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**Department of Sustainability, Environment,
Water, Population and Communities**

Gippsland Lakes Ramsar site

Ecological Character Description

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Chapters 6-7

Other chapters can be downloaded from:

www.environment.gov.au/water/publications/environmental/wetlands/21-ecd.html

6 CHANGES TO ECOLOGICAL CHARACTER

6.1 Timescales Used in the Assessment

In assessing changes to ecological character for Gippsland Lakes, the ECD examines:

- 1) matters affecting ecological character that pre-date listing as Ramsar site (principally long term salinity and hydrology changes through the permanent opening of Lakes Entrance)
- 2) changes that have been observed or documented since listing of the site as a Wetland of International Importance in 1982 up to the present time (as required by the National ECD Framework).

Item 1 has been included as part of this ECD to recognise and discuss the long term trends that affect the ecological character of the site, many of which were occurring prior to listing of the site in 1982 and have continued to influence the site's character in the intervening period to the present time.

6.2 Matters Affecting Ecological Character Prior to Listing

Up until the late 19th century, the Gippsland Lakes was an intermittently closed and open lagoon system, separated from the Southern Ocean by a series of low sand dunes. Riverine discharge meant that fresh water would accumulate in the lagoons and wetlands until high water levels eventually breached the dune system; a temporary opening was then created that allowed a connection with the ocean until sand transport down the Ninety Mile Beach closed the breach and freshwater conditions slowly re-established. The permanent opening of Lakes Entrance in 1889 (and subsequent dredging to maintain the Entrance for shipping) set into motion a long-term change in the character of the site from this intermittently closing and opening estuarine system, with significant freshwater lacustrine (lake) and palustrine (marsh/morass) features, to a more open marine-estuarine system that is regularly influenced by coastal tides, currents and storm surges. Thus the Gippsland Lakes system now shows a salinity gradient from east to west, with the easterly sections almost totally marine and the most westerly sections largely freshwater. Moreover, the creation of the permanent entrance allowed average water levels in the lagoons (and therefore also in the fringing wetlands) to drop by approximately 0.5 metres, as fresh waters no longer built up behind the closed dune system, instead being able to discharge quickly to the sea. As a result of these long term changes in salinity and water-level regimes, the only remaining 'permanent' freshwater features are Macleod Morass (due partly to storm-water discharge and inputs of treated sewage) and Sale Common, although most of the morasses and swamps along Lake Wellington may exhibit freshwater conditions after very large floods.

The current brackish-water conditions existing within Lake Wellington (which ceased to be a freshwater system in the mid-1960s, following severe drought and bushfires, resulting in saline intrusions from the easterly lagoons) have resulted from long-term estuarine processes, highlighted recently by several large floods events in the eastern lakes that caused the overflow and spillage of large quantities of salty water through McLennan Strait into Lake Wellington (Chris Barry, GCB, *pers. comm.* 2009). This process is a direct consequence of the large size of the Gippsland Lakes, as river

discharge from the westerly rivers (for example, Latrobe, Thomson, Macalister) may be out-of-sync with that of the easterly rivers (for example, Nicholson, Mitchell and Tambo). The salinity shift that has taken place in Lake Wellington has seen major shifts in floristics, fish populations and human amenity.

The long-term transition of the western Gippsland Lakes system from a predominantly freshwater system at the time of European settlement into a more estuarine system has led to corresponding changes in the ecological structure and function of site over time (DSE 2003). In general it would be expected that freshwater-dependent flora and fauna species and communities, while still able to preferentially inhabit or use the site during periods of high freshwater flow, are under increasing stress and are likely to be gradually replaced by those species and communities better adapted to more marine and estuarine conditions, or otherwise to the more variable estuarine and brackish conditions in Lake Wellington and the western lake and marshes.

This general hypothesis is substantiated as part of various studies documented in Ecos (unpublished) about wetland habitat and fauna populations over time which are summarised below:

- **Freshwater macrophytes in Lake Wellington:** Freshwater taxa, such as *Vallisneria*, seem to have disappeared after the drought-bushfire-flood-saline intrusion cycle of the late 1960s and not regrown. Lake Wellington is now dominated by phytoplankton, including periodic outbreaks of cyanobacteria (that is, algal blooms). As a result, Lake Wellington has experienced a change in state, and has switched from a macrophyte-dominated system to an algal-dominated system.
- **Seagrass:** There is long term variability in seagrass cover and density in the main lakes (King and Victoria). Roob and Ball (1997) showed clearly that there has been a continual fluctuation in seagrass cover at five sites within the Gippsland Lakes Ramsar site over their study period 1959 to 1997. This variability matches the long-term (decadal) variability observed for seagrass beds in south-eastern Australia since the 1970s. A near-complete loss of seagrasses was reported for the Gippsland Lakes between the 1920s and the 1950s (Coles et al. 2003).
- **Phytoplankton blooms:** Long term salinity changes to the lagoons within the site, in connection with long term nutrient loading from the catchments have made it more prone to cyanobacteria blooms, specifically *Nodularia* as discussed previously in this report.
- **Fringing reedbeds and wetlands vegetation:** The study by Boon et al. (2008) for shifts in vegetation from 1964 to 2003 in Dowd Morass showed the very clear decline in area of common reed (*Phragmites australis*) and increase in area of swamp paperbark (*Melaleuca ericifolia*). There were 467 hectares of common reed community in Dowd Morass in 1982, a decrease of 10 hectares from 1973. The area of swamp paperbark in 1982 was 515 hectares, an increase of 394 hectares over that recorded for 1973. These results indicate clear and substantial changes were occurring in the relative (and absolute) areas of common reed and swamp paperbark in this wetland over time around the time of listing, and it is likely that they reflect changes that have occurred in many other parts of the Gippsland Lakes (for example, see Bird 1986; Crossco 2002).
- **Carp:** Carp represent both a threat (through its role in habitat disturbance particularly in the less saline waterbodies of the site) and also represents a freshwater commercial fishing resource. Carp was introduced into the Gippsland Region in the 1960s for the purpose of farm dam

stocking. They have been abundant in the lower Latrobe and Lake Wellington since the 1970s, prior to Ramsar listing, and now reach very high abundances in the Mitchell and Tambo Rivers, particularly during low flow periods.

- **Drainage works:** Corrick and Norman (1980) reported that drainage works had eliminated 27 wetlands (of 5625 hectares) and reduced the surface area of another 18 (by 1913 hectares) within the Gippsland Lakes system. These works pre-date the listing of the site in 1982, but continue to affect the hydrological regimes of wetlands such as Dowd Morass, the Heart Morass, and Lake Coleman
- **Native freshwater fish:** The regional conservation status of several species has changed over time, due to changes in habitat (triggered by the permanent mouth opening and subsequent changes), water regime (resulting from upstream water regulation and extraction) and catchment condition (resulting in poor water quality in some of the streams and lakes of the Gippsland Ramsar site). The gradual and persistent changes towards a more marine system have seen the extent of habitat for freshwater fish significantly reduced (due to the twin effects of the permanent mouth opening and reduced upstream inflows), and significant reductions in the populations of these fish. A key species for the site, dwarf galaxias (*Galaxiella pusilla*), is a freshwater fish requiring highly vegetated aquatic systems, and shallow temporary wetlands such as Macleod Morass. However, dwarf galaxias is thought to have declined in extent significantly since settlement due to habitat modification (Corrick and Norman 1980) and was likely experiencing decline prior to Ramsar listing.

