, as they: are important in determining the site's unique character; are important in supporting criteria under which the site was listed; are reasonably likely to change in the next 100 years; and changes to them could cause significant negative consequences.

Conceptually, it is the components and processes and the interactions between them that characterise each of the critical ecological services. Each of the critical benefits and services relate directly to a critical component or process. Consequently, identifying changes in the components and processes will be adequate for identifying changes in the critical services. A description of why these services are critical, the criteria for which they are selected, and the components and processes to which they relate, is detailed in Table 14. A more comprehensive description of each benefit/service is described in Section 5.2.1 to 5.2.5.

Table 14. Critical ecological services, the Ramsar criteria they contribute to and the components and processes they relate to.

Critical ecological service	Ramsar Criteria	Components and processes creating the service	Contributing biotic components	Contributing abiotic components
Maintains a diversity of representative, rare or unique wetland types.	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.	The extent and diversity of wetland types within the Logan Lagoon Ramsar site, including Ramsar wetland types: Type E — Sand, shingle or pebble shores; Type J — Coastal brackish/saline lagoons; Type H – Intertidal marshes; Type N — Seasonal/ intermittent/ irregular rivers/streams/creeks; Type Ss – Seasonal/intermittent saline/brackish/alkaline marshes/pools; Type Tp – Permanent freshwater marshes/pools; Type Ts – Seasonal/intermittent freshwater marshes/pools on inorganic soils; and Type W – Shrub-dominated wetlands.	Wetland vegetation community types (Freshwater aquatic herbland; Saline aquatic herbland; and, Lucustrine herbland). Terrestrial vegetation stabilises the surrounding geomorphology.	Water quality. Hydrology – adequate water level for wetland dependent vegetation. Geomorphology – Holocene shorelines and dune systems provide substrate for wetland vegetation communities.
Supports threatened species and communities.	Criterion 2. Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	Fish: dwarf galaxias. Birds: fairy Tern, Australasian bittern.	The habitat provided for supporting threatened species including aquatic and emergent vegetation, aquatic fauna, and invertebrates.	Water quality. Hydrology: adequate water level in lagoon. Geomorphology: Holocene sand, gravel and alluvium deposits are important habitat components for dwarf galaxias.

Critical ecological service (cont.)	Ramsar Criteria (cont.)	Components and processes creating the service (cont.)	Contributing biotic components (cont.)	Contributing abiotic component s (cont.)
Provides habitat for plant and animal species that contribute to the biodiversity of the Tasmanian bioregion.	Criterion 3. Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	The habitat provided for supporting migratory birds, including vegetation, invertebrate populations, and aquatic fauna.	Birds: little tern, curlew sandpiper, red-necked stint, double-banded plovers, cattle egret, ruddy turnstone, sharp-tailed sandpiper, sanderling, lesser sand plover, Latham's snipe, Caspian tern, bar-tailed godwit, satin flycatcher, eastern curlew, whimbrel, Pacific golden plover, common greenshank.	Water quality. Hydrology – water levels such that shorelines are exposed for feeding on by birds.
Supports critical life stages or provides refuge.	Criterion 4. Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.	The habitat provided for supporting migration and breeding, particularly during adverse conditions.	Waterbirds and migratory shorebirds including those listed under Criterion 3.	Geomorphology: Holocene shorelines. Hydrology: adequate water level in lagoon, but not so high as to restrict exposed sand flats which are important for waterbirds.
Supports migratory and resident waterbirds.	Criterion 6. Regularly supports 1 percent of the individuals in a population of one species or subspecies of waterbird.	The physical habitat and biological conditions for supporting waterbirds. Habitat extent and distribution, particularly wetland-dependent vegetation.	Birds: hooded plover, fairy Tern, musk duck, and chestnut teal.	Hydrology – adequate supply of quality water.

5.2.1. *Maintains a diversity of wetland habitats*

The diversity of wetland habitat at Logan Lagoon contributes to the selection of Criterion 1, and results from interactions between the components and processes of geomorphology, climate, hydrology and vegetation. Alluvial processes occurring within Logan Lagoon contribute to the formation of geological features such as shorelines and sand dunes via the deposition of sediments. Accumulation of organic matter provides nutrients for flora communities which help to stabilise the dunes systems. The lagoon facilitates storage, recycling, processing and acquisition of nutrients for use by other organisms inhabiting or using the site. The wetland types that provide habitat for a range of species and communities are described with the vegetation ecological component in Section 4.7.

5.2.2. *Supports threatened species*

Logan Lagoon supports the dwarf galaxias, Australasian bittern and fairy tern which are threatened under the EPBC Act and IUCN Red List and therefore justify the selection of Criterion 2. A combination of components and processes within the site combine to provide the conditions and habitat to support these species and provide this service (Table 14). Central to the support of the dwarf galaxias are (1) the maintenance of the sand, gravel and alluvium deposits associated with the Holocene shorelines (Section 4.11.4) and (2) an adequate and persistent water level in Logan Lagoon or Pot Boil Creek (Section 4.5).

The fairy tern breeds on sandy beaches above the high tide line but below where terrestrial vegetation occurs (BirdLife International 2010). Therefore, the exposed Holocene shorelines and ocean beaches are important geomorphologic components (Section 4.4) for the support of fairy terns.

5.2.3. *Provides habitat for plant and animal species that contribute to the biodiversity of the Tasmanian bioregion*

Logan Lagoon provides a range of habitats for plant and animal species that contribute to the biodiversity of the Tasmanian Bioregion. For example, geomorphologic features such as the Holocene shorelines, support wetland dependent vegetation types, which in turn provide habitat for invertebrate populations and other aquatic fauna. This biota subsequently provides a source of food for the birds that contribute to the site being recognised as a wetland of international importance under Criterion 3. The habitat requirements for species listed under Criterion 3 need to be assessed so that the importance of critical components, processes, and services (such as geomorphology, hydrology, and water quality) for the availability of habitat can be understood.

5.2.4. *Supports critical life stages*

Logan Lagoon provides important resting and feeding areas for waterbirds and migratory shorebirds. During drought conditions on mainland Australia during 2002-2003, 3000 banded stilts arrived at the site and stayed for approximately 8 months. The site also provides breeding habitat for two threatened beach-nesting shorebirds: fairy tern, listed as Vulnerable (TSP Act and IUCN Red List) and little tern (*S. albifrons*), listed as Endangered (TSP Act) and migratory (Bryant 2002).The habitat usage by birds at Logan Lagoon is poorly understood, particularly the relationship between the environmental conditions and the species observed at the site.

5.2.5. *Supports migratory and resident waterbirds*

Logan Lagoon provides the physical habitat and biological conditions for supporting waterbirds and migratory shorebirds. The extent and distribution of suitable habitat, particularly wetland-dependent vegetation and adequate water quality, are important requirements for birdlife. The ephemeral nature of Logan Lagoon results in periods where water levels may be unfavourable for many species of migratory or

resident waterbirds. During these periods, birds are likely to use more permanent water bodies nearby on Flinders Island, in northern Tasmania, or on the Australian mainland. Consequently, most of the services provided to migratory and resident shorebirds by Logan Lagoon may be intermittent and influenced by other components such as climate.

6. A CONCEPTUAL MODEL OF THE SITE

This section attempts to illustrate the fundamental interactions between the key ecosystem components and processes via the following:

1. Describing the associations among the ecosystem services/benefits and components/processes identified in Section 4 (refer Section 6.1 below); and

2. Identification and characterisation of the primary determinants of ecological character for the Logan Lagoon Ramsar site (including those illustrated in the conceptual models – Figure 20 and Figure 21).

6.1. Summary of the conceptual modelling

The region's temperate climate plays a major role in the ecological character at the site, with precipitation being the major source of freshwater inflow into the site, whether via direct rainfall or via runoff from watercourses in the catchment. Persistent westerly winds contribute to precipitation at the site, and, along with temperature, these factors influence the high rates of evaporation recorded in the region. The temperate climate plays a major role in the seasonal hydrological regime at the site and therefore variability in climate parameters geomorphological features.

Logan Lagoon is part of an extensive eastern Flinders Island parallel dune–coastal barrier system. The site contains two sites listed on the Tasmanian Geoconservation Database; Logan Lagoon Holocene Shorelines and Planter Beach Coastal Barrier System, which are of conservation significance for Tasmania. These geomorphic features provide habitat for a range of vegetation communities, some of which are threatened in Tasmania. The colonisation of newly formed dunes by terrestrial vegetation acts to stabilise the dunes and prevents erosion. Consequently, protecting the vegetation communities that colonise these coastal features is also important for maintaining the ecological character of the site.

The hydrological regime has a major influence on the structure of the site, the vegetation it supports and its attraction to fauna, especially birds. Seasonal changes to the hydrological regime have an impact on water quality, where conditions can range from stagnant and hypersaline (no inflow, evaporation), to fresh-brackish (high inflows and rainfall), or be saline during periods of seawater ingress via a breached lagoon-sea entrance. The availability of water at the site plays a key role in the attractiveness of the site for resting and breeding of resident and migratory fauna, including birds. Groundwater influx to Logan Lagoon is likely to influence the water quality parameters at the site.

The present entrance to the sea is only open on an infrequent basis and generally a sand bar extends from the lagoon to the beach. During periods when the bar is open, there can be an outflow of lagoon water or an inflow of seawater into the lagoon, with the extent of seawater exchange being dependent on factors

such as lagoon water levels, tides, extent of bar erosion and storm activity. There have been periods when the entrance is closed and a very high water level has been blamed for waterlogging adjacent farmland. Opening the lagoon mouth by excavating a channel to the ocean has been common practice during the past 50 years; however, this disrupts the natural hydrology and threatens the ecological character of the site.

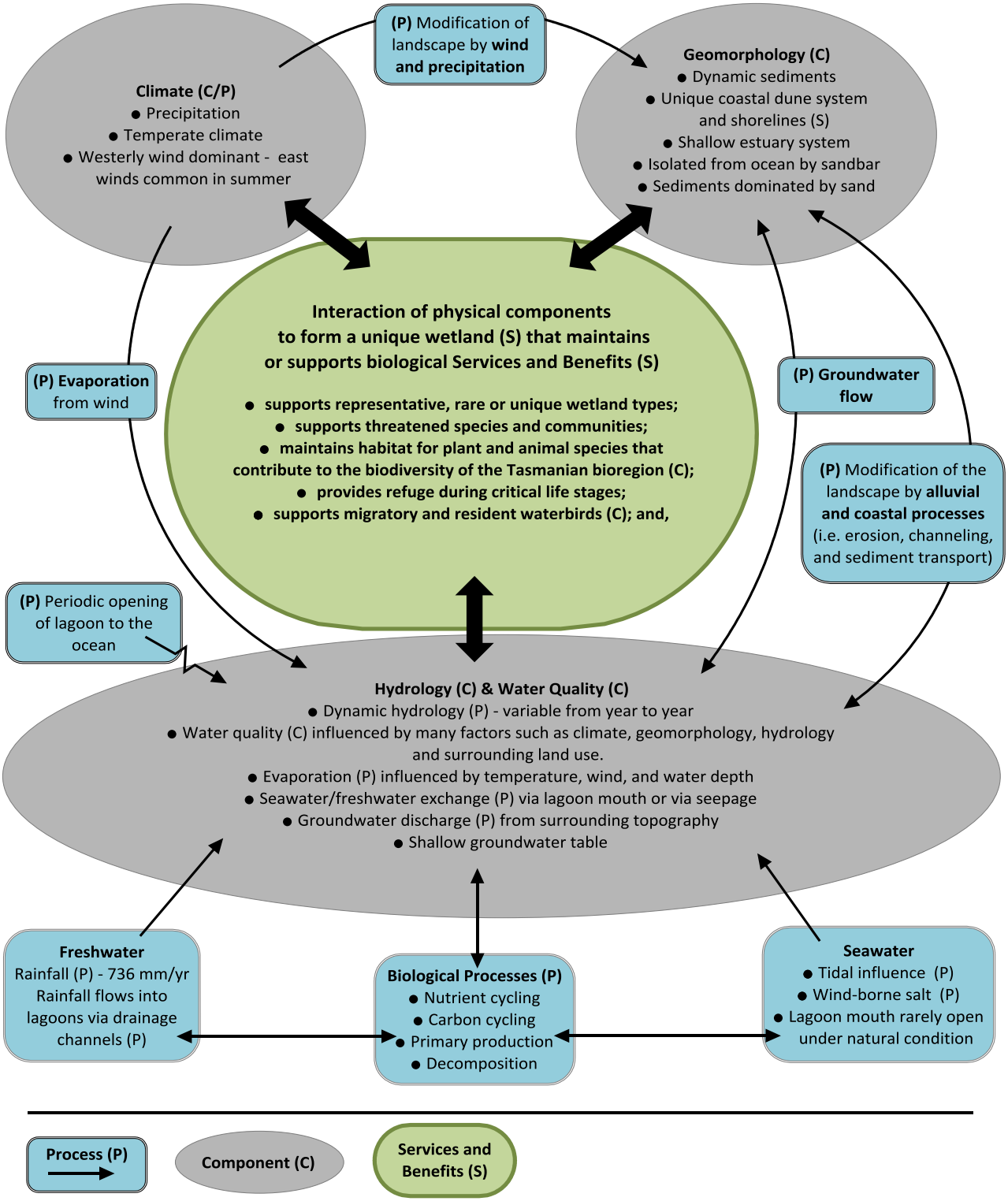


Figure 20. A conceptual model of the Logan Lagoon Ramsar site showing components, processes, services and benefits (S) and the relationships among them. Note that some features may be considered as components or processes as well as ecosystem services or benefits (Created by Elgin Associates 2010).

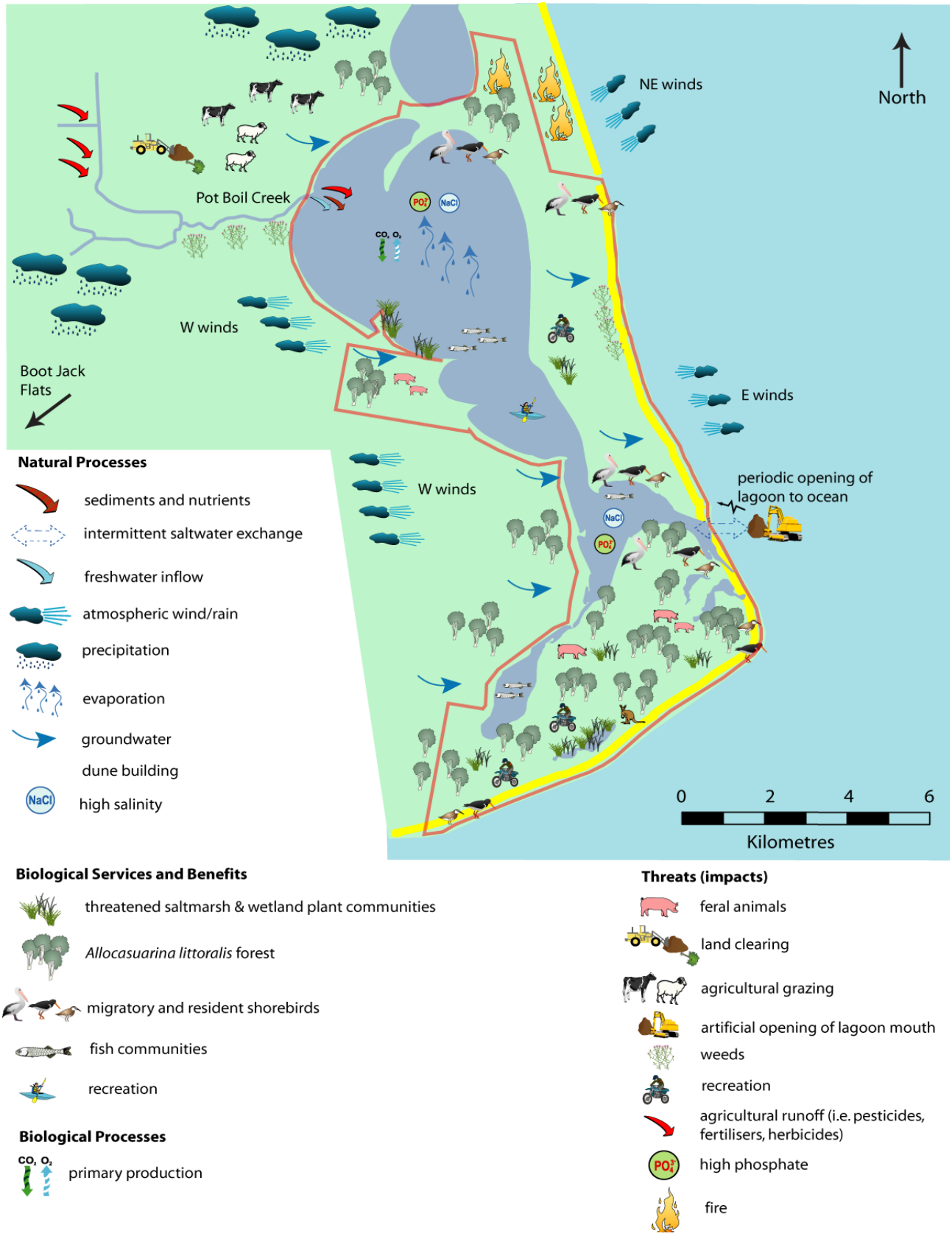


Figure 21. Landscape conceptual model of the Logan Lagoon Ramsar site (note: the positioning of features is indicative only) (Created by Elgin Associates 2010).