While the conversion of areas of the Gippsland Lakes to more estuarine conditions represents a change from what the Lakes were in pre-European times, not all changes to ecological character can be viewed as being adverse in the context of the now broader criteria of the Ramsar Convention. The site now supports large populations of migratory and resident waterbirds that prefer estuarine and nearby marine habitats for important life cycle activities (such as feeding and roosting). Estuarisation has promoted growth of seagrass assemblages in the main lakes, and through the maintenance of the permanent opening at Lakes Entrance a high diversity of marine/estuarine fish and invertebrate species and fish habitats now exist (relevant to Criterion 8).

6.3 Assessment of Ecological Character Changes Since Listing

When considering changes in ecological character of the site, the National ECD Framework requires the ECD to examine any changes to character that have occurred since the listing of the site in 1982.

The nomination documentation for the site (see Victorian Ministry for Conservation 1980) is brief (one typed page). As discussed in Section 2 of this document, it summarises environmental values to waterbird at the time of listing, as well as providing estimated extents of specific wetland features within the site (Macleod Morass, Lake King and so on).

As a result, a range of other information sources have been reviewed in an attempt to identify/characterise the baseline conditions of the site at the time of listing and to assess any anecdotal or documented changes to ecological character since listing. Key points are as follows:

- **Salinity from estuarine and marine inflows:** The 'estuarisation' of the site was well progressed at the time of listing and there is some evidence that floristic changes (for example, loss of reed beds along Lake Wellington) had already occurred within 20 years of the entrance being opened. Nevertheless, it may take centuries for the full impact of the artificial opening to become apparent.
- **Increased river regulation and diversion:** Over the past 25 years there has been a documented reduction in the diversity and volume of surface water flows into the Gippsland Lakes system from the construction of significant water infrastructure (Thomson Dam) to supply water to Melbourne in the late 1970s, from water extraction for irrigation purposes and from increased taking of water for industrial use. This in turn has been exacerbated by increased salinity from a combination of marine inflows, groundwater interaction which has developed predominantly from poor catchment management practices (clearing of vegetation and evapotranspiration) and fires (as a major contributor to vegetation loss and increased evaporation rates) (Boon et al. 2008; SKM 2009). While most of the eastern rivers that flow into water bodies such as Lake Victoria and Lake King largely retain their natural flow regime, the western river catchments that flow into Lake Wellington and its fringing wetlands, such as the Latrobe-Thomson-Macalister system and Avon River are heavily regulated with only large flows reaching the lakes. It has been observed that the absence of smaller, more variable freshwater flows events (that previously occurred in these catchments on a seasonal basis prior to increased water regulation and extraction) have had an impact on the fringing wetlands which, as natural sinks, support important wetland biological processes such as reproduction and recruitment of *Melaleuca* communities that are critical for colonial bird breeding.
- **Water quality and algal blooms:** The larger lakes (particularly Lake Wellington) have been heavily affected by catchment inputs (CSIRO 1998 and 2001) and the increased incidence of algal blooms brought about mostly by the flux of nutrients into the system. Fine sediments and higher turbidity from catchment runoff have also become more permanent features of shallow water bodies like Lake Wellington, contributing to poor water quality and conditions that preclude submerged macrophytes from re-establishing in the lake substrate.



Algal bloom in the Gippsland Lakes in 2008 (source: Paul Boon)

While these physico-chemical changes to water quantity and quality in the Ramsar site continue to be observed and studied, there is little information available to quantify the associated ecological impact of the changes, particularly in the context of critical components and processes such as waterbird abundance and usage and impacts to key life-cycle functions such as breeding.

Table 6-2 (which appears at the end of this section) has been prepared to summarise information about the various wetland and waterbodies within the site at a local scale, in order to qualitatively describe impacts/changes to those values that have been documented in various literature since 1982.

Some of the key conclusions that can be drawn from Table 6-2 are as follows:

- There is poor baseline data and understanding of the conditions of each of the wetlands at the time of listing. The information contained in the Table is highly qualitative and based on information from plans, strategies and scientific papers about the wetland/waterbody areas as opposed to empirical studies.
- There is little information or data available that has been systematically collected over the intervening period since listing from which to quantitatively assess whether the values of each waterbody/wetland continues to exist or function since listing. This is a major information gap in assessing changes to ecological character of the site. As a result it is difficult to provide definitive advice about whether the values of the wetlands have been retained or the extent or reversibility of any adverse impact.
- Notwithstanding the above, even in the absence of quantitative data, the ecological character of several waterbodies/wetlands (for example, Lake Tyers) is unlikely to have changed since listing

based on the conservation-based management regime in place for the area and the relative absence of threatening processes.

- An improvement in ecological condition since listing could be argued in some locations based on documented investment in restoration and rehabilitation measures (see Parks Victoria 2003 for Macleod Morass; Parks Victoria 2008 for the Heart/Dowd Morass) but again a lack of baseline condition data and information prevents quantification of any net environmental gain.
- For other wetlands in the system, aspects of ecological character have likely declined as a result of changes in hydrology and water quality (nutrients, suspended solids and salinity). This is most prominent in the marshes/morasses in the western portion of the site and in Lake Wellington (noting some of these impacts had or were already occurring at the time of listing). This is discussed further in the context of the assessment of ecological character against LAC (see section 6.4), noting the reasons for the changes are likely to be a combination of natural and anthropogenic causes.

Based on the information that is available, some specific examples of aspects of ecological character (related to critical components of this ECD) that have reduced or declined are discussed below:

Waterbird usage and abundance

A general decline in the site's waterbird population has been noted by Ecos (unpublished), though the body of count data is identified in that source as being insufficient to confidently detect trends in waterbird abundance since 1982. Table 6-1 shows the trends in species/group usage of the site (at various locations) based on information about flock sizes and annual average counts presented in the technical appendix to Ecos (unpublished).

While these reductions could be the result of factors outside of the site boundaries in terms of broader migratory waterbird usage patterns, Ecos (unpublished) asserts that trends in abundance for both "declining" and "increasing" species within the site are linked to changes in salinity (as a result of reduced freshwater catchment inflows from a combination of drought and/or anthropogenic impacts, subsequent saline intrusion, and concomitant effects on aquatic flora and fauna, and fringing vegetation).

Salinity may cause profound changes in aquatic fauna and flora on which waterbirds are dependent (Hart et al. 1990 and Froend et al. 1987 in Kingsford and Norman 2002, Halse 1987) and many waterbirds are considered to be intolerant of salinity above about 5000 micrograms per litre (Loyn et al. 2006).

For Gippsland Lakes, Ecos (unpublished) noted a pattern of increasing abundance in the mid-1990s (a period of high rainfall and flooding) was found for almost all of the site's waterbirds, with the exception of those considered tolerant of highly saline conditions (for example, Black-wing Stilt) or marine species (for example, crested tern) which showed an opposite trend. This contrasts with generally suppressed levels of waterbird abundance during the 1980s and since 2000 (concomitant with evidence of lower levels of freshwater inputs and higher ambient salinity levels in wetlands and waterbodies).

Table 6-1 Trends in the populations of important waterbirds (adopted from Ecos unpublished)

Common Name	Trend	Comments (summarised from text presented in Ecos)
Australasian bittern	Declining	Probably lost as a breeding species due to loss of <i>Phragmites</i> habitat
Australasian glebe	Declining	Appears to have been rapidly lost from breeding sites in recent years
Australasian shoveller	Declining	May be continuing to decline as a breeding species below 1980s levels although large flocks have been reported in the 2000s
Australian pelican	Increasing	Breeding population appears to be increasing based on average annual count size
Australian shelduck	Possibly Declining	No substantial variation reported but recent declines
Australian white ibis	Possibly Declining	No substantial variation reported but recent declines
Australian wood duck	Increasing	Substantial increase since the 1980s
Banded stilt	Increasing	More local usage possibly in relation to refugia values of the site and lack of suitable inland habitat
Black swan	Declining	Somewhat stable but average annual count sizes have been declining in recent years
Black-winged stilt	Increasing	Some evidence of increase since 1980s – Roseneath wetlands are a key breeding site
Blue-billed duck	Increasing	Some evidence of increase in Macleod Morass since 1980s
Caspian tern	Stable	Large increases in the 1990s have since stabilised
Chestnut teal	Stable	Stable noting slight decrease in reporting rates but substantial increases in flock size since the 1980s
Common greenshank	Stable	No substantial variation reported since 1980s
Common tern	Stable	Stable despite high degree of natural variability observed since the 1970s
Curlew sandpiper	Stable	No substantial variation reported since 1980s
Dusky moorhen	Substantial Decline	Substantial declines across Gippsland Lakes since the 1970s. Largely absent from eastern end of the Lakes, occurring in predominantly freshwater habitats of Sale Common, Macleod Morass and fringing wetlands of Lake Wellington
Eurasian coot	Substantial Decline	Very substantial decline in flock size and reporting rate since the 1980s. Key habitats include Roseneath and western Lake Victoria, Dowd Morass and Silt Jetties
Fairy tern	Stable	No substantial variation reported since 1980s
Great cormorant	Stable	No substantial variation reported since 1980s
Great crested grebe	Substantial Decline	Very substantial decline in flock size and reporting rate since the 1980s. Key habitats include <i>Vallisneria</i> eel grass habitats as well as Jones Bay and Roseneath Peninsula
Great egret	Declining	Reporting rate has declined by about 50 per cent since the early 1980s. Common in the fringing brackish and freshwater morasses (Dowd, Heart, etc.)
Grey teal	Possibly Declining	High degree of variability – recent reduction in reporting rate
Hardhead	Stable	Reduction in numbers between 1980 and 1999 but have now recovered
Hoary-headed grebe	Substantial Decline	Substantial decline in both reporting rate and average flock size compared to 1980s. Victoria Lagoon in the Roseneath Wetlands is a key habitat area along with other freshwater wetlands areas and Lake Reeve. Link to <i>Vallisneria</i> eel grass habitats which have been lost from Lake Wellington prior to listing of the site
Hooded plover	Stable	No substantial variation reported since 1980s
Latham's snipe	Stable	No substantial variation reported since 1980s
Little black cormorant	Increasing	Increase in annual count size suggesting it may be occurring more commonly
Little pied cormorant	Stable	Decline since 1990s but numbers now appear similar to 1970s and 1980s
Little tern	Stable	May have increased since the 1980s
Musk duck	Substantial Decline	Substantial decline since the 1970s – some rebound in the 1990s but trending downward
Nankeen night heron	Substantial Decline	Average annual counts sizes declining since the 1980s
Pacific black duck	Possibly Declining	May be experiencing reduction in the number of breeding birds using the site
Pacific golden plover	Stable	No substantial variation reported since 1980s

Common Name	Trend	Comments (summarised from text presented in Ecos)
Pied oystercatcher	Stable	Stable with some increases shown since 1990s
Pink-eared duck	Stable	No substantial variation reported since 1980s
Purple swamphen	Substantial Decline	Very substantial decline since the 1990s likely due to loss of suitable habitat at Heart Morass
Red-kneed dotterel	Substantial Decline	Key habitat is Macleod Morass – low occurrence of this species in the past decade
Red-necked avocet	Increasing	Substantial increase since the 1980s
Red-necked stint	Possibly Declining	Substantial decline in the 1980s but recovery in the 1990s
Royal spoonbill	Increasing	Notable increase in reporting rate since 1980s
Sharp-tailed sandpiper	Stable	No substantial variation reported since 1980s
Straw-necked ibis	Stable	Increased in 1990s but has since declined. Still reported in higher levels than 1980s
Whiskered tern	Stable	No substantial variation reported since 1980s
White-bellied sea eagle	Increasing	Notable increase in reporting rate since 1980s
White-fronted tern	Stable	No substantial variation reported since 1980s
Yellow-billed spoonbill	Possibly Declining	Stable but evidence of recent decline

Note: Colour key is as follows: Red = substantial decline; Orange = declining numbers possible below early 1980's level; Yellow = recent decline but numbers do not appear to be below early 1980s level; and Green = stable or increasing since the early 1980s. Source: Ecos (unpublished).

In addition to the information presented in Ecos, BMT WBM undertook additional analyses of waterbird count data provided as part of the current study which is presented in Appendix C. This data analysis relied on data provided from the Victorian Government DSE database as well as Birds Australia count data.

Several key species were selected for analysis as they have been identified in this ECD as significant species in the context of meeting the one per cent of the total population criterion.

Figure 6-1 shows that there is great year to year variability in bird counts. In summary, the analysis of DSE and Birds Australia data for the key species (see Appendix C) indicated the following:

- Little tern – DSE data indicate that average annual counts were greater in the 2000's than in previous years. This could reflect actual increases in abundance or higher sampling effort for this species. There was insufficient data in the Birds Australia database to determine trends.
- Fairy tern – DSE data indicate that highest counts of fairy tern were recorded during two years in the 1990's. However, it is noted that records/counts were very patchy over time and may reflect increased sampling effort rather than actual increased numbers. There was insufficient data in the Birds Australia database to determine trends.
- Musk duck – DSE data indicates that average annual counts have been consistently low since the late-1990s. In previous decades, numbers were relatively high (approximately 100 individuals counted), but variable between years. There was insufficient data in the Birds Australia database to determine trends.
- Black swan – DSE data does not reveal any clear long term temporal trend, reflecting due to inconsistencies in sampling effort. The standardised Birds Australia count data indicate a low reporting rate (and low average annual abundance) since 1990.
- Eurasian coot – Analysis of DSE data indicate that average annual counts were highly variable over time with a peak in 1990. However, no apparent long term trend could be discerned from the DSE data. Similar to black swan, the standardised Birds Australia count data indicate a low reporting rate (and low average annual abundance) since 1999.