The low-lying vegetation around the edge of the lagoon is characteristic of a coastal wetland, comprising submerged macrophytes, saltmarsh, herblands and grasslands. The habitat is determined by a hydrological gradient that extends away from the lagoon shores. There are remnant stands of shrub-dominated

woodlands and forest to the east that have been protected from fire by the lagoon. The remaining areas of the site are dominated by a complex mosaic of coastal scrub, heath and non-eucalypt forests. The vegetation stabilises the surrounding geomorphology and provides habitat for fauna, particularly birds.

The Logan Lagoon Ramsar site is an important area for resident and migratory birds. Over 160 bird species have been recorded on Flinders Island, 46 of which are wetland-dependent and occur in the Logan Lagoon Ramsar site. A number of threatened wetland-dependent species, including 21 migratory waders, have also been recorded at the site. Other non-avian fauna also use the site for foraging, breeding or as habitat refuge, such as the endangered freshwater fish, the dwarf galaxias.

7. LIMITS OF ACCEPTABLE CHANGE

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.

It is important to understand the range of natural variation in the components, processes and services of a wetland ecosystem and to set limits of acceptable change for the wetlands' ecological character. These limits make it easier to determine when the ecological character is likely to change, or when it has changed as a result of technological development, pollution or other human interference.

While change in ecological character can be positive or negative, a change in ecological character for the purposes of notification is limited to 'human-induced adverse alteration'. Identifying human-induced alteration is particularly important for Australian wetlands because they often have a large range of natural variability. Change in ecological character occurs when the critical parameters of the wetland ecosystem fall outside their normal range (Ramsar Convention Secretariat 1996). In assessing limits of acceptable change, Australia has adopted six guidance principles:

1. Assessment of change will be undertaken with respect to critical components, processes and benefits and services of the ecological character of the site.

2. An assessment of change to support a notification must be based on best available science.
3. The fact that a site was undergoing human induced ecological character change at the time of listing does not preclude the need for an assessment, and possible notification of change, if there is evidence of significant ongoing adverse ecological change.
4. Where the natural variability of a site cannot reasonably be established for the critical component (process, benefit or service) against which change is being assessed, a notification, if made, will only be on the basis of 'is likely to' change.
5. A notification will not be made where the apparent character change has been identified as arising from the use of inadequate data sets at the time of listing.
6. A notification will not be made where climate change is the principal cause of identified ecological character change.

It is difficult to define the limits of acceptable change for Logan Lagoon because there is an overall paucity of scientific data and information on the site, including any long-term monitoring datasets (except for birds). Where adequate baseline and supporting evidence permit, a limit of acceptable change has been defined for the critical components, processes, and services (Table 15). Given the lack of available data, these measures will benefit from revision as more data becomes available. Some of this data may be gathered in relatively short time frames (2 years), whilst other data will require regular and long-term monitoring (>10 years). Details of specific monitoring requirements are provided in Section 11.

Each of the critical benefits and services identified in Section 5.2 are directly related to the site's critical components and processes. Consequently, identifying changes in the components and processes will be adequate for identifying changes in the critical services. A description of why these services are critical, the criteria for which they are selected, and the components and processes to which they relate, is detailed in Table 13. A more comprehensive description of each benefit and service is described in Section 5.2.1 to 5.2.5.

Table 15. Limits of acceptable change for critical components and processes of the Logan Lagoon Ramsar site.

Component / Process / Service	**Baseline / supporting evidence**	**Limit of acceptable change**
Climate: Understanding the interactions between the physical conditions at the site and its subsequent use by flora and fauna is important. For example, waterbirds may use the site for breeding only in years when water levels are moderate and there is adequate area for nesting on the shores.		
Climate	The particular attributes of climate that are important in maintaining the ecological character of the site are rainfall, temperature, wind and evaporation. Climate predictions for north-eastern Tasmania suggest a generally warmer climate which is wetter in all seasons. Mean daily temperatures are projected to be warmer (both minimum and maximum temperatures) with increased solar radiation, relative humidity in summer, and increased evaporation (ACE CRC 2010).	The links between climatic conditions, the hydrological responses to such conditions, and their impact on the biological components, are poorly understood and should be further investigated. No LAC can be determined due to a lack of understanding of the impact of climatic processes on other critical components, processes and services, such as hydrology, geomorphology, flora and fauna.

Geomorphology: Protecting the geological features, including the integrity and structure of the dunes, is important for the purposes of geoconservation and maintaining the ecological character which contributes to the site's listing under Criterion 1.		
Holocene Shorelines and dune systems	There are approximately 54 hectares of shorelines, spits, and dune systems that are important for maintaining the geoconservation value of the site under Criterion 1. The area of shorelines, spits, and dunes defined in the TASVEG mapping layers require ground-truthing	Currently there are 54 hectares of high quality shorelines, dune systems and spits mapped within the site. In the absence of studies detailing impacts from human disturbance, a common-sense approach has been adopted, setting a limit of acceptable change at not more than 3 hectares (2 percent) of the area of the Holocene shoreline and dune systems showing evidence of human disturbance through vehicle use or foot traffic. Because the wetland map was made without proper ground-truthing, verification of areas will be required
Hydrology: The hydrological regime is a major driver in the vegetation communities at the site, particularly for wetland-dependent communities. The availability of water plays a key role in the attractiveness of the site for resting and breeding of resident and migratory fauna, especially birds.		
Surface water flow	Flow regimes poorly understood: Historically, lagoon mouth has been artificially breached by local landowners. Alterations to the natural hydrological regime impacts on other components such as geomorphology, water quality, vegetation and fauna. Surrounding farmland drains into the lagoon via a series of channels. High water levels in the lagoon have previously been blamed for inundated pasture on surrounding farms. The link between climate and hydrology is poorly understood. For example, the amount of rainfall required to maintain the natural hydrology.	No unnatural opening of the lagoon mouth. Site observations indicate that fluvial inflows are a significant input of surface water to the lagoon. Whilst this inflow is beneficial in maintaining water in the lagoon, poor water quality in inflow waters could offset this benefit. Site specific hydrology data and further water quality data is therefore required before LAC can be set that takes into account these factors.
Tidal exchange	Historical information on lagoon mouth opening is anecdotal. Future monitoring should include the status of the lagoon entrance (open/closed) because parameters such as salinity may be highly variable when lagoon is open to the ocean.	No unnatural opening of the lagoon mouth. The lagoon is rarely open to the ocean. However, when the hydrological regime shifts to a marine system, advice on appropriate parameters should be sought.

Water Quality: provides suitable water quality to support the persistence of wetland dependent flora and fauna. The ecological character of the site currently depends on the quality of water entering and being retained within the lagoon. Baselines need to be set before LAC can be set.		
Water quality	Only two water samples recorded from the site. pH: Limited data indicates pH of 7.2-7.7 in Logan Lagoon waters. Potential for acid sulphate soils to impact on pH of lagoon waters. Salinity: Limited data indicates salinity (as Total Dissolved Solids) ranging between 2,600-35,700 mg/L: Salinity highly variable depending on seasonal climatic and hydrological processes. Dissolved Oxygen: No data available. Turbidity: Limited data indicates range between 0.5 and 4.9 NTU: Turbidity varies with freshwater inflows, wind and tidal influences. Nutrients: Limited site data indicates Total P (0.09 – 0.2 mg/L and Total N (1.4-1.5 mg/L).	Cannot determine LAC due to insufficient data.
Vegetation: the hydrology, climate, water quality and soil quality of Logan Lagoon influence the vegetation that is supported at the site. The threatened wetland-dependent vegetation communities contribute to the regional biodiversity and selection of Criterion 1 and 3.		
Threatened plant species	There are currently three threatened wetland-dependent plant species mapped at the site.	In the absence of accurate mapping, a common sense approach has been adopted, setting a limit of acceptable change as the persistence of the following threatened species within the Logan Lagoon boundary: Swamp fireweed (*Senecio psilocarpus*) Large-fruit seatassel (*Ruppia megacarpa*) Northern leek orchid (*Prasophyllum secutum*) These three species are cryptic and therefore seasonally specific surveying will be required to identify them. Species should be observed during two out of every three surveys.

Threatened plant communities	Poor quality information on the current distribution and abundance of threatened plant communities because maps based on TASVEG mapping layers have not been ground-truthed. The areas of threatened wetland-dependent vegetation communities are: Saline aquatic herbland = 9.23 hectares Freshwater aquatic herbland = 1.28 hectares Lacustrine herbland = 3.71 hectares	There are 14.22 hectares of threatened wetland-dependent vegetation communities at the site. Common sense would suggest no loss greater than 10 percent for each wetland type based on TASVEG mapping layers. Because the wetland map was made without proper ground-truthing, verification of areas will be required. Based on current estimates made for this ECD, the maximum areas of threatened wetland vegetation that could be lost before causing unacceptable change to the site are: Saline aquatic herbland: 0.9 hectares Freshwater aquatic herbland: 0.5 hectares Lacustrine herbland: 4 hectares
Fauna: Logan Lagoon supports and large number of birds, many with conservation significance locally, nationally, and internationally which justifies the selection of Ramsar criteria 3, 4 and 6.		
Number of waterbird species counted at the site annually	Annual counts of waterfowl carried out at Logan Lagoon during February 1985 - 2009, excluding 1987, 1989, 1994 and 2008. The area counted varied among years and data are not comparable, making it difficult to detect population trends.	No LAC can be determined due to insufficient data. To be defined once population trends for waterfowl are clear from systematic annual counts.
Number of shorebirds recorded in annual surveys	There has been no systematic, long term monitoring of shorebirds within the Ramsar site to enable a numerical baseline to be set, although Birds Tasmania conducted counts along the ocean coastline of the site in 2008 and 2010, and is planning future work.	No LAC can be determined due to insufficient data. To be defined once population trends for shorebirds are clear from systematic annual counts.
Threatened mammals, reptiles, amphibians	Very little systematic data. Poor information on the current distribution and abundance of threatened species.	No LAC can be determined due to insufficient data. To be defined once systematic surveys undertaken for a range of species.

8. THREATS TO THE ECOLOGICAL CHARACTER OF THE LOGAN LAGOON SITE

The major threats to the maintenance of environmental values in the Logan Lagoon Ramsar site are summarised in Table 16. These risks result from activities within the wetlands themselves, on adjacent land and within the catchment generally, and an integrated approach to their management is required. Further detail on the identified threats is given in Section 8.1 to 8.7.

The Logan Lagoon Ramsar site has previously been classified as a near-pristine wetland (Dunn, 2002). However, the impacts of recent threats at the site, such as frequent fire, feral pests or inappropriate recreational vehicle use, need to be assessed before the 'near-pristine' classification is applied in future.

Table 16. Summary of threats the ecological character of the Logan Lagoon Ramsar site, the potential impacts to the components, processes and services, the likelihood of a threat occurring, and an estimated timing.

Threat to ecological character	**Potential impacts to wetland components, processes and/or services**	**Likelihood**	**Timing of threat**
Inappropriate fire regime	Altered vegetation communities Loss of threatened communities Increased susceptibility of dune systems to erosion	Certain	Immediate
Inappropriate use of recreational vehicles at the site	Disturbance to resident and migratory fauna Erosion of shoreline vegetation and alteration of dune structure Damage of soils and vegetation – potential for activation of acid sulphate soils Disturbance of coastal breeding birds and/or destruction of their eggs	Certain	Immediate

Threat to ecological character	Potential impacts to wetland components, processes and/or services	Likelihood	Timing of threat
Alteration to drainage regime: Artificial opening of the lagoon mouth Modifications of the natural flow into the lagoon	Changes to the hydrological regime Unnatural water quality conditions Reduced water depth leading to reduced habitat for some species	Medium	Immediate – Medium term (5 years)
Introduction of animal and plant pests diseases Feral pigs and cats	Reduction of habitat and changes in vegetation structure Competition with native flora and fauna Introduction of disease (e.g. *Phytophthora cinnamomi* or Chytrid fungus) Loss of native species Change to geomorphic processes (for example proliferation of marram grass, sea spurge)	Certain	Immediate
Surrounding land use/agriculture	Sediment deposition and increased turbidity Nutrient enrichment from pastoral runoff Salinisation Movement of weeds into the system	Certain	Medium term (5 years)
Climate change impacts via: Sea level rise Changed rainfall patterns Changed temperature and wind regimes More frequent and severe weather events	Altered hydrological regimes – timing, magnitude and frequency of flows Variations to water depth Altered habitat condition and availability for flora and fauna Coastal retreat and habitat loss	Medium	Medium – long term (5 years to decades)

8.1. Fire

Islands of the Furneaux Group were not occupied by Aboriginal people at the time of European settlement and archaeological evidence suggests there were probably no human-induced influences such as fire on the vegetation for at least several thousand years before European settlement. Since the arrival of Europeans, Flinders Island has been subject to a regime of frequent and extensive firing which has dramatically altered some of the vegetation within the Logan Lagoon site.

The vegetation on the western windward side of the lagoon is very conducive to fire, containing areas of tussock grasslands, sedgeland, heath and scrub. Similarly, in the southern part of the Ramsar site, there is

mainly *E. nitida* dominated scrub with a heath understorey which in many places has been converted to a predominantly bracken understorey by the high fire frequency.

The lagoon itself has little combustible vegetation (even when dry) and acts as a firebreak, protecting the vegetation to the east of Logan Lagoon from fires in other parts of the site. Consequently, this area has remnant vegetation communities that are of conservation significance (Parks and Wildlife Service 2007), including stands of western peppermint, coast tea tree, silver banksia and Oyster Bay pine (see Appendix F; Table F2) for a description of these species).

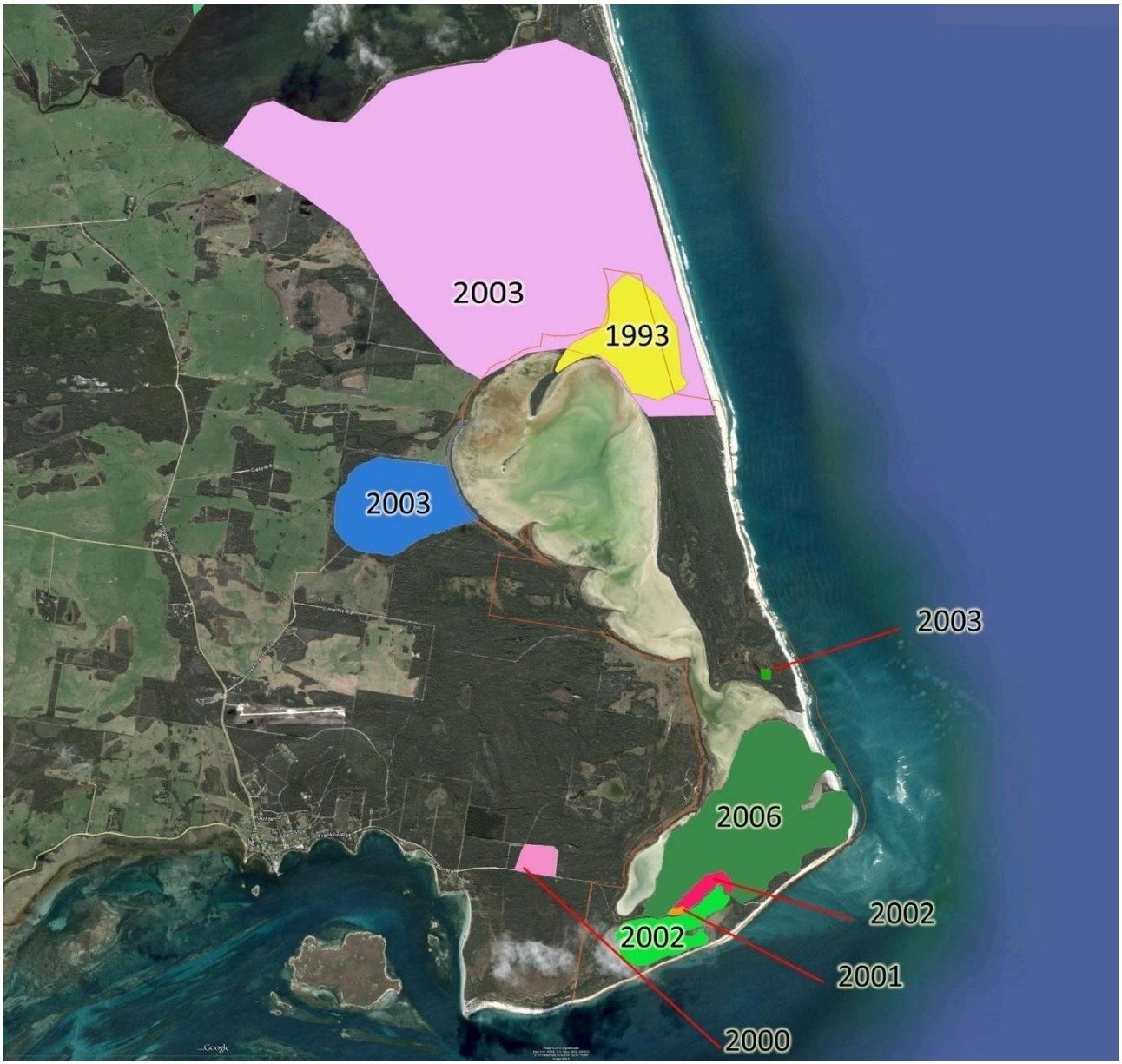


Figure 22. Map of the estimated area of fires in the vicinity of Logan Lagoon Ramsar site since 1993. The colours represent the extent and year of the different fire events (Data layers: DPIPWE – Parks and Wildlife Service; Created by Elgin Associates 2010).