- Chestnut teal – DSE data indicate that numbers appear to have been relatively stable over time, the exception being a peak in 1984. The standardised Birds Australia count data indicate that most surveys containing 20 minute count data occurred in the period 1988 through the 1990's, but there were was a low reporting rate post 2000.

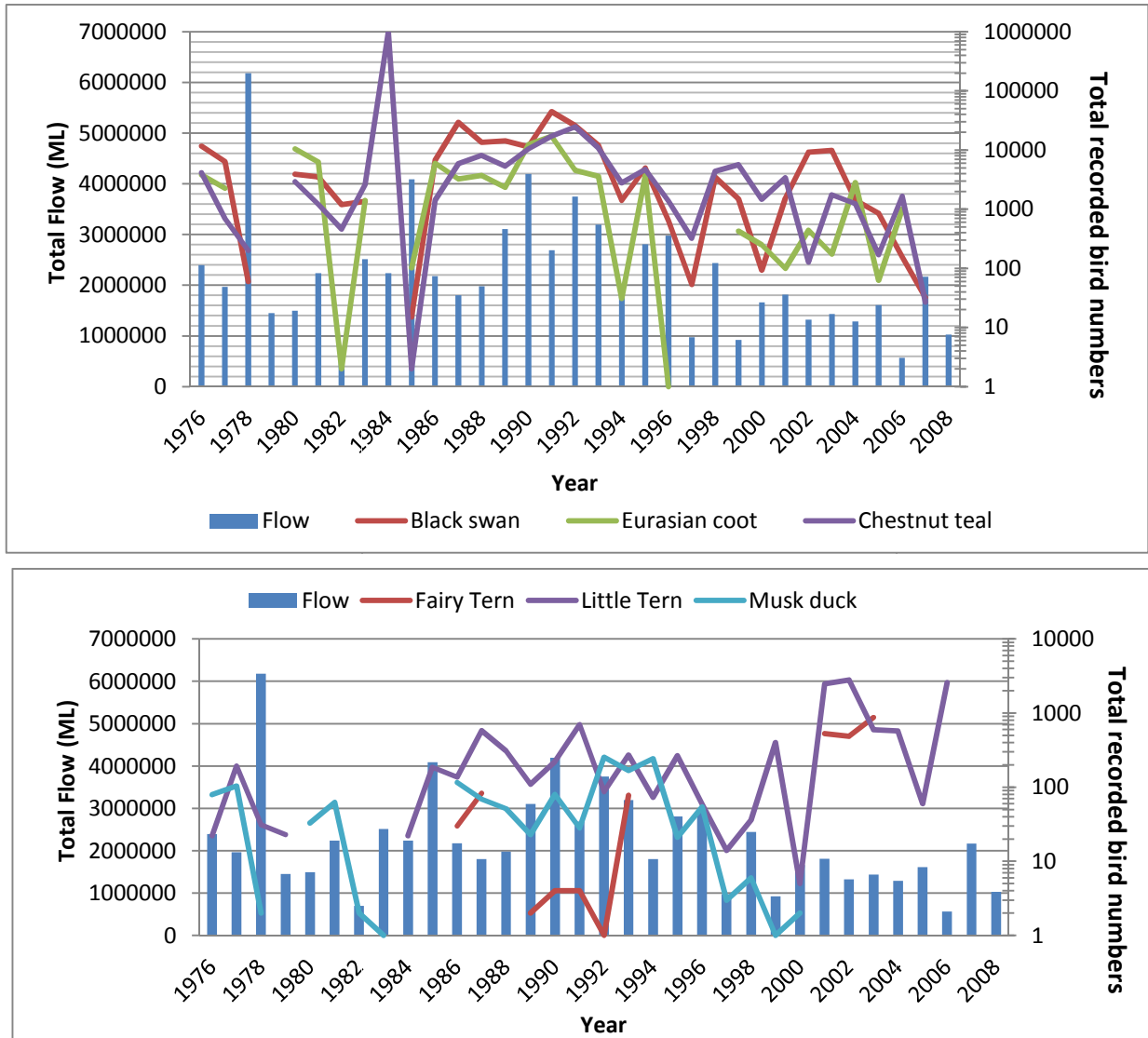


Figure 6-1 Total number of individuals recorded in each year for black swan, Eurasian coot, chestnut teal, fairy tern, little tern and musk duck, together with total annual river inflows into the site (DSE Database)

With some exceptions, this data review generally agreed with the findings of Ecos; namely that waterbird usage of the site since listing in 1982 generally shows that predominantly freshwater-dependent birds (for example, musk duck) are now occurring in lower numbers. However, in considering these trends it is important to note the following:

- Count data were not standardised in terms of survey methods, survey locations and survey effort. These can severely bias data, and therefore results should be considered as indicative only. Refer to Appendix C for discussion.
- The extent to which these patterns relate to drought conditions over most of this period, anthropogenic impacts from increased abstraction of water from contributing catchments, increased salinity impacts in traditional freshwater water habitats from the long term estuarisation of the Lakes, natural variation or a combination of these factors cannot be definitively determined based on the absence of comprehensive sampling data over time.

Wetland habitat condition

While there has not been a comprehensive assessment of habitat extent and condition across the Ramsar site, specific studies of particular wetlands and waterbodies within the Gippsland Lakes have shown more demonstrable changes to ecosystem condition than to extent. Two specific examples of observed changes to habitat condition include changes to the vegetation community structure at Dowd Morass (refer Boon et al. 2008) and changes to seagrass assemblages in the main lagoon system (refer Hindell 2008).

Long term studies of Dowd Morass discussed in Boon et al. (2008) show clear evidence of the conversion of *P. australis* reed-dominated systems to one that is dominated by *M. ericifolia* and swamp scrub over the period from 1964 to 2003, with the greatest rate of change during the period of 1982 to 1991. This change in the vegetation community structure is attributed within Boon et al. (2008) to changes in the hydrological regime (site drainage works undertaken in the 1970s caused more regular inundation of the morass) as well as persistent increasing salinity levels and microtopological relief within the system which impacts on plant reproduction patterns. As a management response, Dowd Morass was partially dried by Parks Victoria in 1995 and completely dried in 1998 with a more active management regime instigated through use of gated culverts since that time (Parks Victoria 2008). While each of the fringing wetlands within the Gippsland Lakes are somewhat unique, it has been postulated that similar changes to wetland vegetation communities have occurred in the other fringing wetlands of Lake Wellington, particularly at Clydebanks Morass and Lake Coleman (which have even greater levels of salinity than Dowd Morass). However, there have not been historical studies of the vegetation communities at these wetlands to the same level of detail as Dowd Morass.

In studies of seagrass in the Gippsland Lakes, Hindell (2008) found that seagrass had lower densities than previous recordings by Roob and Ball (1997) with declines noted at 23 of the 30 sites sampled. The studies were undertaken principally to assess changes to seagrass assemblages in response to the persistent algal blooms within the Lakes in 2007, and it was noted by Hindell that the declines could reflect 'natural cycles in productivity or changes in environmental conditions that could be independent of the current phytoplankton blooms'. Recommendations were made for further studies using the 2008 study as a baseline. Based on the findings of the study, there have been reductions in

the extent and condition of seagrasses at several locations in the main lakes, although the permanence of the change (and ability of the habitat to recover) remains a knowledge gap.

Black bream populations

Black bream catch has shown a marked decline since listing which is especially noticeable post-1986 (refer Figure 3-20). The cause/s of this change in catch are not fully known but likely relate to a combination of threats including reduced freshwater inflows, water quality and associated algal blooms, over-harvesting, and incremental habitat loss. Notwithstanding, the decline in catch (particularly during the period from the mid 1980s to 1990s when effort was equivalent to pre-1982 levels) could represent a decline in the overall abundance of this species. However, more detailed investigations are required to determine the key drivers of the observed changes.

Table 6-2 Waterbody/Wetland level assessment

NOTES:

^A Information sourced from the Strategic Management Plan for the Gippsland Lakes Ramsar site (DSE 2003), previous Ramsar Information Sheets, nomination documentation as well as other sources listed in the References Section.

Waterbody/ wetland name	Habitat types and wetland values supported at time of listing (1982) (^A)	Description of trends/ impacts to wetland values during the period since listing (1982 – 2010)	Likely reason/source of impact(s)	Key indicators for assessing future impacts (links to Monitoring Needs)	Source of Information
Sale Common	Deep freshwater marsh Supports: <ul style="list-style-type: none"> Waterbirds of significance such as little bittern, Australasian bittern, painted snipe and great egret Example of a wetland type (freshwater marsh) now rare in the Gippsland Lakes region 	Generally stable; values at time of listing are likely to continue to be supported Changes to flow regime and the seasonality of flow have been observed leading to loss of wetland connectivity and altered wetting and drying cycles Highly dependent on maintenance of flows from the Latrobe system Infestation of invasive weed Brazilian milfoil	Increased allocation of water for consumptive purposes from the Latrobe River system Reduced variability of flows from the catchment (more regular inundation) Long term hydrology changes from construction of Sale Canal Recreation usage possibly increasing weed impacts	Hydrology Water quality (pH, salinity, nutrients) Bird usage (breeding use and bird abundance) Presence of freshwater fish species Fringing vegetation extent and condition Weed dominance	WGCMA (2007) Ecos (unpublished)
Dowd Morass	Deep freshwater marsh Supports: <ul style="list-style-type: none"> Ibis and spoonbill breeding colony Waterbirds of significance such as great egret, hooded robin, little bittern, Australasian bittern, freckled duck, egret, painted snipe and white bellied sea eagle 	Values at time of listing are likely to continue to be supported but ecological condition has deteriorated Broad scale (greater than 100 hectare) changes to fringing vegetation extent and community type (for example, <i>Phragmites</i> to <i>Melaleuca</i>) since listing Bird usage in smaller numbers than previously recorded Water quality now predominantly brackish except following high flow events. Low pH due to possible ASS impacts. Algal blooms recorded.	Long term salinity intrusion from Lake Wellington and catchment sources Reduced variability of flows from the catchment (more regular inundation during large events) Activation of ASS from altered water regimes as well as nutrient enrichment	Hydrology Geomorphology Water quality (pH, salinity, nutrients) Bird usage (breeding use and bird abundance) Fringing vegetation extent and condition Vegetation ratio of <i>Phragmites</i> : <i>Melaleuca</i> and possible increase in saltmarsh taxa	Boon et al. (2008); WGCMA (2007) Ecos (unpublished)
Heart Morass	Deep freshwater marsh Supports: <ul style="list-style-type: none"> Ibis breeding colony in swamp scrub waterbird usage including white bellied sea eagle 	Values at time of listing are likely to continue to be supported but ecological condition has deteriorated Broad scale changes to vegetation extent and community type (for example, <i>Phragmites</i> to <i>Melaleuca</i>) and increased presence of <i>Juncus</i> (saltmarsh species)	Long term salinity intrusion from Lake Wellington and catchment Reduced variability of flows from the catchment (more regular inundation) Activation of ASS from	Hydrology Water quality (pH, salinity, nutrients) Geomorphology Bird usage (breeding use and bird abundance)	WGCMA (2007) Ecos (unpublished)

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Waterbody/ wetland name	Habitat types and wetland values supported at time of listing (1982) (A)	Description of trends/ impacts to wetland values during the period since listing (1982 – 2010)	Likely reason/source of impact(s)	Key indicators for assessing future impacts (links to Monitoring Needs)	Source of Information
		<p>Loss of terrestrial vegetation (for example, Eucalyptus species) as a result of secondary salinisation and/or water logging</p> <p>Water quality now predominantly brackish except following high flow events</p>	<p>altered water regimes as well as nutrient enrichment</p>	<p>Fringing vegetation extent and condition</p> <p>Vegetation ratio of <i>Phragmites</i> : <i>Melaleuca</i> and possible increase in saltmarsh taxa</p>	
<p>Lake Coleman and Tucker Swamp (within the site boundary)</p>	<p>Deep freshwater marsh (Lake Coleman {east} and Tucker Swamp)</p> <p>Supports:</p> <ul style="list-style-type: none"> Habitat for growling grass frog (EPBC) and waterbirds Swamp Scrub communities in Tucker Swamp provide important breeding habitat for pied cormorant 	<p>Values at time of listing are likely to continue to be supported but ecological condition has deteriorated</p> <p>Long term hydrology changes leading to increased salinity in Lake Coleman</p> <p>Contaminants in water quality from sewage treatment and paper mill discharge can affect water quality</p> <p>Possible historic contamination residues from Department of Defence use</p>	<p>Long term salinity intrusion from Lake Wellington and the catchment</p> <p>Historical legacy of paper mill and sewage effluent at Dutson Downs</p> <p>Activation of ASS from altered water regimes as well as nutrient enrichment</p>	<p>Hydrology</p> <p>Water quality (salinity, nutrients and toxicants (residue from Defence use))</p> <p>Geomorphology</p> <p>Bird usage (breeding use by cormorants and bird abundance)</p> <p>Fringing vegetation extent and condition</p> <p>Vegetation ratio of <i>Phragmites</i> : <i>Melaleuca</i> and possible increase in saltmarsh taxa</p>	<p>WGCMA (2007) Ecos (unpublished) HLA (2007)</p>
<p>Clydebank Morass</p>	<p>Deep freshwater marsh</p> <p>Supports:</p> <ul style="list-style-type: none"> Waterbird usage but no substantial breeding colonies 	<p>Values at time of listing are likely to continue to be supported but ecological condition has deteriorated</p> <p>Long term hydrology changes; greater connectivity with Lake Wellington as a result of major floods in 1990. Large areas are now permanently dry.</p> <p>Loss of fringing vegetation (reed beds)</p> <p>Greatly affected by salinity (including groundwater) with extensive saltmarsh species now present</p>	<p>Long term salinity intrusion from Lake Wellington and the catchment and decreased freshwater flows from river basins</p> <p>Reduced variability of flows from the catchment (more regular inundation) and groundwater salinity</p>	<p>Hydrology</p> <p>Water quality (salinity)</p> <p>Geomorphology</p> <p>Bird usage (bird abundance)</p> <p>Fringing vegetation extent and condition</p> <p>Vegetation ratio of <i>Phragmites</i> : <i>Melaleuca</i> and possible increase in saltmarsh taxa</p>	<p>Ecos (unpublished)</p>
<p>Lake Wellington</p>	<p>Permanent freshwater lake</p> <p>Supports:</p> <ul style="list-style-type: none"> Large numbers of waterbirds (black swan, crested tern, common tern) 	<p>Values at time of listing are likely to continue to be supported but ecological condition has deteriorated</p> <p>Significant water quality deterioration from</p>	<p>Decreased catchment runoff from large rivers</p> <p>Salinity results from marine inflows from the</p>	<p>Hydrology</p> <p>Water quality (salinity, turbidity and nutrients)</p>	<p>Ecos (unpublished)</p>