Fire frequency at Logan Lagoon (Figure 22) may have varying degrees of impact on the different vegetation communities, as some communities are more susceptible to changes in fire regime than others. For example, frequent firing has, in some areas, led to the replacement of woody vegetation by floristically poor bracken fields or tussock grasslands (Figure 23). The dense vegetation is often perceived as a safety risk due to potential wildfire and often results in legal and illegal fuel-reduction burning. Species which

regenerate from seeds, rootstocks or sensitive underground organs are often eliminated by such frequent fires (Parks and Wildlife Service 2007).

Two native grassland communities (Coastal grass and herbfield and Lowland *Poa labillardierei* grassland) occur in patches throughout the site. Fire is considered to be an important management tool for native grasslands, as it impedes the establishment of woody species and provides disturbance that maintains high species diversity. Appropriate fire regimes vary depending on the grassland type, the grazing regime and the species present (DPIWE 2007).

Figure 23. Aerial photograph of the northern area of Logan Lagoon Ramsar site illustrating the change in vegetation structure between areas with low (A) and high (B) fire frequency (Photograph: Luke Finley, Elgin Associates, July 2009).

The *Callitris rhomboidea* forest community occurs at the northern end (Figure 23) of the Logan Lagoon Ramsar site and the Chain of Lagoons area (S Harris, DPIPWE, *personal communication* 12 Oct 2009). *Callitris rhomboidea* is fire-sensitive, generally confined to infrequently burned vegetation in eastern Tasmania and although it will regenerate well after fire, frequent fires will eliminate it (DPIWE 2007). Other vegetation communities that occur throughout the Ramsar site are also vulnerable to changes in fire frequency and rely on appropriate fire regimes to maintain the species composition of the communities.

Fire management in the Ramsar site is important for the protection of assets, such as private land to the west, and the township of Lady Barron five kilometres to the west. Although the maintenance of specific conservation values often depends upon periodic low-intensity fires (Parks and Wildlife Service 2007), the recent high frequency of fires at the site is unsustainable and it is argued that fire should be prevented (where possible), particularly on the eastern side of the lagoon.

8.2. Recreational activities

Visitor numbers to the Ramsar site have not been recorded, but it is believed that they are increasing. Logan Lagoon is close to the township of Lady Barron and is used by local people, as well as tourists, for a

range of recreation activities (fishing, bird watching, beach walking and off-road driving). No camping areas or toilets have been provided at the site (Parks and Wildlife Service 2007).

Under regulation 18 and 28 of the National Parks and Reserved Land Regulations 2009, off-road driving is not permitted within the Logan Lagoon Ramsar site, unless a person is driving in a 'designated vehicle area' or has been granted an 'authority to do so'. People access the area in off-road vehicles and motorbikes to go beach fishing and duck hunting on Crown Land. Off-road vehicle use may impact on the Ramsar site's key natural values via erosion, vegetation damage, spread of introduced plants, disturbance of breeding birds and the destruction of their eggs.

Figure 24. Recreational vehicle tracks leading around the edge of Logan Lagoon towards its opening to the ocean (Photograph: Luke Finley, Elgin Associates, July 2009).

Evidence suggests that inappropriate off-road driving and the use of two, three and four wheeled motorbikes is becoming more common, causing damage to the vegetation within the Ramsar site, particularly to the saltmarsh edge at the mouth of the lagoon (Figure 24 – disturbance tracks). The vegetation is easily damaged and takes many years to recover, so vehicle tracks are easily recognisable. Logan Lagoon also has some small localised areas with a high potential (>70% chance) of Acid Sulphate Soils (ASS). Damage from vehicles (Figure 25) can exacerbate ASS because the protective covering of vegetation is often damaged or removed, thus enabling oxidation of the underlying substrate.

Environmental damage is greater in winter because vehicles bog more easily in the soft, wet ground. Recreational driving has also caused erosion at the lagoon mouth where vehicles have spun tyres in the soft sediments or become bogged. Off-road driving on sand dunes north of the Ramsar site has resulted in vegetation being destroyed, allowing blowouts to develop. The use of off-road vehicles on Planter Beach south of Cameron Inlet within the Ramsar site is a major problem, causing erosion of sand dunes, disturbance of beach and coastal breeding birds and destruction of their eggs. Anecdotal evidence suggests that little terns have attempted to nest at Pot Boil Point since about 1994 but have failed, partly due to human disturbance (Parks and Wildlife Service 2007).

Figure 25. Evidence that the protective covering of saltmarsh vegetation (*Sarcocornia quinqueflora*) is being damaged by frequent passage of recreational vehicles, thus enabling exposure and possible oxidation of the underlying substrate (Photograph: Luke Finley, Elgin Associates, July 2009).

8.3. Anthropogenic changes to drainage

Logan Lagoon is generally one to two metres in depth and is isolated from the sea by a large sand bar. Consequently, the water level of the lagoon fluctuates seasonally with rainfall, generally being high during winter and spring and low during late summer and autumn. Opening of the sand bar occurs periodically under natural conditions, and can be breached from either side. Breaches occur from the lagoon side when it is full and overflowing, and from the seaward side when rough seas erode the dunes during persistent easterly weather or large storms. In extended dry periods (between 1995 and 1996, and between 1998 and early 2000) the lagoon dried out and water was only contained in the southernmost section. All other lagoons on the east coast of Flinders Island, except Cameron Inlet, were also dry. During much of 1998, 1999 and early 2000, the lagoon mouth was open naturally.

Drains have been constructed on private land adjacent to Logan Lagoon that channel runoff into Pot Boil Creek. In this way, water has been directed into the lagoon from as far away as Bootjack Flats, approximately seven kilometres west of the lagoon. Many of these drains have become overgrown with vegetation, impeding the movement of water, and during extended periods of wet weather the land adjacent to the lagoon becomes waterlogged. The water level in the lagoon has often been blamed for this waterlogging and on a number of occasions the mouth was artificially opened without authority. Opening the lagoon mouth by excavating a channel to the ocean has been common practice during the past 50 years. There was a belief by local farmers that this relieved the inundation of land surrounding the lagoon. However, a Department of Agriculture (1987) report indicates that the waterlogging was caused by lack of water movement within the drains rather than the water level of the lagoon.

Human interference in the natural hydrological processes of Logan Lagoon, such as artificially opening the mouth, may be detrimental to many of the species inhabiting the lagoon ecosystem, including aquatic plant

and algal species, fish, amphibians, birds, crustaceans and gastropods. Aquatic plant species that occur in these coastal lagoon systems are well adapted to natural fluctuations in physical conditions, such as varying salinities, elevated water temperatures and prolonged exposure to air. However, artificial modification to the hydrological regime may also modify other physical or biological parameters that in turn affect ecosystem services (Parks and Wildlife Service 2007). For example, species that have adapted to the extreme variability in environmental conditions, such as salinity, may require extended periods of evaporation and hypersalinity to complete a particular stage of their lifecycle (Parks and Wildlife Service 2007).

Interference in the natural processes of the lagoon by artificially opening of the nearby Cameron Inlet lagoon mouth was shown to have adverse impacts on waterfowl (Mooney 1996). Impacts comprised:

- reduced food supplies and a consequent decline in hatchlings, primarily due to a reduced water perimeter and shallows;
- reduced nest security and increased exposure to predation;
- reduced chick survival due to exposure while moving over sand and mud to the receding waters edge; and
- reduced chick survival due to reduced food supplies and vegetation cover.

8.4. Feral pests

Introduced animal species have established wild (feral) populations on Flinders Island and in the Logan Lagoon Ramsar site. Feral animals pose varying threats to the native fauna and flora.

8.4.1. Pigs

Pigs (*Sus scrofa*) became feral on Flinders Island in the 1800s after being released by sealers and following the shipwreck of the *City of Foo Chow* in 1877. This population has since been supplemented by pigs that were accidentally or intentionally released. The main populations of feral pigs on Flinders Island occur in Strzelecki National Park in the southwest corner of the island and throughout the wetlands along the east coast, including the Logan Lagoon Ramsar site (Copson 2002).

It is believed that the populations of feral pigs in Strzelecki National Park and those found in wetlands along the east coast of Flinders Island could be separate populations, as extensive land clearing for agriculture has effectively isolated the two populations (Tasmanian Planning Commission 2010). It is difficult to estimate the current number of feral pigs on Flinders Island because they are elusive animals and are rarely sighted. It was conservatively estimated that 1000 feral pigs were present on the island in 2001, with at least this number remaining in April 2008 (Tasmanian Planning Commission 2010).

Feral pigs are widespread throughout the Ramsar site, usually associated with seasonal wetlands because of their reliance on fresh water (Parks and Wildlife Service 2007). Habitat degradation is one of the main threats to plant species within the Ramsar site and feral pigs have caused extensive localised damage to terrestrial and wetland vegetation (Parks and Wildlife Service 2007). Extensive runways have been created and pigs uproot large areas of the soft sandy soils in their search for food (Figure 26).

Figure 26. Damage to pasture caused by pigs on farmland adjacent to Logan Lagoon Ramsar site (Photograph: Luke Finley, Elgin Associates, July 2009).

Feral pigs consume a range of native flora and fauna, such as reptile and bird eggs, frogs, invertebrates, fungi, roots and tubers. The uprooting disturbance to vegetation and soils can destroy soil structure, promote erosion and invasion by weeds, displace invertebrates and hasten drying out. Ecological parameters affected by feral pig activities include species composition, succession, and nutrient and water cycles. Feral pigs may contribute to the spread of cinnamon fungus *Phytophthora cinnamomi* (DEH 2005).

Feral pigs impact endangered heathlands, valuable wetlands, estuarine marshes and relict *Callitris rhomboidea* scrub-woodland communities, all of which are of considerable conservation significance (Section 4.7). They also impact upon the New Holland mouse, *Psuedomys novaehollandiae* (vulnerable, EPBC Act and TSP Act) by uprooting their burrows (Tasmanian Planning Commission 2010).

Predation, habitat degradation, competition and disease transmission by feral pigs is listed as a key threatening process under the EPBC Act. A threat abatement plan (DEH 2005) has been prepared under the EPBC Act to protect listed native species and ecological communities from the impacts of pigs, and to prevent impacts of pigs from causing further species and ecological communities to decline and become listed as threatened.

Funds were obtained in 1998 from the Natural Heritage Trust to undertake a comprehensive study of feral pigs on Flinders Island. The study focused on the impact of pigs on the values of Strzelecki National Park (where the population is relatively isolated and surrounded by farmland) and prescribed more effective management strategies for their control and possible eradication in this area. Although not developed for the East Coast region containing Logan Lagoon (at the time of writing), the strategy could be applied to feral pig populations in other parts of Flinders Island, including the east-coast wetlands.

There is currently little feral pig control carried out at Logan Lagoon other than the occasional shooting of pigs by local residents (J Cooper, Feral Management Solutions, *Personal communication.* 23 February 2010).

8.4.2. Cats

Feral cats are widespread on Flinders Island, including throughout the Logan Lagoon Ramsar site (Parks and Wildlife Service 2007). Feral cats are known to prey on native wildlife, but may also have indirect effects on native fauna by carrying and transmitting infectious diseases such as toxoplasmosis (DEWHA 2008b).

On mainland Tasmania and Australia, rabbits appear to make up a large part of the feral cat's diet. However, on Flinders Island there are no rabbits and therefore native birds, reptiles, rodents and other small mammals are the staple diet of feral cats (DEWHA 2008b). Bird species that reside at or visit Logan Lagoon are particularly vulnerable to feral cat predation because they may spend some or all of their time on the ground, particularly during nesting season. Birds that are particularly susceptible to cat predation include the hooded plover (which nests below the dunes along beaches), fairy tern (Vulnerable on the IUCN Red List, and TSP Act), little tern (Endangered, TSP Act) and white-fronted tern (Vulnerable, TSP Act) (Flinders Council, 2010). The *Threat Abatement Plan for Predation by Feral Cats* (DEWHA 2008b) also lists the fairy prion (Vulnerable, EPBC Act) as a species which may be adversely affected by feral cats and this species may occur in the Logan Lagoon area.

Predation by cats is listed nationally as a Key Threatening Process under the EPBC Act. The *Threat Abatement Plan for Predation by Feral Cats,* (DEWHA 2008b) identifies research, management and other actions needed to control cats. Tasmania has no specific legislation to control cats, although there are regulations that prohibit them being abandoned in public reserves. Flinders Council is implementing a range of voluntary measures to control both domestic and feral cats.

The Furneaux Field and Game Association, in conjunction with NRM North, received funding through the Federal Government Envirofund to implement a Cat Management Program on Flinders Island (Flinders Council 2010). This program supported responsible domestic cat ownership and identified key information about feral cats that will be used in ongoing feral cat management. The program included feral cat surveys to identify distribution, diet and their effect on native wildlife. A feral cat trapping program has been completed, consisting of an intensive seasonally targeted phase and an ongoing random trapping and data collection program. Some of this work was carried out in the Logan Lagoon area (J. Cooper, Feral Pest Management Solutions, *personal communication,* 23 February 2010).

8.4.3. Other pests

Some exotic birds are also present in the Logan Lagoon area. For example, European starlings (*Sturnus vulgaris*) compete with native birds for nesting hollows. Domestic dogs, including those used for hunting in the Chain of Lagoons area, may pose a risk to native wildlife. Rabbits and foxes have not been introduced to Flinders Island, which is fortunate because these two species can have a devastating impact on vegetation and native fauna (Parks and Wildlife Service 2007).

8.5. Introduced plants and pathogens

Recent years have seen the spread and new invasions of exotic plants throughout Flinders Island. A number of introduced plant species, as well as the root-rot fungus *Phytophthora cinnamomi,* have been introduced to the Logan Lagoon Ramsar site.

8.5.1. Weeds

A number of 'declared' weeds (*Weed Management Act 1999*) occur in the Logan Lagoon Ramsar site. Pampas (*Cortaderia selloana)*, slender thistle (*Carduus pycnocephalus)*, and African boxthorn (*Lycium ferocissimum)* are all listed as declared weeds in Tasmania (Parsons and Cuthbertson 1992). All of these

species are invasive and out-compete other plants, particularly where the soil has been disturbed. Sea spurge (*Euphorbia paralias)* is also colonising the southern beach of the Ramsar site (Figure 27).

Figure 27. Sea spurge (inset) covering the incipient foredune of the southern coastline of the Logan Lagoon Ramsar site. Sea spurge is distributed on many of the beaches and coastal ecosystems of Flinders Island (Photograph: Luke Finley, Elgin Associates, July 2009).

Sea spurge is one of a number of weeds that are significantly affecting beach and coastal ecosystems (Figure 27) throughout Flinders Island and the rest of Tasmania. Sea spurge invades beaches and dune plant communities, displacing native species (Parks and Wildlife Service 2003). It also alters the structure of dunes and creates a dense vegetation cover on sand spits and along the back of the beach where few plants normally grow. This is likely to have serious impacts on some beach nesting shorebirds, such as pied oystercatchers, hooded and red-capped plovers, and beach-nesting seabirds such as little and fairy terns, which prefer open sands for nesting (DPIPWE 2010).

Pampas grass, *Cortaderia selloana,* thrives in a variety of habitats in Tasmania, including coastal heath and dune systems. The most severe infestations occur on Flinders Island. The Flinders Island community is in the process of implementing a 10-year pampas grass eradication strategy (DPIPWE 2009f). Pampas grass primarily reproduces by seed but can grow from root segments. Seed production is highly prolific, with up to 100,000 seeds per flower head which are light and can be windblown up to 25 kilometres. An individual plant therefore has tremendous potential to spread.

Slender thistle is a widely distributed, serious weed in Tasmania. It occurs in most agricultural areas where it invades pastures, crops and neglected areas with moderate to highly fertile soils. It commonly infects areas that receive more than 500 millimetres rainfall per year and readily establishes on disturbed sites (DPIPWE 2009g).

African boxthorn is a woody shrub, the stems of which bear large, rigid spines. It may grow to five metres high. It is found at a range of locations around Tasmania, and was previously planted for hedging purposes, mostly on farms. From these deliberate plantings it escaped into adjoining pastures and roadsides. Some of the most severe infestations occur across the Furneaux Islands (DPIPWE 2009h).

8.5.2. *Phytophthora cinnamomi*

Phytophthora cinnamomi is an introduced plant pathogen that has the capacity to kill a wide variety of native plant species. It is widely recognised as one of the most threatening of all disease epidemics to affect native plant communities anywhere on the globe (Schahinger *et al.* 2003). In consequence, dieback caused by the root-rot fungus *Phytophthora cinnamomi* is listed as a key threatening process under the EPBC Act (DEH 2006). A threat abatement plan (DEWHA 2009c) has been prepared under the EPBC Act to protect listed native species and ecological communities from the impacts of *Phytophthora,* and to prevent the impacts of *Phytophthora* from causing further species and ecological communities to decline and become listed as threatened.

Phytophthora cinnamomi is recognised as being a very real and rapidly spreading threat to many of Tasmania's plant species and communities (Rudman 2005; Schahinger *et al*. 2003). The pathogen is causing a substantial decline in the populations of many susceptible plant species and markedly modifying the structure and composition of plant communities. Most of the susceptible plant communities occur within the moorland, heathland and heathy dry sclerophyll vegetation types (Schahinger *et al*. 2003).

The most serious epidemics of *Phytophthora* are those that pose identifiable threats of extinction for some rare and threatened species and ecological communities and cause serious disruption, and modification of structure and bioproductivity in native communities over extensive areas. These epidemics are found in temperate climatic zones south of 30 degrees latitude (DEWHA 2009c), including winter-dominant rainfall areas in maritime climates of coastal and sub-montane Tasmania, such as Flinders Island. *Phytophthora cinnamomi* is widespread on Flinders Island and the areas considered to be most at risk are the Wingaroo Nature Reserve in the north-east of Flinders Island and the Northern Patriarchs on the east coast, north of Logan Lagoon. These areas contain vegetation communities that are particularly susceptible to the pathogen (Schahinger *et al*. 2003).

Phytophthora cinnamomi is present at Logan Lagoon but the impact of the disease on the wetland-dependent or other vegetation has not been investigated (T Rudman, DPIPWE, *personal communication*, 10 February 2010). Vegetation communities that are wetland-dependent and susceptible to *Phytophthora* are lowland sedgy heathland (SHL) (T Rudman, DPIPWE, *personal communication*, 10 February 2010). The lowland sedgy heathland occurs in one small patch in the north of the site, as well as several larger patches just outside the boundary to the west (Section 4.7). If these areas became infected with *Phytophthora,* it would be difficult to contain because vectors, such as feral pig activities and vehicle-use, would allow the spread of the pathogen throughout the site. The subsequent infection of other vegetation, particularly wetland-dependent communities, poses a significant threat to the ecological character of the site.

8.5.3. *Chytrid fungus*

Chytrid fungus (*Batrachochytrium dendrobatidis*) causes the disease known as chytridiomycosis or chytrid infection and currently threatens Tasmania's native amphibians. The fungus infects the skin of frogs, destroying its structure and function, and can ultimately cause death. Sporadic deaths occur in some frog populations, and 100 percent mortality occurs in other populations.

The disease has now been recorded in four regions in Australia - the east coast, southwest Western Australia, Adelaide and Tasmania. In mainland Australia, chytrid has caused the extinction of one frog species, and has been associated with the extinction of three other species. Researchers from DPIPWE conducted a preliminary survey for chytrid fungus in 2009. They swabbed the mouthparts of 20 Limnodynastes tadpoles to determine chytrid status, however, the swabs have not been analysed due to budgetary constraints (Annie Phillips, DPIPWE, *personal communication.* 21 Dec 2009). Analysis of these swabs would indicate whether frogs at Logan Lagoon are infected with chytrid fungus.

8.6. Surrounding land use – agricultural

Most of the water that enters the Logan Lagoon Ramsar site originates in or flows through land that is subject to agricultural activities, particularly pasture improvement for grazing (Figure 28). Runoff and leaching of fertilisers into the water system may impact on the natural properties of the lagoon, through changes in water parameters such as pH, phosphates, nitrates and turbidity, and introduction of toxicants into the system. Nutrient enrichment can lead to eutrophic conditions, where rapid growth and subsequent die-off of aquatic vegetation can result in smothering of wetland beds by wrack and deficient dissolved oxygen levels.

Agricultural land in the vicinity of coastal lagoons is periodically subject to flooding and fluctuations in salinity are part of the natural hydrological cycle. A buffer of native or riparian vegetation along streams leading into coastal lagoons can help to reduce the impact of frequent flooding, particularly if salt and flood-tolerant species are planted in the expected zone of flooding (Parks and Wildlife Service 2007).

Figure 28. Aerial photograph of the Eastern coastline of Flinders Island. At the top of the frame is the area known as Chain of Lagoons (top left) and large water mass in the top right is the northern extremity of Logan Lagoon Ramsar site. The land in the foreground contains dams and drainage channels, and evidence of clearing of vegetation for conversion to grazing land (Photograph: Luke Finley, Elgin Associates, July 2009).

8.7. Climate change

Climate change is considered a threat to the ecological character of the site, with estuaries and wetlands identified as one of the coastal ecosystem types most at risk from the effects of climate change (DCC 2009). Changed weather patterns and rising sea levels have the potential to cause wide ranging impacts at the site that could result in fundamental changes to its structure and ecology.

Climate predictions for north-eastern Tasmania suggest a generally warmer climate which is wetter in all seasons. Mean daily temperatures are projected to be warmer (both minimum and maximum temperatures) with increased solar radiation, relative humidity in summer, and increased evaporation (ACE CRC 2010). Changes associated with such a climate may potentially impact the hydrology, geomorphology, vegetation, habitat and species at Logan Lagoon.

Figure 29. Coastal erosion on Planters Beach displaying the undercutting of dune structure by ocean processes and associated destruction of vegetation (Photograph: Luke Finley, Elgin Associates, July 2010).

On average, annual runoff in the eastern areas of the state is generally projected to increase, particularly in the lowlands (ACE CRC 2010). Whilst an increase in seasonal flow to the East coast lagoons may contribute to higher water levels and longer water retention times, these may be offset by the projected increase in temperature, solar radiation and evaporation. For plant and animal species, variation in climate can cause stress, affect their behaviour and phenology (i.e. response to temperature), and provide opportunities for weeds and invasive species to fill niche gaps previously held by stressed species (DCC 2009). Factors such as these can change ecosystem composition and function and reduce suitable habitat for many animals, including migratory birds (DCC 2009).

The site is vulnerable to the impacts of rising sea levels, due to a coastal setting that includes an open-coast sandy shoreline which is backed by lagoons and sandy low lying plains. For coastal settings of this type, sea level rise and a higher frequency of extreme high tide events, associated with climate change, could potentially result in major geomorphic and hydrological changes. These include increased shoreline erosion and associated landward recession, followed by inundation of seawater into lagoons, wetlands and other low lying areas (Sharples 2006). Seawater inundation could occur via the existing lagoon entrance, with DCC

(2009) predicting intermittent lagoon entrances (such as at this site) could become more permanent. Depending on the extent of dune erosion and/or increased mobility, new lagoon entrances could also be formed (Sharples, 2006) and coastal groundwater tables would also be expected to rise and become more saline (DCC 2009).

9. CHANGES TO THE COMPONENTS AND SERVICES SINCE LISTING

There are few records of the ecological condition of the Logan Lagoon Ramsar site in 1982. This makes identifying and establishing changes to the components and services difficult. Anecdotal evidence from Flinders Island locals, searches of the Tasmanian Archives and interviews with current and previous managers of the site revealed a range of issues that have potentially impacted upon the ecological character of the site.

Periodic human interference in the natural hydrological processes of Logan Lagoon, such as artificial opening of the lagoon mouth (Section 8.3), was more frequent in the time leading up to 1982. Artificial opening may have been detrimental to species inhabiting the lagoon ecosystem, including aquatic plant and algal species, fish, amphibians, birds, crustaceans and gastropods. Reduction in the frequency of forced opening since listing has likely improved some critical components, particularly the site's water quality and hydrological regime, and these may be closer to their natural state than at the time of listing.

The impacts of feral animals on the ecological character of the site have probably increased since 1982 (W Dick, DPIPWE Parks, *personal communication*, 7 June 2010) although their impact has not been quantified. Pigs can modify geomorphology and soil quality, which affects the integrity of vegetation and water quality. Cats threaten the birdlife supported by the lagoon, either by direct predation or the spread of disease.

The two water samples collected from Pot Boil Creek in 1982 and 2009 (Section 4.6) display similar characteristics, with surface water inputs to Logan Lagoon dominated by sodium and chloride ions. However, given the ephemeral nature of the site, two water samples taken 28 years apart tell little about the change between sampling events.

Some threats to the site can rapidly change the ecological character (forced opening of lagoon mouth), whereas others are ongoing in nature (feral animals or drainage of the surrounding land) and seem to have been contributing to the ecological character well before the time of listing. Other threats, such as introduced disease, may have a devastating effect on local populations of flora and fauna, particularly threatened species, if adequate prevention and control measures are not implemented.

In summary, many of the site features that supported the listing of Logan Lagoon as a wetland of international importance in 1982 remain. However, changes to the site's ecological character between listing and present day are not well documented and. there is insufficient evidence or data to determine whether the Limits of Acceptable Change have been exceeded.

10. SUMMARY OF KNOWLEDGE GAPS

There is an overall paucity of scientific data and information on the Logan Lagoon Ramsar site, and extensive monitoring plans could be suggested for almost every component, benefit, or service. However, it is important to identify and prioritise only those monitoring needs that are important for describing and maintaining the ecological character of the system – the critical components, processes and services (Section 5.1).

The key knowledge gaps that require research in order to fully describe the ecological character of Logan Lagoon are listed in Table 17. Actions required to fulfil the recommendations will enable rigorous and defensible limits of acceptable change to be established into the future. The paucity of relevant information will need to be addressed for most components and processes, before limits of acceptable change can be defined. A more detailed description of the essential monitoring requirements for assessing limits of acceptable change in future is detailed in Section 11.

Table 17. Identified knowledge gaps and recommended actions.

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP	RECOMMENDATION
Climate		
Climatic processes (High)	The relationship between climatic conditions (rainfall, temperature, wind and evaporation) and the hydrological responses to such conditions, and the requirements for maintaining the natural hydrology of the site, are poorly understood.	Monitor hydrological indicators such as water level, flow rates and the extent of inundation under a range of climatic conditions.

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP	RECOMMENDATION
Geomorphology		
Geomorphic features (Medium)	Geomorphic landforms, materials processes, ages and stability of the site are poorly described (in the literature).	For management purposes a better understanding of geomorphic response to projected climate change, especially sea level rise, would be useful. TASMARC methodology provides an indication of the month-to-month and seasonal shoreline movement, and as a basis for long-term (i.e. covering years to decades) observation of the movement of beaches. The techniques are relatively simple and could be readily accomplished by Coastcare groups (TASMARC 2004).
Soils (Medium)	Potential acid sulphate soils: The effect of disturbance on acid sulphate soils has not been investigated at the site.	Review the potential and actual threat of acid sulphate soils to water quality and ecological character of the site.
Hydrology		
Hydrological processes (Medium)	There is no systematic information on the water levels within Pot Boil Creek or the lagoon. No information on the flow of groundwater through the system.	Pot Boil Creek flow monitoring. Groundwater monitoring. Lagoon level monitoring.
Water Quality		
Water Quality (High)	There is no comprehensive data on water quality, particularly the influence of surrounding land practices, or changes during different hydrological conditions (eg opening of the lagoon to the ocean).	Regular water quality monitoring for salinity, nutrients and key toxicants such as pesticides and herbicides. Monitor the water quality under different hydrological regimes to establish baseline parameters for typical scenarios (i.e. lagoon mouth open/closed)

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP	RECOMMENDATION
Vegetation		
Wetland-dependent vegetation (High)	All vegetation was mapped using 1:42 000 aerial photos taken in 1999. There was no ground-truthing in the area. The distribution of Ramsar wetland types, including threatened wetland-dependent communities, has not been established and there is evidence that the area of some types may be expanded (Section 4.8). There is no recent information on the community composition, distribution and temporal patterns of aquatic communities within the estuary.	Ground-truthing and re-classing (where necessary) of the site's vegetation in a systematic way. Map the distribution of Ramsar wetland types identified in Section 3.5. Map the extent and species composition of aquatic communities within the lagoon.
Littoral vegetation (High)	There is very little current information on the extent and condition of threatened species or communities. The distribution and impacts of exotic plant species and *Phytophthora* within the site. The impact of fire on the current extent and condition of vegetation types is unknown.	Establishment of baseline flora species and community data. Establishment of permanent transects across hydrological gradients. Low level aerial photography taken in November/December every five years in conjunction with resurveying transects. Map exotic species and *Phytophthora* within the site and identify the level of threat these pose where they occur. Investigate the impact of fire on the vegetation species and communities.
Fauna		
Mammals, Reptiles and Amphibians (High)	There are limited fauna observations at the site, particularly for threatened species such as New Holland mouse, common wombat (Bass Strait), and green and gold frog. The presence of frogs infected with Chytrid fungus has not been confirmed but poses a significant threat to frog populations at the site.	Systematic fauna searches with a focus on wetland-dependent threatened species. Analyse the swabs previously obtained from frog mouth parts to confirm the presence of Chytrid fungus.

COMPONENT / PROCESS / SERVICE	IDENTIFIED KNOWLEDGE GAP	RECOMMENDATION
Fish (Medium)	There is very little current information on the community composition and abundance of fish communities.	Investigation of the fish population in Pot Boil Creek and Logan Lagoon, particularly the Dwarf galaxias.
Birds		
Waterfowl * (High)	There has been a long term survey and reporting of abundance and species composition but there are insufficient data to determine spatial and temporal trends or habitat usage.	Continue waterbird monitoring following a formalisation of the survey methodology. Species of particular interest as the site supports > 1 % of the population are: Musk Duck (250) Chestnut teal (1000)
Shorebirds (High)	Shorebird surveys of Logan Lagoon have been mainly limited to the immediate coastline. Standardised methodologies have been used over time to permit limited and preliminary determination of spatial and temporal trends or habitat usage by some species.	Establish shorebird monitoring program using appropriate methodology to allow quantitative estimates of site populations. Extend shorebird surveys to include Logan and Syndicate Lagoons.

*Note: Although annual counts have been undertaken by DPIPWE in most years since 1985, these data do not permit identification of population numbers or trends as the areas surveyed were not consistent among years.

11. MONITORING NEEDS

There is limited monitoring of components within the Logan Lagoon site, and there is no over-arching monitoring program designed to detect and manage changes to the ecological character of the wetland. A management plan (Parks and Wildlife Service 2007) released in July 2009 acts as a guide for decision makers and stakeholders in the region. The plan recommends monitoring priorities for Logan Lagoon. However, the monitoring prescribed in the management plan would benefit from the outcomes of this ECD, including the identification of knowledge gaps and monitoring needs.

Annual counts undertaken by DPIPWE in most years since 1985, before the duck hunting season, were used to assess the importance of Logan Lagoon for waterfowl. These data were not strictly comparable as the area surveyed varied among years, although from 2004 onwards methods were standardised. Nonetheless, they provided the only longitudinal data set for the Ramsar site and were used to assess fluctuations in waterfowl numbers over time. As Logan Lagoon is part of a network of wetlands on Flinders Island, and given the ephemeral nature of wetlands in Australia, it is recommended that systematic annual counts of waterfowl are extended to a selection of wetlands on Flinders Island, using standardised techniques including defined areas, fixed numbers of observers and fixed counting times.

Shorebird surveys of Logan Lagoon have been carried out by Birds Tasmania but have been limited to the immediate ocean coastline. It is recommended that shorebird monitoring programs be extended to include the ocean coastline - which is important breeding habitat for three species of particular interest, the hooded plover, fairy and little terns - together with Logan and Syndicate lagoons. Migratory shorebird species have been periodically sighted at Logan and Syndicate lagoons, in numbers approaching the 1% threshold used to apply Criterion 6 and it is necessary to understand patterns of usage by migratory shorebirds.

Many wetland species have limited tolerances to fluctuations or modifications to hydrological regimes, including water quality measures (such as salinity, temperature and pH). A range of water quality measurements that are easily recorded can give a rapid indication of parameters that may affect wetland health without complex analyses. Well established benchmarks allow water samples to be compared in a broader regional context, or allow assessment of conditions over time. The establishment of a water quality monitoring regime with appropriate guidelines would allow changes in ecological character to be detected.