CHANGES TO ECOLOGICAL CHARACTER

Waterbody/ wetland name	Habitat types and wetland values supported at time of listing (1982) (A)	Description of trends/ impacts to wetland values during the period since listing (1982 – 2010)	Likely reason/source of impact(s)	Key indicators for assessing future impacts (links to Monitoring Needs)	Source of Information
		nutrient and sediment inputs and associated algal blooms Loss of fringing vegetation (reed beds)	permanent connection to the sea at Lakes Entrance and groundwater salinity Increased water column turbidity as a result of sediment resuspension and lack of vegetative (seagrass) cover Nutrient enrichment from catchment sources	Sediment – water - nutrient flux Frequency/intensity of algal blooms Shoreline erosion/vegetation extent	
McLennan Strait and Isthmus and wetlands of Roseneath Peninsula Victoria Lagoon, Morley Swamp and Lake Betsy	Narrow coastal strait and estuarine wetland complex but including predominantly freshwater areas Supports: <ul style="list-style-type: none"> • Broad area supporting growing grass/ green and golden bell frog habitat • Feeding habitat for breeding waterbirds 	Values at time of listing are likely to continue to be supported Vegetation reported to be largely intact but susceptible to increased salinity and conversion to saltmarsh Regular inflows from Lake Wellington	N/A	Hydrology Water quality (salinity) Bird usage (feeding) Presence of frog species Fringing vegetation extent and condition Vegetation ratio of <i>Phragmites</i> : <i>Melaleuca</i> and possible increase in saltmarsh taxa	Ecos (unpublished) WGCMA (2007)
Lake Victoria (including Blond Bay Wildlife Reserve but excluding Jones Bay)	Coastal brackish lake/lagoon with subtidal seagrass beds Supports: <ul style="list-style-type: none"> • Large numbers of waterbirds • Seagrass assemblages • Blond Bay supports breeding waterbirds 	No major changes to ecological characteristics or functions were identified in the literature review Some water quality deterioration from nutrient and sediment inputs and associated algal blooms and increasing salinity Some decreases in the condition and dieback of seagrass has been observed as part of recent sampling but may reflect natural variability	Algal blooms driven from catchment nutrients are seen as the most likely cause of the changes	Seagrass extent/condition Sediment – water - nutrient flux Frequency/intensity of algal blooms Shoreline erosion/vegetation extent	Ecos (unpublished) Hindell (2008)
Lake Reeve	Saline coastal lagoon and saltmarsh complex (predominantly hypersaline) Supports: <ul style="list-style-type: none"> • Important breeding habitat for waterbird species 	Stable - No major changes to ecological characteristics or functions were identified in the literature review	N/A	Geomorphology (integrity of sand dunes) Hydrology Saltmarsh vegetation extent and condition	Parks Victoria (1998) Ecos (unpublished)

CHANGES TO ECOLOGICAL CHARACTER

Waterbody/ wetland name	Habitat types and wetland values supported at time of listing (1982) (A)	Description of trends/ impacts to wetland values during the period since listing (1982 – 2010)	Likely reason/source of impact(s)	Key indicators for assessing future impacts (links to Monitoring Needs)	Source of Information
	<ul style="list-style-type: none"> Nursery area for many fish species Contains valuable remnants of vegetation communities that have been disturbed throughout their range 			<p>Sea level rise</p> <p>Fish usage</p>	
Macleod Morass (freshwater because of stormwater and sewage)	<p>Deep freshwater marsh</p> <p>Supports:</p> <ul style="list-style-type: none"> Ibis and black-winged stilt breeding colony Roosting site for waterbirds Habitat for green and golden bell frog, southern bell frog 	<p>No major changes to ecological characteristics or functions were identified in the literature review</p> <p>Some changes to flow regime from volume of outflows associated with STP</p> <p>Changes to water quality from STP discharge</p> <p>Loss of fringing vegetation (reed beds)</p>	<p>Increased allocation of water from the Mitchell</p> <p>STP discharge of wastewater into the wetland</p> <p>Management of flow regime and rehabilitation projects have been implemented to maintain/improve condition</p>	<p>Hydrology</p> <p>Water quality (nutrients)</p> <p>Bird usage (breeding, roosting)</p> <p>Presence of freshwater fish species</p> <p>Presence of frog species</p>	<p>Parks Victoria (2003)</p> <p>Ecos (unpublished)</p> <p>East Gippsland Water Reports</p>
Jones Bay	<p>Coastal brackish lake/lagoon</p> <p>Supports:</p> <ul style="list-style-type: none"> Large numbers of waterbird and migratory waterbirds 	<p>Stable - No major changes to ecological characteristics or functions were identified in the literature review</p> <p>Some water quality deterioration from nutrient and sediment inputs</p> <p>Initiation point for many algal blooms</p>	<p>STP discharge through Macleod Morass</p>	<p>Water quality (nutrients, salinity and turbidity)</p> <p>Frequency/intensity of algal blooms</p> <p>Sediment – water - nutrient flux</p> <p>Shoreline erosion/vegetation extent</p>	<p>Ecos (unpublished)</p>
Lake King (including Lakes Entrance)	<p>Coastal brackish lake/lagoon with subtidal seagrass beds</p> <p>Supports:</p> <ul style="list-style-type: none"> Large numbers of waterbirds Supports one per cent of national little tern population and fairy terns 	<p>Some water quality deterioration from nutrient and sediment inputs and associated algal blooms</p> <p>Some decrease in the condition and dieback of seagrass has been observed as part of recent sampling but this may be part of natural variability</p>	<p>Algal blooms driven from catchment nutrients are seen as the most likely cause of the changes</p>	<p>Seagrass extent/condition</p> <p>Water quality (nutrients, salinity and turbidity)</p> <p>Sediment – water - nutrient flux</p> <p>Frequency/intensity of algal blooms</p> <p>Shoreline erosion/vegetation extent</p>	<p>Ecos (unpublished)</p> <p>Hindell (2008)</p>
Lake Tyers	<p>Intermittently closed and open lagoon (Lake Tyers) with seagrass beds</p>	<p>Stable - No major changes to ecological characteristics or functions were identified in the literature review</p>	<p>N/A</p>	<p>Submerged plant extent/condition</p>	<p>Fisheries Victoria (2007)</p>

CHANGES TO ECOLOGICAL CHARACTER

Waterbody/ wetland name	Habitat types and wetland values supported at time of listing (1982) (A)	Description of trends/ impacts to wetland values during the period since listing (1982 – 2010)	Likely reason/source of impact(s)	Key indicators for assessing future impacts (links to Monitoring Needs)	Source of Information
	Supports: <ul style="list-style-type: none"> • Black bream and dusky flathead spawning site • Nursery habitat for fisheries • Waterbird feeding area • Lake Tyers is a historic breeding site for little tern • Green and golden bell frog habitat 			Breeding usage by little tern Abundance of black bream and dusky flathead Sediment – water - nutrient flux Water quality (nutrients, salinity and turbidity) Shoreline erosion/vegetation extent	GCB (2006) Ecos (unpublished)
Lake Bunga and Lake Bunga Arm	Freshwater coastal lagoon intermittently opening to an estuary (Lake Bunga) with subtidal seagrass beds Bunga Arm supports: <ul style="list-style-type: none"> • breeding populations of fairy tern, hooded plover and white-bellied sea-eagle • Nursery habitat for fisheries 	Stable - No major changes to ecological characteristics or functions were identified in the literature review Some decrease in the condition and dieback of seagrass has been observed as part of recent sampling but this may be part of natural variability	N/A	Breeding usage by seabirds (little tern) Water quality (nutrients, salinity and turbidity) Seagrass extent/condition Bird feeding habitat (on seagrass)	Ecos (unpublished) WGCMA (2007) Hindell (2008)

6.4 Assessment of Changes to Ecological Character Against LAC

The National ECD Framework requires that the assessment of changes to ecological character make reference to whether or not any limits of acceptable change (LAC) set as part of the ECD have been exceeded.

Drawing upon the waterbody/wetland scale assessment presented in Table 6-2, Table 6-3 provides an assessment against the LAC as outlined in Section 4 of this document. Table 6-4 provides a specific analysis of the LAC for the critical component wetland habitats focussing on whether or not the classification of the wetland (using Corrick and Norman 1980) has changed since listing.

Table 6-3 Assessment of ecological character changes against LAC

LAC		Has there been an exceedance of the LAC since listing?	Comments
LAC for Critical Components – Habitats (refer Table 4-1)			
Habitat Extent/Condition	(C1) Seagrass and subtidal algal beds	Uncertain but possible. Seagrass assemblages show considerable natural variability but appear to have significant reduced densities and extent since 1997 based on recent assessments by Hindell based on original mapping by Roob and Ball. The rate of recovery of these assemblages following cessation of algal blooms and increased rainfall is unknown, and Hindell did not rule out that observed changes could have been a result of natural variability.	Refer to recent seagrass assessment by Hindell (2008).
	(C2) Saline or brackish lagoons	Unlikely; water quality shows episodic loads of total suspended solids and nutrients but long term stability with the median baseline (that is, pre-listing values) between the 20 th and 80 th percentile values for key parameters. Refer Appendix B. There has not been a 'change in state' in terms of the eastern lakes since listing whereas Lake Wellington was already considered to have turned from a predominantly clear, macrophyte dominated system to a more turbid, algae-dominated system prior to listing (c. 1965).	The incidence of recent algal blooms in the eastern lakes are likely an acute rather than chronic response to nutrient and sediment loads as a result of large fires in the catchment in 2007. Lake Tyers remains in a near natural state with representative habitats for the drainage division.
	(C3) Fringing wetlands - freshwater	Uncertain but possible due to drought and reduced freshwater inflows. The draft Management Plan for Macleod Morass (Parks Victoria 2003) discusses the trend of common reed and cumbungi	There has not been an ecological condition assessment of Sale Common or Macleod Morass reviewed as part of the current study. Long term habitat extent (based on analysis of EVC) is relatively stable.

LAC		Has there been an exceedance of the LAC since listing?	Comments
		replacing/supplanting giant rush communities. Water quality and hydrological impacts on ecological values is an information gap within these wetland systems.	Likewise, it is unlikely there has been the loss of any of the identified wetland types since listing.
	(C4) Fringing wetlands - brackish	Uncertain but possible based on the fact that long term changes to vegetation structure at least one morass (Dowd) have occurred and similar effects have been observed at neighbouring wetlands. Based on studies by Boon et al. (2008), less than 50 per cent of the <i>Phragmites</i> reed habitats present within Dowd Morass have been replaced by <i>Melaleuca</i> indicating that this LAC has been met since listing. Water quality and hydrological impacts on ecological values is an information gap within these wetland systems.	Long term habitat extent (based on analysis of EVC) is relatively stable. The key issue is the declining condition of the habitat in the context of the loss/replacement and structure of key vegetation community types (<i>Phragmites</i> being replaced by <i>Melaleuca</i> and saltmarsh species), and the extent to which this has been caused by underlying critical processes such as the freshwater flow regime and tidal inflows. Refer to the long term study by Boon et al. (2008) for Dowd Morass. The other wetlands require similar studies about long term extent and condition to be carried out.
	(C5) Fringing wetlands - saltmarsh	Unknown but unlikely on the basis that these species are resilient to changes or increases in salinity within the range of natural variability. Water quality and hydrological impacts on ecological values is an information gap within these wetland systems.	Lake Reeve remains in a near natural state with representative habitats for the drainage division. Key saltmarsh areas within the site are also largely contained in protected tenure (for example, Lake Reeve). Long term changes to hydrology (for example, from climate change) may have a future impact on these communities. Long term habitat extent (based on analysis of EVC) is relatively stable. Likewise, it is unlikely there has been the loss of any of the identified wetland types since listing.
LAC for Critical Components – Species (refer Table 4-1)			
Species/Groups	(C6) Waterbirds	Unknown but possible based on overall reduction in bird usage as noted in Ecos (unpublished). In terms of the species listed in the previous RIS (Casanelia 1999) as meeting the one per cent threshold, musk duck (<i>Biziura lobata</i>), and Eurasian coot (<i>Fulica atra</i>) are most likely to no longer meet the Convention requirement for the site. The other one per cent species are reported by Ecos (unpublished) as possibly declining or relatively stable.	Trends in waterbird usage have been derived by Ecos (unpublished) but do not represent actual bird counts or a formal comprehensive survey. The survey data considered in the present ECD (see Appendix C) were insufficient to derive an appropriate empirical baseline. As indicated in the LAC, a more reliable baseline (with multiple sampling episodes over a ten year period) is needed to assess this LAC over time.
	(C7) Threatened frogs	Unknown; through key habitat (freshwater/brackish wetlands) are in decline in some areas.	Presence and usage of the site by these species is not well understood; suitable habitats include McLennan Strait, Sale Common, Macleod Morass and the Heart