Detailed monitoring design is essential to ensure that appropriate and useful data is collected. A comprehensive monitoring program design for each of these components is beyond the scope of an ecological character description and it is therefore recommended that the Ramsar framework for designing a wetland monitoring programme (Ramsar Convention Secretariat 2006) be used as a guide in developing monitoring programs. The recommended monitoring to meet the obligations under Ramsar and the EPBC

Act with respect to the Logan Lagoon Ramsar site are provided in Table 18. While there are some programs in place that will meet these monitoring requirements, there are others that will need to be established or augmented. Given the paucity of information regarding the site's ecological character, prioritising monitoring needs for critical components all ranked highly.

Table 18. Monitoring needs for the Logan Lagoon Ramsar site.

Component, process, benefit or service	Objective of monitoring	Indicator/measure	Frequency	Priority
Climate				
Climatic processes	Establish limits of acceptable change	Rainfall, temperature, wind and evaporation and the hydrological responses such as water level, flow rates and the extent of inundation	Monthly	High
Geomorphology				
Holocene shorelines	Establish limits of acceptable change	• high water mark • beach profile	Monthly	Medium
Hydrology / Hydrological processes				
Water Quality	Establish limits of acceptable change	• Salinity • Nutrients • Key toxicants such as pesticides and herbicides. • Acid sulphate soils	Monthly	Highest priority
Water flow	Establish limits of acceptable change	• Pot Boil Creek flow • Groundwater levels • Lake level	Monthly	Medium
Vegetation				
Littoral vegetation	Establish benchmarks and limits of acceptable change	Establishment of baseline flora species and community data via permanent transects across hydrological gradients. • Species presence/absence • Ecological community identification and composition • Ecological community mapping and extent • Threatened species population size and health.	Every 5 years: low level aerial photography taken in November/December in conjunction with resurveying of transects	High

Aquatic Plants	Establish benchmarks and limits of acceptable change	• Mapping extent and species composition within the lagoon.	Annual	High
Fauna (not including birds)				
Amphibians	Establish benchmarks and limits of acceptable change	• Presence/absence of species • Presence/absence of threatened species • Numbers of animals	Annual	High
Fish	Establish benchmarks and limits of acceptable change	• Species richness • Abundance, particularly the dwarf galaxias. • Habitat usage	Annual	High
Introduced fauna	Detection of change - likely threat to native fauna and habitat	• Extent • Rate of spread within habitat	Annual	High
Birds				
Waterfowl	Establish benchmarks and limits of acceptable change	• Presence/absence of waterfowl species • Presence/absence of target species • Numbers of birds	Annual	High
Shorebirds	Establish benchmarks and limits of acceptable change	• Presence/absence of shorebird species • Presence/absence of target species • Numbers of birds	Annual	High

12. COMMUNICATION AND EDUCATION

The Logan Lagoon Ramsar site is a wetland of international importance. This ECD has identified the components, processes, benefits and services that contribute to the ecological character of the site. For example, the Holocene shorelines and dune systems are of geoconservation significance, being representative and outstanding examples for the Tasmanian Bioregion. The site also has remnant areas of pre-European vegetation that have not been modified by fire, whilst other areas have wetland types that support threatened vegetation communities and threatened fauna species. The local community and visitors to the site should be educated in Ramsar's 'wise use' policy to ensure that the ecological character of Logan Lagoon is preserved into the future. To date, the site has not been actively promoted or presented to the public, and is not widely appreciated outside relatively small groups of local users and birdwatchers.

The Ramsar Convention established a Program of Communication, Education and Public Awareness (CEPA) 2003-2008 with the aim of raising awareness of wetland values and functions. The program calls for coordinated international and national wetland education, public awareness and communication. In response to this, the Australian Government has established the Wetland Communication, Education and Public Awareness (CEPA) National Action Plan 2001-2005. The role of this Plan is to provide a framework for the effective and collaborative delivery of wetland CEPA activities across Australia. The Plan will enable mechanisms for sharing knowledge, suggest methods for building capacity, present goals, provide links between and among people doing similar work, and build links among national and international networks.

The Plan suggests that interpretation and education of Ramsar sites should aim to develop pre-visit awareness of special features, including: the encouragement of visitors to pursue their interests and explore what the area has to offer; to realise the site's educational values; and to canvas management issues related to the area. In this regard, community recognition and support for Ramsar sites is very important. The aim of fostering community support is to develop community appreciation of and support for the area's values; promote a positive image of the Ramsar site and its contribution to the community; and encourage community involvement in site management.

12.1. Existing CEPA activities

Current CEPA activities relevant to Logan Lagoon comprise:

- two interpretation signs in the Logan Lagoon Ramsar site at the two main access roads (Logan Lagoon road and Pot Boil road) where they enter the Ramsar site. The sign at the northern access road to the lagoon comprises: a description of the boundary of the site, a discussion of the ecological features of the lagoon and why it is internationally important, a list of the other Ramsar wetlands in Tasmania, and the aims of the Ramsar Convention on wetlands;

- shorebird monitoring projects coordinated by Birds Australia including collection of records for shorebird and migratory species in the Logan Lagoon area in 2008 (Woehler 2008);.
- a similar survey in 2010 combined with a workshop for local residents. The workshop was attended by 27 locals who learnt important tools, including: how to identify resident and migratory birds; the status and trends of local bird populations; and how to record data to ensure it complies with existing data protocols. Several of the attendees showed a willingness to be involved with regular surveys of the local coastline (E. Woehler, Birds Tasmania, *personal communication*, 24 Jan 2010);
- annual counts of duck populations undertaken by DPIPWE in most years since 1985 before the duck hunting season. These surveys have often been conducted by local residents who are willing and able to identify the duck species that inhabit Flinders Island; and
- an NRM North programme that has engaged 14 farmers in Property Management Planning. This project is aimed at encouraging sustainable farming practices in the catchment of Logan Lagoon and Cameron's Inlet. Participating landholders from within the catchments are provided with high quality mapping, detailed reports and recommendations on the water, soil and biodiversity assets of their farms. This project encourages investment in on-farm activities that provide natural resource outcomes such as revegetation and fencing off riparian areas.

12.2. Scope for future CEPA activities

There are many opportunities for CEPA activities involving members of the local Flinders Island community, interested groups and visitors to Logan Lagoon Ramsar site. Logan Lagoon has the potential to be an important educational resource for natural science, especially given its relatively pristine condition, its role as a sanctuary for migratory birds and its geological values. Logan Lagoon has outstanding and representative ecological features on local, bioregional and global scales. However, many of its features are poorly understood (see Summary of Knowledge Gaps – Section 10) and there has been very little reporting or monitoring of any kind at the site.

With some limited training by qualified personnel, community members could be educated to identify, document and report species at the site. This data may then be provided to site managers or relevant State authorities (such as DPIPWE) and subsequently fed into databases from which much of the information in this ECD was derived. This would provide a greater understanding of the site's importance, and empower locals to protect the ecological values of the site.

Encouraging locals to become more involved in the site may lead to increases in visitor numbers. All visitors should understand the potential impacts of their activities when visiting the site. Many of the threats to the ecological character (see Section 8) result from activities within the wetlands themselves, on adjacent land and within the catchment generally. Alleviating the impact of visitors is possibly the biggest challenge for managing the site as there is a history of human induced modification of ecological features within the Ramsar site (Parks and Wildlife Service 2007).

At any time of year vehicles pose a threat to the ecological character of the site, causing erosion of sand dunes, and at certain times disturbing coastal breeding birds and destroying their eggs. Evidence suggests that off-road vehicle use is becoming more common, causing damage to the vegetation within the Ramsar site; particularly to the *Sarcocornia quinqueflora* saltmarsh edge at the mouth of the lagoon. This vegetation is easily damaged and takes many years to recover, so vehicle tracks are easily recognisable (Parks and Wildlife Service 2007).

12.3. CEPA prioritisation

There is a number of communication and education messages that could be prioritised which may help facilitate this process, including:

- The importance of responsible driving of off-road vehicles – how to minimise disturbance to foreshores and biota;
- Emphasising the effect of disturbance on migratory birds – the importance of energy conservation for migratory birds and steps the community can take to minimise shorebird disturbance by walking, boating, recreational vehicles and domestic pets;
- The importance of privacy for nesting birds - the impact of disturbance on nesting birds (particularly species such as pelicans, hooded plovers, fairy and little terns, that nest on easily accessible beaches) and ways in which the community can undertake recreational activities while minimising disturbance to nests;
- The significance of the values of the Ramsar site. This would include the international significance of the site and threats to the values of the site, particularly in relation to landuse management and feral animals;
- The need to obtain essential data to assist in more effective management of the Ramsar site (see Section 10: Summary of knowledge gaps); and
- Educating local community members on how to record and report sightings of flora and fauna at the site. One particularly useful outcome of this process would be increased information on the occurrence and distribution of feral animals, such as pigs and cats. Establishing the usage of the site by these animals may help managers plan for their future eradication.

12.4. Logan Lagoon Ramsar Site Management Plan

The Logan Lagoon Management Plan (Parks and Wildlife Service 2007) was developed in consultation with community, landowners, site managers, local council, state government departments and other stakeholders. The Plan provides a range of detailed management prescriptions that address issues such as access to the site, monitoring and research requirements, managing development and community involvement. The finalised plan was released publicly in 2009 and some of the prescriptions were being planned at the time of writing this ECD (e.g. seasonal closure of tracks by Parks and Wildlife Service rangers to prevent damage to vegetation and substrate).

Many of the suggestions for CEPA could be implemented within the framework of the Management Plan. In general, the plan proposes actions that are in line with the Ramsar Conventions 'wise use' policy, such as protection of the outstanding natural and cultural values, and the provision for an appropriate range of recreational opportunities. In particular, the plan proposes:

- greater involvement of the community, landowners and other stakeholders in management of the Ramsar site;
- improving interpretation of the Ramsar site, and investigating the potential for a bird hide and short interpreted walk;
- liaising with neighbouring land managers to achieve cooperative and complementary management of adjoining areas, to protect the values of the Ramsar site;
- providing continued off-road vehicle access to the coast during summer under controlled conditions designed to protect vulnerable shorebirds, whilst restricting vehicle access in winter in order to limit environmental impact and protect fragile dunes, vegetation and the lagoon foreshore; and

- guidelines for artificial breaching of the lagoon mouth under conditions of high water.

The plan makes several recommendations with regard to interpretation and education for Logan Lagoon. These include maintaining existing interpretive signs, erecting signs at appropriate locations to indicate nesting shorebirds and guidelines for observing the birds while minimising disturbance and impact. The management plan also recommends liaison with schools and organisations such as Landcare to encourage educational programs in the Ramsar site, and to adopt strategies for beach use that will minimise impact and protect nesting sites.

The plan also provides recommendations to encourage community involvement. These include supporting the development of friends and volunteer programs in the Ramsar site, developing relations with adjacent land managers, local community groups and the Aboriginal community, liaising with the tourism industry, recreational and educational groups regarding visitor uses of the Ramsar site and consulting with the Flinders Island Council in order to achieve complementary planning for land in the catchment of Logan Lagoon.

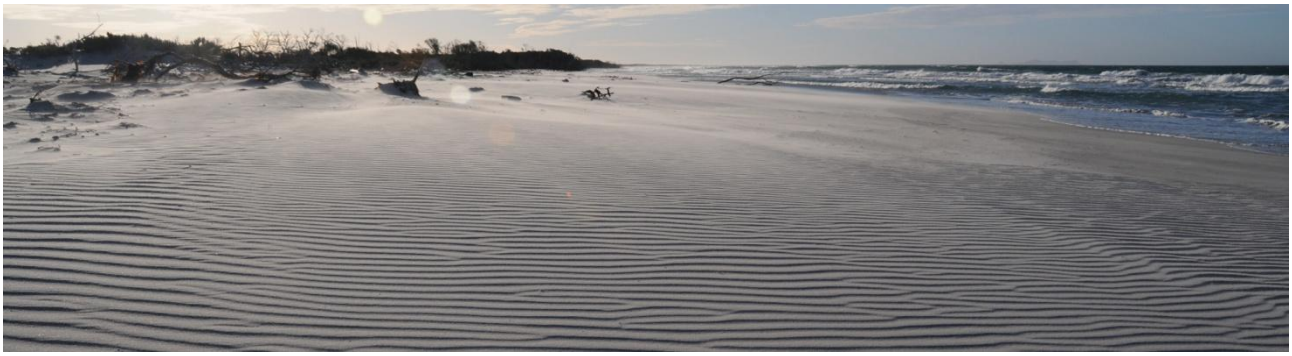
Land use in the surrounding catchment is a threat to the ecological character of Logan Lagoon (see Section 8.3). Many of the artificial drains that direct water from private land into Logan Lagoon have become overgrown with vegetation, preventing the movement of water. During periods of wet weather, land adjacent to the lagoon becomes waterlogged and this is often attributed to increases in the lagoon water level. On occasions, the lagoon mouth has been illegally opened, leading to unnatural hydrology regimes in the lagoon. Surrounding farmers should be educated in ways to reduce the risk of flooding, such as ensuring that drains on their properties are cleared of vegetation and properly maintained, and plant salt- and flood-tolerant species in the expected zone of flooding on adjacent land (Parks and Wildlife Service 2007).

13. GLOSSARY

TERM	DEFINITION
Acceptable change	The variation that is considered 'acceptable' in a particular measure or feature of the ecological character of a wetland. Acceptable variation is that variation that will sustain the component or process to which it refers. See "Limits of Acceptable Change".
Administrative authority	The agency within each contracting party charged by the national government with oversight of implementation of the Ramsar Convention within its territory.
Adverse conditions	Ecological conditions unusually hostile to the survival of plant or animal species, such as those that occur during severe weather like prolonged drought, flooding, cold, etc (Ramsar Convention Secretariat 2005b).
Assessment	The identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities (as defined by Ramsar Convention Secretariat 2002, Resolution VIII.6).
Barred estuary	Estuary with a sand-bar at the mouth, which may or may not close off the exchange of water
Baseline	Condition at a starting point. For Ramsar wetlands, it will usually be the time of listing of a Ramsar site.
Benchmark	A standard or point of reference. A predetermined state (based on the values that are sought to be protected) to be achieved or maintained
Benefits	Benefits here refer to the economic, social and cultural benefits that people receive from ecosystems (Ramsar Convention Secretariat 2005a, Resolution IX.1 Annex A). These benefits often rely on the underlying ecological components and processes in the wetland. See also 'Ecosystem services'.
Biogeographic region	A scientifically rigorous determination of regions as established using biological and physical parameters such as climate, soil type, vegetation cover, etc IBRA, IMCRA
Biological diversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species (genetic diversity), between species (species diversity), of ecosystems (ecosystem diversity), and of ecological processes.
Brackish	Water containing salt. Normally a mixture of fresh water and sea water
Catchment	The total area draining into a river, reservoir, or other body of water

Change in ecological character	Human-induced adverse alteration of any ecosystem component, process, and/or ecosystem benefit/service (Ramsar Convention Secretariat 2005a, Resolution IX.1 Annex A).
Community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another (ANZECC and ARMCANZ 2000).
Community composition	All the types of taxa present in a community (ANZECC and ARMCANZ 2000).
Conceptual model	Wetland conceptual models express ideas about components and processes deemed important for wetland ecosystems
Critical stage	Stage of the life cycle of wetland-dependent species (e.g. breeding, migration stopovers, moulting) that, if interrupted or prevented from occurring, may threaten long-term conservation of the species (Ramsar Convention Secretariat 2005b).
Deflation	The process by which wind removes dry, lose sand, silt and clay form the land surface.
Deposition	The dropping of material which has been picked up and transported by wind, water, or other processes
Ecological character	The combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.
Ecological communities	Any naturally occurring group of species inhabiting a common environment that interacts with each other, especially through food relationships, and that is relatively independent of other groups. Ecological communities may be of varying sizes, and larger ones may contain smaller ones
Ecosystem components	The separate physical, chemical and biological parts of a wetland ecosystem
Ecosystem processes	Dynamic forces within an ecosystem. They include all those processes that occur between organisms and within and between populations and communities, including interactions with the nonliving environment that result in existing ecosystems and that bring about changes in ecosystems over time. They may be physical, chemical or biological.
Ecosystem services	The benefits that people receive or obtain, directly or indirectly, from an ecosystem
Ecosystems	Within the Millennium Ecosystem Assessment, ecosystems are described as the complex of living communities (including human communities) and nonliving environment (ecosystem components) interacting (through ecological processes) as a functional unit, which provides, inter alia, a variety of benefits to people (ecosystem services) (Ramsar Convention Secretariat 2005a, Resolution IX.1 Annex A).
Endemic species	A species that originates and occurs naturally in a particular limited area.
Evaporative basin	Shallow depression in landscape from which open water is prone to evaporate
Geoconservation	The identification and conservation of geological, geomorphological and soil features, assemblages, systems and processes (geodiversity) for their intrinsic, ecological or heritage values.

Indicator species	Species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem; taxa that are sensitive to environmental conditions and which can therefore be used to assess environmental quality
Introduced (non-native) species	Species that does not originate or occur naturally in a particular country
Limits of acceptable change	Variation that is considered acceptable in a particular component or process of the ecological character of the wetland without indicating change in ecological character that may lead to a reduction or loss of the criteria for which the site was Ramsar listed
List of wetlands of international importance ('the Ramsar List')	Wetlands that have been designated by the Ramsar Contracting Party in which they reside as internationally important, according to one or more of the criteria that have been adopted by the Conference of the Parties.
Monitoring	Collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management
Ramsar	City in Iran, on the shores of the Caspian Sea, where the Convention on Wetlands was signed on 2 February 1971; thus the Convention's short title, 'Ramsar Convention on Wetlands'
Ramsar Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar (Iran), 2 February 1971. UN Treaty Series No. 14583. As amended by the Paris Protocol, 3 December 1982, and Regina Amendments, 28 May 1987. The abbreviated names "Convention on Wetlands (Ramsar, Iran, 1971)" or "Ramsar Convention" are used more commonly.
Ramsar Criteria	Criteria for identifying wetlands of international importance, used by Contracting Parties and advisory bodies to identify wetlands as qualifying for the Ramsar List on the basis of representativeness or uniqueness or of biodiversity values.
Ramsar Information Sheet (RIS)	Form upon which Contracting Parties record relevant data on proposed Wetlands of International Importance for inclusion in the Ramsar Database; covers identifying details like geographical coordinates and surface area, criteria for inclusion in the Ramsar List and wetland types present, hydrological, ecological, and socioeconomic issues among others, ownership and jurisdictions, and conservation measures taken and needed.
Ramsar List	List of Wetlands of International Importance.
Ramsar Sites	Wetlands designated by the Contracting Parties for inclusion in the List of Wetlands of International Importance because they meet one or more of the Ramsar Criteria.
Wetland assessment	Identification of the status of, and threats to, wetlands as a basis for the collection of more specific information through monitoring activities
Wetland types	As defined by the Ramsar Convention's wetland classification system.
Wetlands	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
Wise use of wetlands	Maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development" (Ramsar Convention 2005a Resolution IX.1 Annex A).



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15. APPENDICES

APPENDIX A: Sources of data and limitations

Climate data

Climate data have been recorded at the Flinders Island Airport recording station (BoM Station 99005) since 1940 and is considered the best station for describing the climatic conditions at Logan Lagoon. The data were obtained from the SILO database of the Bureau of Meteorology (BoM) in September 2009. Wind data was available for the period 1962-2006 (BoM 2009).

The general climate of Logan Lagoon is described using available historical weather data ranging from 1940 to 2008. In addition, two discrete time periods are used to describe changes in climate: 1957 to 1982 (25 years up to and at the time of listing), and; 1983 to 2009 (25 years since listing).

Water Quality Testing

Water quality data for Logan Lagoon is extremely limited, both before and since listing in 1982. Historical data was limited to a paper by Bowling and Tyler (1984), which included water quality data for Logan Lagoon collected as part of a sampling program of lagoons on King and Flinders Islands in 1982. Due to the lack of water quality data, Elgin Associates, with the assistance of NRM North, collected water samples from two sites around the perimeter of Logan Lagoon in August 2009 (Figure 10). The water quality of freshwater inflows into Logan Lagoon was also considered by sampling Pot Boil Creek. The creek was sampled near its discharge point into the lagoon in July and August 2009. Whilst this data provides only a snapshot of water quality in and entering the Lagoon, it does provide some useful information about the quality of water entering the lagoon in periods of high flow, in the absence of long term or more frequent monitoring data.

The timing of the data collected by Bowling and Tyler in May 1982 coincides with the time of Ramsar listing, and so provides some indication of water quality in Logan Lagoon at that time. The later data collected by Elgin Associates in July and August 2009 coincides with the time of preparation of this ECD. The suite of parameters tested in water samples collected in 1982 and 2009 were generally similar and allowed comparisons to be made between the datasets. For the measurement of total dissolved solids (TDS), the 1982 data reported this parameter as ‘salinity’ which is closely comparable to the ‘TDS’ results reported in the 2009 sampling event.

The water samples collected by Elgin Associates were tested for a range of parameters that included physico-chemical, nutrients and pesticides. A field chemistry kit and filters were not available at the time of sampling, therefore dissolved oxygen, temperature and chlorophyll–a were not able to be measured and are gaps in the dataset.

Water Quality Guidelines

The water quality data for Logan Lagoon was considered against draft indicator levels developed for Tasmanian estuaries by the Tasmania Agriculture and Fisheries Institute (Murphy *et al.* 2003). The draft indicator levels for estuarine waters were developed as region specific in response to a lack of Tasmanian data in the default trigger values provided in the ANZECC (2000) Guidelines for Fresh and Marine Water Quality. The draft indicator levels are referenced in the 2003 and 2009 Tasmania State of the Environment Reports (Tasmanian Government 2003; 2009) as part of the assessment of the environmental health of estuaries in Tasmania.

Estuary indicators were considered appropriate for Logan Lagoon as the lagoon was previously classified as a 'coastal lagoon' estuary with high conservation significance by Edgar *et al.* (1999) as part of a classification study of estuaries across Tasmania. This study was considered by Murphy *et al.* (2003) in the development of the draft indicator levels although it was noted by Edgar *et al.* (1999) that Logan Lagoon may fall outside the definition of an estuary due to the prolonged dry periods that can occur in the lagoon.

The draft indicator levels for Tasmanian estuaries include values for low, medium, high and very high to indicate ranges of 'pressure', that may be placed on the system by levels of turbidity, chlorophyll-a, oxides of nitrogen and reactive phosphorus (Table A1).

Table A1. Draft Indicator Levels for Tasmanian Estuaries (from Murphy *et al.* 2003).

Draft Indicator Level	Units	Low	Medium	High	Very High
Turbidity	NTU	0 to 4	4.1 to 10	10.1 to 20	>20
Chlorophyll-a	µg/L	0 to 2	2.1 to 5	5.1 to 10	>10
NOx-N	µg/L	0 to 20	21 to 50	51 to 100	>100
PO4-P	µg/L	0 to 5	6 to 15	16 to 30	>30

Acid Sulphate Soils

Risk assessment uses proximity (from the soil surface) of a known ASS layer to determine the likelihood of that layer being disturbed and causing impact. It can be utilised to determine the risk of intercepting / oxidising ASS materials should disturbance occur via mechanical (excavation) or hydrological (groundwater recession / drainage) processes. Full site data can be found in the DPIPWE report by Moreton *et al.* (2009).

Vegetation

The Natural Values Atlas (NVA) contains data that have been gathered from ecological surveys carried out by DPIPWE, museum and herbarium specimens, professional botanists outside of DPIPWE, competent field naturalists, and the botanical literature. Species names and common names were taken from Wapstra *et al.* (2005).

Vegetation community types present within the Logan Lagoon area were reviewed using TASVEG 2.0 spatial data, which contains information from the Tasmanian Vegetation Mapping and Monitoring Program. TASVEG is a comprehensive digital map of the extent of vegetation communities in Tasmania and can be accessed online via LISTmap (DPIPWE 2009d). The 1:25,000 vegetation map is based on over 147 vegetation and 11 non-vegetated communities.

Records of plant specimens collected in the Logan Lagoon area were requested from the State Herbarium of Tasmania (records dated since 1975) and the State Herbarium of Victoria (records dated since 1952). These records included specimens collected in Logan Lagoon and the surrounding area.

Information referring to threatened flora protected under the EPBC Act was obtained from the Department of the Environment, Water, Heritage and the Arts Protected Matters Search Tool (DEWHA 2009a).

Fauna

Records of fauna observations for the Logan Lagoon Ramsar site are limited. The majority of available records were sourced from the NVA (DPIPWE 2009c), Protected Matters Search Tool (DEWHA 2009a) and the Logan Lagoon Conservation Area Management Plan (Parks and Wildlife Service 2007).

Birds

A desktop assessment of potential bird species occurring at the site was conducted by reviewing biological databases: NVA (DPIPWE 2009c) and, Protected Matters Search Tool (DEWHA 2009a). Birds were considered to be the dominant fauna residing in or using the site. Therefore, the Atlas of Australian Birds (AAB 2009) database was also reviewed. The AAB is maintained by Birds Australia, a non government organisation dedicated to the conservation of Australian birds. The AAB is one of the largest continent-wide, wildlife databases in the world: containing some six million records from 400,000 surveys. It is continuously updated with additional survey sheets which accumulate at a rate of 700 to 1,000 per week (Barrett *et al.* 2003; Dunn and Weston 2008). The AAB data have been collected in a standardised manner for many years through a well-established network of volunteers.

Records obtained from the AAB for the Logan Lagoon area include those collected between 1977 and 1982 and between 1998 and 2009, and comprised all bird records within a six kilometres radius of a central point at Logan Lagoon (40° 11’ 21”S, 148° 18’ 50”E). Records were not available for the period between 1983 and 1997.

Annual counts undertaken by DPIPWE before the duck hunting season in most years since 1985 were used to assess the importance of Logan Lagoon for waterfowl. These data were not strictly comparable as the area surveyed varied among years, although from 2004 onwards methods were standardised. Nonetheless, they provided the only longitudinal data set for the Ramsar site and were used to assess fluctuations in waterfowl numbers over time.

A conservation assessment of beach nesting and migratory shorebirds in Tasmania was carried out in 1998-1999 and included surveys on Flinders Island (Bryant 2002). A survey was also carried out on Flinders Island in 2008 (Woehler 2008) providing information on important shorebird and tern sites on the Flinders Island coast. These surveys included collection of records for shorebird and migratory species in the Logan Lagoon area.

APPENDIX B: Climate data

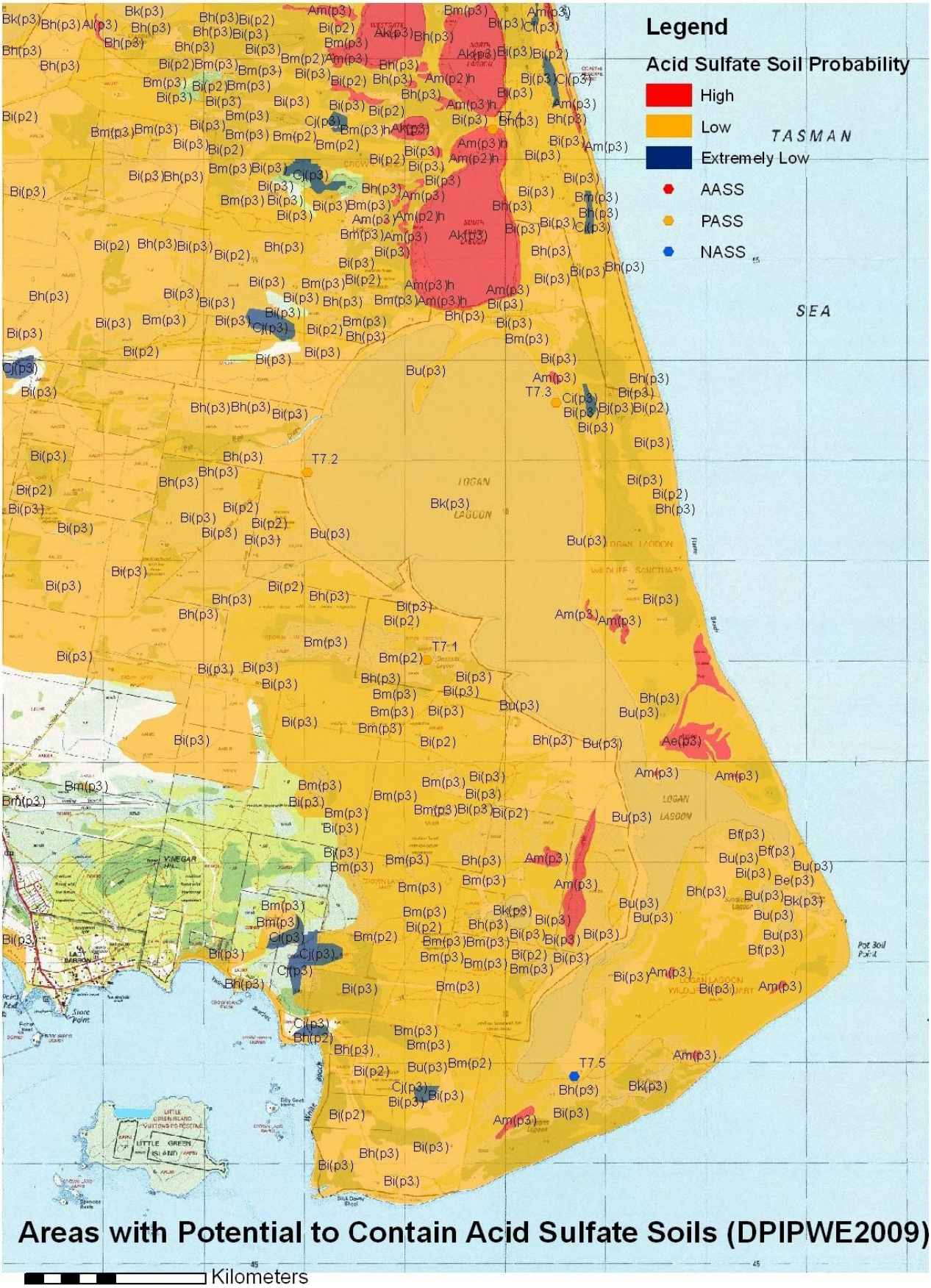
Table B1. Mean minima and maxima temperatures – Flinders Island Airport.

	Mean Minimum Temperature (°C)		Mean Maximum Temperature (°C)	
	1957-82 (25 years up to time of listing)	**1983-2008 (25 years up to ECD)**	**1957-82 (25 years up to time of listing)**	**1983-2008 (25 years up to ECD)**
January	13.0	13.6	22.0	22.0
February	13.5	13.7	22.4	22.5
March	12.6	12.4	21.1	21.2
April	10.6	10.7	18.6	18.7
May	8.6	9.2	15.9	16.3
June	6.8	7.2	14.0	14.2
July	5.9	6.5	13.0	13.5
August	6.3	6.8	13.5	13.9
September	7.2	7.6	14.9	15.1
October	8.5	8.7	16.6	16.7
November	9.8	10.4	18.2	18.5
December	11.5	12.1	19.9	20.3

Table B2. Annual rainfall data from 1940-2008, and for two 25 year periods: up to the time of listing (1957-1982); and up to the time of the ECD (1983-2008).

Parameter	**1940-2008 (Average using all available data)**	**1957-1982 (25 years up to time of listing)**	**1983-2008 (25 years up to time of ECD)**
Annual Average Rainfall	736 millimetres	777 millimetres	687 millimetres
Deviation from 1940-2008 average rainfall	--	+41 millimetres (6 percent higher)	-49 millimetres (7 percent lower)
Percentage of years of above average rainfall	41 percent	50 percent	31 percent
Percentage of years of below average rainfall	59 percent	50 percent	69 percent

APPENDIX C: Map of potential acid sulphate soils (Moreton *et al*. 2009)



APPENDIX D: Water Quality Data

Logan Lagoon Water Quality 1982

One water sample was collected from Logan Lagoon in May 1982 by Bowling and Tyler (1984), with analysis for physico-chemical parameters, major cations and anions and total phosphorus. The location of the water sampling site at the lagoon was displayed on a simple small scale map of Flinders Island, and appears to have been collected in the northern part of the lagoon. According to Bowling and Tyler, the water sample was collected in May 'at the end of an extremely dry summer', which is consistent with climate data (Figure 7) and the 1982-83 drought that occurred in southeast Australia.

Table D1. Lagoon Water Quality - May 1982.

Parameter	**Result**
Electrical Conductivity (K_{18})	36,600 µS/cm
Salinity	35,672 mg/L
Turbidity	0.5 NTU
pH	7.20
Gilvin	0.750 g_{440}/m
Na^+	435 meq/L
K^+	13.3 meq/L
Ca^{2+}	51.6 meq/L
Mg^{2+}	142 meq/L
Cl^-	485 meq/L
SO_4^{2-}	100 meq/L
HCO_3	3.64 meq/L
Fe	0.40 mg/L
SiO_2	1.2 mg/L
Total Phosphorus	90 µg/L

Logan Lagoon Water Quality 2009

Water samples were collected from two sampling sites adjacent to the shoreline of Logan Lagoon by Elgin Associates on 31 August 2009 (Figure 13). The sampling sites, nominated as LL1 and LL2 were located in the far northern and far south-western parts of the lagoon, respectively. The samples were collected after a period of high rainfall on Flinders Island - 174.6 millimetres in August 2009, which is approximately 100 millimetres greater than the long-term monthly average.

Table D2. Lagoon Water Quality - August 2009.

Parameter	Units	LL1 site	LL2 site
Site Co-ordinates (WGS 84)		N:55 609335 E:5554497	N:55 610345 E:5547011
Date of Sampling		31 August 2009	31 August 2009
Total Dissolved Solids	mg/L	2600	5370
Suspended Solids	mg/L	7	8
Turbidity	NTU	4.9	1.4
pH		7.71	7.68
Total Alkalinity	mg/L	113	188
Na^+	mg/L	762	1480
K^+	mg/L	31	64
Ca^{2+}	mg/L	86	152
Mg^{2+}	mg/L	92	173
Cl^-	mg/L	1320	2500
SO_4^{2-}	mg/L	242	542
Ammonia as N	mg/L	<0.01	0.03
Nitrite as N	mg/L	<0.01	<0.01
Nitrate as N	mg/L	<0.01	<0.01
Nitrite+Nitrate as N	mg/L	<0.01	<0.01
Total Kjeldahl Nitrogen as N	mg/L	1.5	1.4
Total Nitrogen as N	mg/L	1.5	1.4
Total Phosphorus as P	µg/L	90	200
Organochlorine/Organophosphorus Pesticides	µg/L	Not Detected	Not Detected

Pot Boil Creek Water Quality - 2009

The Pot Boil Creek sampling site (PBC1) was upstream of the bridge on Logan Lagoon Rd (Figure 15). This site was approximately 100 metres upstream of where Pot Boil Creek enters Logan Lagoon. The sampling event on August 31 was preceded by a period of above average monthly rainfall, whilst average rainfall was recorded prior to the July sampling event. Pot Boil Creek was observed to have a moderate flow in July 2009, with higher flows observed in August 2009.

Table D3. Pot Boil Creek (PBC1) Water Quality Results - July and August 2009

Parameter – Site PBC1	Units	July 2009	August 2009
Site Co-ordinates	WGS84	N:55 608273 E:55539625	N:55 608273 E:55539625
Date of Sampling		21 July 2009	31 August 2009
Total Dissolved Solids	mg/L	2270	608
Suspended Solids	mg/L	18	10
Turbidity	NTU	6.0	14.0
pH		7.51	7.68
Total Alkalinity	mg/L	NA	88
Na^+	mg/L	NA	110
K^+	mg/L	NA	7
Ca^{2+}	mg/L	NA	37
Mg^{2+}	mg/L	NA	18
Cl^-	mg/L	NA	192
SO_4^{2-}	mg/L	NA	44
Ammonia as N	mg/L	<0.01	<0.01
Nitrite as N	mg/L	<0.01	<0.01
Nitrate as N	mg/L	0.18	<0.01
Nitrite+Nitrate as N	mg/L	0.18	<0.01
Total Kjeldahl Nitrogen as N	mg/L	2.0	2.5
Total Nitrogen as N	mg/L	2.2	2.5
Total Phosphorus as P	µg/L	350	420
Reactive Phosphorus as P	µg/L	140	NA
Organochlorine/Organophosphorus Pesticides	µg/L	Not Detected	Not Detected

NA – Not Analysed

APPENDIX E: Flora species recorded at the Logan Lagoon Ramsar site.

Table E1. Species recorded as occurring within the Logan Lagoon area (including a 500 metre buffer). *- species of conservation significance which may or may not be listed on the NVA (DPIPWE 2009c). i - introduced species to Tasmania (NVA; DPIPWE 2009c). R/r = Rare; V/v = Vulnerable; E/e = Endangered (EPBC in CAPS, TSP in lowercase)

	Family	*Species*	Common name	EPBC Act Status	TSP Act Status
	AIZOACEAE				
		Carpobrotus rossii	native pigface		
	AMARANTHACEAE				
		Hemichroa pentandra	trailing saltstar		
	APIACEAE				
*		*Eryngium vesiculosum*	prickfoot		
*		*Hydrocotyle muscosa*	mossy pennywort		
		Hydrocotyle sibthorpioides	shiny pennywort		
		Lilaeopsis polyantha	jointed swampstalks		
*		*Trachymene composita*	parsnip trachymene		
	ASTERACEAE				
		Angianthus preissianus	cupflower		
		Chrysocephalum baxteri	fringed everlasting		r
*		*Gnaphalium indutum*	tiny cottonleaf		
		Leptinella reptans	creeping buttons		
		Nablonium calyceroides	spiny everlasting		
		Senecio pinnatifolius	coast groundsel		
		Senecio psilocarpus	swamp fireweed	V	r
	BRASSICACEAE				
i		*Cakile edentula*	American sea rocket		
i		*Cakile maritima sub sp. Maritima*	sea rocket		
	CAMPANULACEAE				
*		*Lobelia anceps*	angled lobelia		
*		*Pratia irrigua*	salt pratia		
	CARYOPHYLLACEAE				
*		*Colobanthus apetalus var. apetalus*	coast cupflower		
i		*Sagina apetala*	annual pearlwort		
*		*Stellaria multiflora*	rayless starwort		r
	CENTROLEPIDACEAE				
*		*Centrolepis strigosa subsp. strigosa*	hairy bristlewort		
	CHENOPODIACEAE				
		Atriplex cinerea	grey salt bush		
*		*Sarcocornia quinqueflora*	beaded glasswort		
	CONVOLVULACEAE				
		Wilsonia backhousei	narrowleaf wilsonia		
	CRASSULACEAE				
		Crassula decumbens	spreading stonecrop		
		Crassula helmsii	swamp stonecrop		
		Crassula sieberiana	rock stonecrop		
	CUPRESSACEAE				
		Callitris rhomboidea	oyster bay pine		

	Family	Species	Common name	EPBC Act Status	TSP Act Status
	CYPERACEAE				
		Baumea arthrophylla	fine twigsedge		
*		*Baumea juncea*	bare twigsedge		
		Carex appressa	tall sedge		
		Eleocharis acuta	common spikesedge		
		Gahnia filum	chaffy sawsedge		
*		*Gahnia trifida*	coast sawsedge		
		Isolepis cernua	nodding clubsedge		
		Isolepis producta	nutty clubsedge		
		Isolepis nodosa	knobby clubsedge		
*		*Lepidosperma gladiatum*	coast sword sedge		
*		*Schoenus nitens*	shiny bogsedge		
	DENNSTTEADTIACEAE				
		Pteridium esculentum	bracken		
	DILLENIACEAE				
		Hibbertia prostrata	prostrate guineaflower		
	EPACRIDACEAE				
		Leucopogon lanceolatus	lance beardheath		r
		Monotoca glauca	goldey wood		
	EUPHORBIACEAE				
		Euphorbia paralias	sea spurge		
	FABACEAE				
		Gompholobium huegelii	common wedgepea		
		Swainsona lessertiifolia	coast poisonpea		
	GENTIANACEAE				
i		*Centaurium tenuiflorum*	slender centaury		
*		*Sebaea albidiflora*	white sebaea		
	GOODENIACEAE				
*		*Selliera radicans*	shiny swampmat		
	HALORAGACEAE				
*		*Myriophyllum salsugineum*	lake watermilfoil		
	HEPATICAE - GEOCALYCACEAE				
		Chiloscyphus semiteres	liverwort		
	JUNCACEAE				
		Juncus kraussii	sea rush		
		Juncus caespiticius	grassy rush		
	JUNCAGINACEAE				
*		*Triglochin nanum*	dwarf arrowgrass		
*		*Triglochin procerum*	greater waterribbons		
*		*Triglochin striatum*	streaked arrowgrass		
	LICHEN - PARMELIACEAE				
		Flavoparmelia sp	lichen		
	MALVACEAE				
*		*Lawrencia spicata*	candle salt mallow		
	MIMOSACEAE				
		Acacia longifolia var. longifolia	coast wattle		
		Acacia mucronata	caterpillar wattle		
		Acacia mucronata subsp. mucronata	erect caterpillar wattle		
		Acacia verticillata	prickly moses		

	Family	Species	Common name	EPBC Act Status	TSP Act Status
	MUSCI - BRACHYTHECIACEAE				
		Brachythecium rutabulum	moss		
	MUSCI - DICRANACEAE				
		Dicranoloma billarderii	moss		
	MUSCI - HYPNACEAE				
		Hypnum cupressiforme	moss		
	MUSCI - LEMBOPHYLLACEAE				
		Lembophyllum clandestinum	moss		
	MUSCI - LEUCOBRYACEAE				
		Campylopus introflexus	moss		
	MUSCI - POTTIACEAE				
		Barbula unguiculata	moss		
		Triquetrella papillata	moss		
	MUSCI - PTYCHOMNIACEAE				
		Ptychomnion aciculare	moss		
	MUSCI - SEMATOPHYLLACEAE				
		Sematophyllum homomallum	moss		
	MUSCI - THUIDIACEAE				
		Thuidiopsis furfurosa	moss		
	MYOPORACEAE				
		Myoporum insulare	common boobialla		
	MYRTACEAE				
		Eucalyptus globulus	Tasmanian blue gum		
		Eucalyptus ovata var. ovata	black gum		
		Eucalyptus nitida	western peppermint		
		Eucalyptus viminalis	white gum		
		Leptospermum lanigerum	woolly teatree		
*		*Leptospermum laevigatum*	coast teatree		
		Leptospermum scoparium	common teatree		
		Melaleuca ericifolia	coast paperbark		
	ORCHIDACEAE				
		Caladenia latifolia	pink fairies		
*		*Caladenia pusilla*	tiny fingers		r
*		*Caleana major*	flying duck orchid		
		Caleana minor	small duck orchid		
*		*Prasophyllum secutum*	northern-leek orchid	E	e
		Pterostylis tunstallii	Tunstall's greenhood		e
		Thelymitra *holmesii (was T.pauciflora var. holmesii)*	bluestar sun orchid		r
	POACEAE				
		Lachnagrostis filiformis	common blown grass		
		Poa poiformis	coastal tussock grass		
		Poa labillardierei	silver tussock grass		
		Poa sp	Tussock grass		
i		*Polypogon monspeliensis*	annual beard grass		
	POLYGALACEAE				
		Comesperma calymega	bluespike milkwort		
	POLYGONACEAE				
*		*Muehlenbeckia adpressa*	climbing lignum		

Family	*Species*	Common name	EPBC Act Status	TSP Act Status
RANUNCULACEAE				
	Clematis clitorioides	pleasant clematis		
RHAMNACEAE				
	Spyridium parvifolium	dusty miller		r
RUPPIACEAE				
	Ruppia megacarpa	largefruit seatassel		r
	Ruppia polycarpa	manyfruit seatassel		
SCROPHULARIACEAE				
	Mimulus repens	creeping monkeyflower		
URTICACEAE				
	Urtica incisa	scrub nettle		
ZANNICHELLIACEAE				
*	*Lepilaena cylindrocarpa*	longfruit watermat		

Table E2. Description of threatened non-wetland dependent vegetation species.

Common name (*Species*)	Description
Tiny fingers (*Caladenia pusilla*)	Tiny fingers is listed as rare under the TSP Act. It grows on well drained sand and clay loams in sclerophyll forest and coastal heaths, often forming small clumps. It flowers in spring mainly September to October. Inflorescence is up to nine centimetres high with one flower 12 millimetres across, and cream to deep pink. This species has been recorded north of Lady Barron approximately four kilometres from Logan Lagoon. If this species were found in the Logan Lagoon Conservation Area Ramsar site it would be a valuable population because this species is not well represented in reserves. Identification of this cryptic species at the site would require targeted seasonally specific surveying.
Fringed everlasting (*Chrysocephalum baxteri*):	Fringed everlasting is listed as rare under the TSP Act. It is found on sand dunes between beaches and lagoons, also granite bedrock with some large tors and sandy soils on bare, recently burnt forest. There is limited information on the distribution and conservation status of this species in Tasmania. Identification of this species at the site would require targeted seasonally specific surveying.
Lance beardheath (*Leucopogon lanceolatus var. lanceolatus*)	Lance beardheath is listed as rare under the TSP Act. In Tasmania, it is found in a broad range of habitats including wet gullies and riverbanks, eucalypt forest and on stabilised dunes. The distribution includes the Bass Strait Islands in the north and Maria Island and the Forestier Peninsula in the south-east (TSS 2005, Harris *et al.* 2001). Lance beardheath was collected in 1978 in the Logan Lagoon Conservation area near the mouth of Pot Boil Creek. It was found in a small scrub patch, approximately 30 metres from the lagoon verge with *Eucalyptus ovata, Hakea teretifolia, Leptospermum laevigatum, Helichrysum dendroideum, Banksia marginata, Melaleuca ericifolia, Pultenaea dentata, Acacia longifolia* var *sophorae* and *Muehlenbeckia adpressa*. This patch had been affected by fires.

Tunstall's greenhood (*Pterostylis tunstallii*)	Tunstall's greenhood is listed as endangered (TSP Act). In Tasmania, it is so far known only from the eastern Bass Strait Islands, occupying an area of approximately two hectares in total. It grows in open forest and woodland, often in accumulated litter, on granite-derived gravelly and loamy soils. This species is currently subject to a recovery plan (TSS 2006a). The only substantial known population of Tunstall's greenhood occurs on Flinders Island at the start of the Strzelecki walking track, where most plants in the population are found just outside the park boundary on private land. The species was recorded at Lady Barron on Flinders Island in 1969, but searches in suitable habitat on the Lady Barron foreshore and nearby Vinegar Hill in 1999 failed to locate the species here. If this species were found in the Logan Lagoon Conservation Area Ramsar site it would be a valuable population because this species is not well represented in reserves. This would require targeted seasonally specific surveying.
Australian dusty miller (*Spyridium parvifolium var. parvifolium*)	The Australian dusty miller is listed as rare under the TSP Act. In Tasmania, it is restricted to the north of the State including the Bass Strait Islands and has been recorded from low, open woodland, shrubbery and heath (TSS 2003b). This plant was collected near a fire trail off Logan Lagoon Road at Logan Lagoon Conservation Area in 2000.
Rayless starwort (*Stellaria multiflora*)	The Rayless starwort is listed as rare under the TSP Act. It occurs in Tasmania, Western Australia, South Australia, Victoria and New South Wales. Although the species has a wide distribution throughout Tasmania, population sizes are small with generally less than 10 individuals and the area occupied is small (TSS 2003c). The area of *Melaleuca squarrosa* scrub (SMR) and Dry scrub (SDU) communities behind Planter Beach at the northern end of Logan Lagoon is an important site for this species. Targeted seasonally specific surveying is required.
Bluestar sun orchid *(Thelymitra holmesii)*	The bluestar sun-orchid (*Thelymitra holmesii*: previously known as *Thelymitra pauciflora* var. *holmesii*) is listed as rare under the TSP Act. It has been collected in several locations north-east of Lady Barron two to three kilometres from the Logan Lagoon Conservation Area. If this species were found in the Logan Lagoon Conservation Area Ramsar site it would be a valuable population because this species is not well represented in reserves. Requires targeted seasonally specific surveying.
Prickly arrowgrass (*Triglochin mucronatum*)	The prickly arrowgrass (*Triglochin mucronatum*) is listed as endangered under the TSP Act and known from Vansittart Island and Flinders Island. This species is quite inconspicuous, and grows in herbfields on damp saline soils of salt-flats and coastal saltmarshes. The species was listed as endangered in October 2008 because of its restricted distribution, low numbers of plants and subpopulations and a continuing decline (TSS 2009). This plant has been recorded near the mouth of Cameron's Inlet and with targeted seasonally specific surveying may be found within the boundary of the Ramsar site.

APPENDIX F: Fauna species recorded at the Logan Lagoon Ramsar site

Note: Fauna species may potentially occur within a six kilometre radius of the Logan Lagoon Conservation Area because of limitations of database searches identified in Section 2.6.

Table F1: Fauna (non-avian) recorded on Flinders Island and likely to occur at Logan Lagoon. *species recorded as occurring within the Logan Lagoon area. All other species listed are likely to occur in the Logan Lagoon area.

Common Name	***Scientific Name***	**Status EPBC Act**	**Status TSP Act**
Mammals			
Australian fur seal	*Arctocephalus pusilla*		
Echidna *	*Tachyglossus aculeatus*		
swamp antechinus	*Antechinus minimus*		
common wombat	*Vombatus ursinus*	V	
common ringtail possum	*Pseudocheirus peregrinus*		
common brushtail possum	*Trichosurus vulpecula*		
Eastern pigmy-possum	*Cercartetus nanus*		
long-nosed potoroo	*Potorous tridactylus*		
Tasmanian pademelon	*Thylogale billardierii*		
red-necked wallaby	*Macropus rufogriseus*		
lesser long-eared bat	*Nyctophilus geoffroyi*		
chocolate wattled bat	*Chalinolobus morio*		
little forest vespadelus	*Vespadelus vulturnus*		
water rat	*Hydromys chrysogaster*		
New Holland mouse	*Pseudomys novaehollandiae*		e
swamp rat	*Rattus lutreolus*		
Frogs			
brown tree frog*	*Litoria ewingi*		
green and golden frog	*Litoria raniformis*	V	v
common froglet*	*Crinia signifera*		
southern toadlet	*Pseudophryne semimarmorata*		
spotted marsh frog*	*Limnodynastes tasmaniensis*		
eastern banjo frog*	*Limnodynastes dumerili*		
Fish			
short-finned eel	*Anguilla australis*		

long-finned eel	*Anguilla reinhardtii*		
dwarf galaxias	*Galaxiella pusilla*	V	r
Tasmanian mudfish	*Galaxias cleaveri*		
spotted galaxias	*Galaxias truttaceous*		
jolleytail	*Galaxias maculatus*		
climbing galaxias	*Galaxias brevipinnis*		
pygmy perch	*Nannoperca australis*		
freshwater flathead	*Pseudophritis urvilli*		
Reptiles			
common copperhead	*Austrelaps superbus*		
tiger snake	*Notechis ater*		
white-lipped snake	*Drysdalia coronoides*		
mountain dragon	*Tympanocryptis diemensis*		
three-lined skink	*Bassiana duperreyi*		
White's skink	*Egernia whiteii*		
delicate skink	*Lampropholis delicata*		
Bougainville's skink	*Lerista bougainvillii*		
metallic skink	*Niveoscincus metallicus*		
spotted skink	*Niveoscincus ocellatus*		
Southern grass skink	*Pseudomoia entrecasteauxii*		
glossy grass skink	*Pseudomoia rawlinsoni*		
blotched blue-tongue	*Tiliqua nigrolutea*		
Tasmanian tree skink	*Niveoscincus pretiosus*		
Introduced fauna			
cat	*Felis catus*		
black rat	*Rattus rattus*		
house mouse	*Mus musculus*		
pig *	*Sus scrofa*		

Table F2: Threatened bird species likely to occur at Logan Lagoon Ramsar Site.

Note: species considered wetland-dependent are in **bold**. * species recorded as occurring within the Logan Lagoon area. All other species listed are likely to occur in the Logan Lagoon area (but may not have been observed and recorded in a relevant database). ** identified by the EPBC Protected Matters Search for which there are no records of the species occurring in the Logan Lagoon area.

Common Name	***Scientific Name***	**Status EPBC Act**	**Status TSP Act***	**Migratory listing**
fork-tailed swift	*Apus pacificus*			JAMBA, CAMBA
wedge-tailed eagle	*Aquila audax fleayi*	E	e	
cattle egret *	***Ardea ibis***			CAMBA
ruddy turnstone*	***Arenaria interpres***			Migratory, JAMBA, CAMBA, ROKAMBA
Australasian Bittern	***Botaurus poiciloptilus****	E		
sharp-tailed sandpiper*	***Calidris acuminata***			Migratory, JAMBA, CAMBA, ROKAMBA
sanderling *	***Calidris alba***			Migratory, JAMBA, CAMBA
curlew sandpiper*	***Calidris ferruginea***			Migratory, JAMBA, CAMBA, ROKAMBA
red-necked stint*	***Calidris ruficollis***			Migratory, JAMBA, CAMBA, ROKAMBA
double-banded plover*	***Charadrius bicinctus***			Migratory
lesser sand plover*	***Charadrius mongolus***			Migratory, JAMBA, CAMBA, ROKAMBA
southern royal albatross**	*Diomedea epomophora epomophora*	V		Migratory
northern royal albatross**	*Diomedea epomophora sandfordi*	E		Migratory
wandering albatross**	*Diomedea exulans*	V	e	Migratory, JAMBA
Antipodean albatross**	*Diomedea antipodensis*	V	e	Migratory
Gibson's albatross**	*Diomedea gibsoni*			Migratory
northern royal albatross **	*Diomedea sanfordi*			Migratory
Latham's snipe*	***Gallinago hardwickii***			Migratory, JAMBA, CAMBA, ROKAMBA
white-bellied sea-eagle	*Haliaeetus leucogaster*			Migratory
white-throated needletail	*Hirundapus caudacutus*			JAMBA, CAMBA

Common Name	*Scientific Name*	Status EPBC Act	Status TSP Act*	Migratory listing
Caspian tern*	***Hydroprogne caspia***			JAMBA, CAMBA
bar-tailed godwit*	***Limosa lapponica***			Migratory, JAMBA, CAMBA, ROKAMBA
southern giant petrel	*Macronectes giganteus*	E	v	Migratory
northern giant petrel	*Macronectes halli*	V	r	Migratory
satin flycatcher *	*Myiagra cyanoleuca*			Migratory
eastern curlew*	***Numenius madagascariensis***			Migratory, JAMBA, CAMBA, ROKAMBA
whimbrel*	***Numenius phaeopus***			Migratory, JAMBA, CAMBA, ROKAMBA
forty-spotted pardalote	*Pardalotus quadragintus*	E	e	JAMBA
Pacific golden plover*	***Pluvialis fulva***			Migratory, JAMBA, CAMBA, ROKAMBA
white-headed petrel	*Pterodroma lessonii*		v	
little tern*	*Sterna albifrons sinensis*		e	Migratory, JAMBA, CAMBA, ROKAMBA
fairy tern*	***Sternula nereis nereis***	V	**v**	
white-fronted tern*	***Sterna striata***		**v**	
Buller's albatross**	*Thalassarche bulleri*	V		Migratory
shy albatross**	*Thalassarche cauta cauta*	V	v	Migratory
Salvin's albatross**	*Thalassarche cauta salvini*	V	v	
white-capped albatross**	*Thalassarche cauta steadi*	V	v	
Campbell albatross**	*Thalassarche impavida*			Migratory
black-browed albatross**	*Thalassarche melanphrys*	V	e	
Salvin's albatross**	*Thalassarche salvini*			Migratory
white-capped albatross **	*Thalassarche steadi*			Migratory
common greenshank*	***Tringia nebularia***			Migratory, JAMBA, CAMBA, ROKAMBA

JAMBA: listed under the Japan – Australia Migratory Birds Agreement

CAMBA: listed under the China – Australia Migratory Birds Agreement

ROKAMBA: listed under the Republic of Korea – Australia Migratory Birds Agreement

Migratory: listed under the Convention on Migratory Species

Table F3: Bird species recorded at the Logan Lagoon Ramsar site. Species in **bold** are considered wetland dependent.

* Species recorded at the Logan Lagoon Ramsar site. All other species have been recorded as occurring within a six kilometre radius of the Logan Lagoon Conservation Area and are likely occur at the site. ** Species identified by the EPBC Protected Matters Search for which there are no records of the species ever occurring in the Logan Lagoon area.

Common name	***Scientific name***
Native species	
Tasmanian Thornbill	*Acanthiza ewingii*
Collared Sparrowhawk	*Accipiter cirrocephalus*
Brown Goshawk	*Accipiter fasciatus*
Eurasian Skylark	*Alauda arvensis*
Chestnut Teal	***Anas castanea****
Grey Teal	***Anas gracilis****
Australasian Shoveler	***Anas rhynchotis****
Pacific Black Duck	***Anas superciliosa****
Fork-tailed Swift	*Apus pacificus*
Wedge-tailed Eagle	*Aquila audax*
Great Egret, White Egret	**Ardea alba ***
Cattle Egret	***Ardea ibis****
Eastern Great Egret	***Ardea modesta****
Fork-tailed Swift	*Apus pacificus*
Short-tailed Shearwater	*Ardenna tenuirostris*
Ruddy Turnstone	***Arenaria interpres****
Dusky Woodswallow	*Artamus cyanopterus*
Hardhead	***Aythya australis****
Musk Duck	***Biziura lobata****
Australasian Bittern	***Botaurus poiciloptilus****
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Pallid Cuckoo	*Cacomantis pallidus*
Striated Fieldwren	*Calamanthus fuliginosus*
Sharp-tailed Sandpiper	***Calidris acuminata****
Sanderling	***Calidris alba****
Curlew Sandpiper	***Calidris ferruginea****
Red-necked Stint	***Calidris ruficollis****
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*
Cape Barren Goose	***Cereopsis novaehollandiae****
Shining Bronze-Cuckoo	*Chalcites lucidus*

Common name	*Scientific name*
Double-banded Plover	***Charadrius bicinctus****
Red-capped Plover	***Charadrius ruficapillus****
Silver Gull	***Chroicocephalus novaehollandiae***
Swamp Harrier	*Circus approximans*
Grey Shrike-thrush	*Colluricincla harmonica*
Rock Dove	*Columba livia*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Forest Raven	*Corvus tasmanicus*
Brown Quail	*Coturnix ypsilophora*
Australian Magpie	*Cracticus tibicen*
Black Swan	***Cygnus atratus ****
Laughing Kookaburra	*Dacelo novaeguineae*
Southern Royal Albatross	*Diomedea epomophora **
Antipodean Albatross	*Diomedea antipodensis**
Gibson's Albatross	*Diomedea gibsoni **
Northern Royal Albatross	*Diomedea sanfordi**
Little Egret	***Egretta garzetta****
White-faced Heron	***Egretta novaehollandiae***
White-fronted Chat	*Epthianura albifrons*
Little Penguin	*Eudyptula minor*
Brown Falcon	*Falco berigora*
Nankeen Kestrel	*Falco cenchroides*
Peregrine Falcon	*Falco peregrinus*
Eurasian Coot	***Fulica atra ****
Latham's Snipe	***Gallinago hardwickii****
Tawny-crowned Honeyeater	*Glyciphila melanops*
Sooty Oystercatcher	***Haematopus fuliginosus****
Australian Pied Oystercatcher	***Haematopus longirostris****
white-bellied sea-eagle	*Haliaeetus leucogaster*
White-throated Needletail	*Hirundapus caudacutus*
Welcome Swallow	*Hirundo neoxena*
Caspian Tern	***Hydroprogne caspia****
Silver gull	***Larus novaehollandiae****
Pacific Gull	***Larus pacificus****
Lewin's Rail	***Lewinia pectoralis****

Common name	***Scientific name***
Yellow-throated Honeyeater	*Lichenostomus flavicollis*
Bar-tailed Godwit	***Limosa lapponica****
Southern Giant-Petrel	*Macronectes giganteus*
Northern Giant-Petrel	*Macronectes halli*
Superb Fairy-wren	*Malurus cyaneus*
Little Grassbird	***Megalurus gramineus***
Dusky Robin	*Melanodryas vittata*
Black-headed Honeyeater	*Melithreptus affinis*
Strong-billed honeyeater	*Melithreptus validirostris*
Little Pied Cormorant	*Microcarbo melanoleucos**
Australasian Gannet	*Morus serrator*
Satin Flycatcher	*Myiagra cyanoleuca*
Blue-winged parrot	*Neophema chrysostoma**
Southern Boobook	*Ninox novaeseelandiae*
Eastern Curlew	***Numenius madagascariensis****
Whimbrel	***Numenius phaeopus****
Olive Whistler	*Pachycephala olivacea*
Golden Whistler	*Pachycephala pectoralis*
Spotted Pardalote	*Pardalotus punctatus*
Forty-spotted Pardalote	*Pardalottus quadragintus*
Striated Pardalote	*Pardalotus striatus*
White-faced Storm-Petrel	*Pelagodroma marina*
Australian Pelican	***Pelecanus conspicillatus****
Tree Martin	*Petrochelidon nigricans*
Scarlet Robin	*Petroica boodang*
Flame Robin	*Petroica phoenicea*
Great Cormorant	*Phalacrocorax carbo**
Black-faced Cormorant	*Phalacrocorax fuscescens**
Little Black Cormorant	*Phalacrocorax sulcirostris**
Brush Bronzewing	*Phaps elegans*
Common Pheasant	*Phasianus colchicus*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Crescent Honeyeater	*Phylidonyris pyrrhopterus*
Green Rosella	*Platycercus caledonicus**
Pacific Golden Plover	***Pluvialis fulva***

Common name	*Scientific name*
Hoary-headed Grebe	***Poliocephalus poliocephalus***
Purple Swamphen	***Porphyrio porphyrio***
Grey Fantail	*Rhipidura albiscapa*
White-browed Scrubwren	*Sericornis frontalis*
Tasmanian Scrubwren	*Sericornis humilis*
Little tern	***Sterna albifrons ****
White-fronted Tern	***Sterna striata****
Fairy Tern	***Sternula nereis nereis****
Black Currawong	*Strepera fuliginosa*
Australasian Grebe	***Tachybaptus novaehollandiae****
Australian Shelduck	***Tadorna tadornoides****
Buller's Albatross	*Thalassarche bulleri ***
Shy Albatross	*Thalassarche cauta ***
Campbell Albatross	*Thalassarche impavida ***
Black-browed Albatross	*Thalassarche melanphrys***
Salvin's Albatross	*Thalassarche salvini ***
White-capped Albatross	*Thalassarche steadi ***
Crested Tern	***Thalasseus bergii****
Hooded Plover	***Thinornis rubricollis****
Common Greenshank	***Tringa nebularia****
Masked Lapwing	*Vanellus miles*
Banded Lapwing	*Vanellus tricolor*
Silvereye	*Zosterops lateralis*
Introduced species	
Australasian Pipit	*Anthus novaeseelandiae*
European Goldfinch	*Carduelis carduelis*
Common Greenfinch	*Chloris chloris*
House Sparrow	*Passer domesticus*
Common Starling	*Sturnus vulgaris*
Common Blackbird	*Turdus merula*

APPENDIX G: The Consultants

Dr Luke Finley – Marine Biologist / Environmental Scientist

Luke has over 10 years experience in marine ecology with a solid understanding of Australian coastal processes and ecosystems. Luke was the project manager for the preparation of the Logan Lagoon ECD and in this role he liaised with the steering committee, stakeholders, and the Department to gather relevant information and gain feedback on the final product. Luke compiled and reviewed much of the ECD content.

Luke has worked in a range of freshwater and marine environments from temperate to polar waters, with experience that includes three voyages to Antarctica as a biologist to assess the pelagic ecosystems of the Southern Ocean. Luke is skilled in: stakeholder consultation; maintaining a collaborative team-oriented approach; preparing literature reviews and scientific publications; knowledge of the practicalities of conducting field surveys, and; an ability to synthesise complex information into concise and reader-friendly documents.

Mr Andrew Roberts – Environmental Scientist / Chemist

Andrew Roberts is an Environmental Scientist who contributed to the Logan Lagoon ECD in the areas of climate, hydrology, water quality, soils and geomorphology, and key threats associated with climate change and upstream catchment management issues. He has worked on a diverse range of environmental management projects across Australia and North America, mostly focussed on pollution investigation and clean-up in surface water and groundwater systems. His experience on other Ramsar sites includes a catchment management project for a waterway entering the Western Port Ramsar site, and environmental monitoring in the Swan Bay Ramsar site associated with a nearby harbour redevelopment. Andrew is a member of the Environment Institute of Australia and New Zealand and the Australian Marine Sciences Association.

Mr Barry Baker – Environmental Consultant / Wildlife Management

Barry is a specialist in the management of threatened species of vertebrates, particularly birds and mammals who contributed to the Logan Lagoon ECD in the areas of flora and fauna, and reviewed the document several times. He has extensive experience in compiling and coordinating literature reviews and issues papers addressing population status, distribution and threats to a diverse range of threatened species. Barry is highly skilled in negotiation and consultation with State and Commonwealth agencies, overseas organisations, industry, stakeholders and the public. He has successfully facilitated workshops and meetings where issues have been contentious and the participants have had conflicting agendas.

Barry has been involved in Australian delegations to several international organisations, including: the Conference of Parties of the Convention on Migratory Species (CMS or Bonn Convention); the Commission for Conservation of Southern Bluefin Tuna (CCSBT), and; the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). In 1996 Barry worked with the Ramsar Bureau, as an Australian Government representative and coordinator of the organisation of the 6th Conference of Parties. This provided him with the opportunity to develop a strong understanding on the objectives of the Ramsar Convention and to forge relationships with key personnel in the convention, many of whom are still active in wetlands conservation.

Ms Katrina Jensz – Environmental Consultant / Wildlife Management

Katrina has extensive experience with interpretation and administration of the *EPBC Act 1999*. She contributed to the Logan Lagoon ECD in the areas of flora and fauna, threatened species, state and federal

legislation, and other general content throughout. Katrina specialises in the management of threatened species and, in particular, the development and implementation of recovery plans, threat abatement plans, issues papers and management plans. Katrina has an excellent understanding of relevant legislation (State and Commonwealth) which is essential in the preparation of these documents. She also has a good understanding of the *EPBC Act 1999* in relation to conservation of Ramsar wetlands and Australia's obligations under the Ramsar Convention.

Katrina has solid understanding of the Ramsar ECD framework having assisted in the preparation of the ECDs for several Ramsar wetlands (Ashmore Reef National Nature Reserve, Coral Sea Reserves (Coringa-Herald and Lihou Reefs and Cays), and Elizabeth and Middleton Reefs Marine National Nature Reserve, and the Coorong, Lakes Alexandrina and Albert Wetlands). Katrina provided expert advice on threatened species and ecological communities (marine turtles, dugongs, Mount Lofty Ranges Southern Emu-wren, Orange-bellied Parrot, Southern Bell Frog, Swamps of the Fleurieu Peninsula, and several species of plants and fish), wetland-dependent birds including migratory species, seabirds, as well as providing advice on processes threatening the ecosystems.