LAC	Has there been an exceedance of the LAC since listing?	Comments
	(C8) Threatened flora species	<p>Morass.</p> <p>Presence and usage of the site by these flora species is not well understood or documented; suitable habitats include various terrestrial wetland habitats including mesic heathlands, swamps and waterbody margins.</p> <p>It is notable that metallic sun orchid has become nationally endangered since the listing of the site.</p>
LAC for Critical Processes (refer Table 4-1)		
(P1) Hydrological regime	<p>General LAC for hydrology have been set based on expert opinion and literature review. It is unknown whether they have been exceeded since the listing date for the wetlands listed.</p> <p>More defined ecological flow requirements for the hydrological regime of the Gippsland Lakes have been determined as part of the Environmental Water Requirements study (Stages 1 and 2 – refer Tilleard et al. 2009 and Tilleard and Lawson 2010).</p> <p>The extent to which these flow objectives have been met since listing or are currently being met will require more detailed modelling and historical analysis that is outside the scope of the current study.</p>	<p>The environmental water requirements for various wetlands and their values as mentioned in this ECD are currently being considered and assessed by the Victorian Government as part of the implementation of the Sustainable Water Strategy (State of Victoria 2010).</p>
(P2) Waterbird breeding	<p>Unknown but possible for certain species in terms of breeding success and overall waterbird usage.</p>	<p>While trends in waterbird usage have been derived by Ecos (unpublished), these are not based on actual bird counts or a formal comprehensive survey of life cycle functions such as key breeding sites, roosting sites and similar. This is a key information gap noting that waterbird usage would also have been affected by the persistent drought conditions over the past decade but may be recovering following more recent conditions.</p>
LAC for Critical Services/Benefits (refer Table 4-1)		
(S1) Threatened species	<p>See above for threatened species that are critical components.</p> <p>In relation to painted snipe and Australasian bittern - Unknown; though key habitats (<i>Phragmites</i> reed beds) are in decline in some areas (McLennan Strait and Dowd Morass).</p>	<p>Presence and usage of the site by these species is not well understood. Suitable habitat exists in McLennan Strait, Sale Common, Dowd and the Heart Morass, Macleod Morass and upper reaches of Lake Tyers.</p> <p>Ecos (unpublished) reports that Australasian bittern may be lost as a breeding species in the site but how this</p>

LAC	Has there been an exceedance of the LAC since listing?	Comments
	<p>In relation to Australian grayling, unknown due to a lack of information about species usage of the site but unlikely.</p>	<p>has been determined is unknown.</p> <p>Based on environmental flow assessments for the Thomson and Macalister Rivers, it was argued that abundances of this species were low and populations were unlikely to be self sustaining (Thomson Macalister Environmental Flows Task Force 2004) in these Rivers.</p> <p>However, the other river catchments (for example, Mitchell, Nicholson, Tambo) would likely continue to support Grayling.</p> <p>Presence and usage of the site during the obligate larval stage of this species is not well understood; a survey of the species usage of the site is required.</p>
(S2) Fisheries resource values	<p>Unknown.</p> <p>An ecological character change is possible in relation to black bream populations which show a marked decline in abundance since 1986.</p>	<p>Refer to recent seagrass assessment by Hindell (2008) and analysis of black bream populations in the Lakes (Section 3 of this document).</p> <p>Black bream spawning occurs in the tidal interface/lower reaches of the rivers leading into the site including upper areas of Lake Tyers.</p> <p>The extent to which spawning activity has been affected by long term and contemporary environmental conditions is unknown.</p> <p>A series of surveys would be required to establish a baseline and to determine any change in fish species richness and in the context of life cycle history usage and proportions of the key fish species.</p>

Table 6-4 Assessment of ecological character changes against LAC for wetlands habitat types

Wetland type (based on Corrick and Norman 1980)	Description of typology ¹⁰	Has the 1980 typology been maintained since listing?
Deep freshwater marsh	<p>Wetlands that generally remain inundated to a depth of one to two metres throughout the year during years of average or above average rainfall.</p> <p>Using the description of the 'saline wetland' type as a guide (see below), water quality in these wetlands should generally be less than three grams per litre.</p>	<p>Sale Common and Macleod Morass – No change in typology is determined to have occurred in these wetlands since listing.</p> <p>Dowd Morass – The typology is largely still applicable as the wetland continues to be managed as a freshwater wetland (Parks Victoria 2008). However, it should be noted that the wetland experiences brackish/saline water quality conditions (between 2.6 and 12 grams per litre) with periods above the three grams per litre limit.</p> <p>In terms of inundation and water depth, the wetland has been actively managed since 1997 to allow more periodic wetting and drying that is characteristic of the wetland's hydrology during pre-European settlement (Tilleard and Ladson 2010; Parks Victoria 2008).</p> <p>The Heart Morass - The typology is largely still applicable. Similar comments to Dowd Morass in terms of salinity and management regime.</p> <p>Clydebank Morass and Eastern Lake Coleman (for example, Tucker Swamp) – these wetlands experience more persistent high salinity levels (greater than six grams per litre and up to 29 grams per litre) and have characteristic saline/brackish vegetation communities present. It could be argued they now should be classified either as 'semi-permanent saline' or as 'permanent saline wetlands' using the Corrick and Norman classification system.</p>
Permanent open freshwater	Wetlands that are usually more than one metre deep. They can be natural or artificial. Wetlands are described to be permanent if they retain water for longer than 12 months; however they can have periods of drying.	Lake Wellington – Water quality data shows that it experiences a wide range of salinity conditions (ranging from 0.2 to 21 grams per litre based on EPA data from 1986 – 2008 – refer Section 3 of this document) but this may not be considered sufficient to change its characterisation to a 'permanent saline wetland'. Based on this, it is suggested that the typology 'permanent open freshwater' is still appropriate.
Semi permanent saline	These wetlands may be inundated to a depth of two metre for as long as eight months each year. Saline wetlands are those in which salinity exceeds three grams per litre throughout the whole year.	Lake Reeve; wetlands around western Lake Victoria (McLennan Strait) – No change in typology is determined to have occurred in these wetlands since listing.
Permanent	These wetlands include coastal	Lake Tyers, Lake Victoria, Lake King – No change in typology is

¹⁰ From Corrick and Norman (1980) and information on the DSE website: \\Wetland Categories

Wetland type (based on Corrick and Norman 1980)	Description of typology ¹⁰	Has the 1980 typology been maintained since listing?
saline	wetlands and parts of intertidal zones. Saline wetlands are those in which salinity exceeds three grams per litre throughout the whole year.	determined to have occurred in these lakes/lagoons since listing.

Source: The description of the typology in the table is sourced from information on the DSE Website: www.land.vic.gov.au/DSE 'Wetland Categories' and Corrick and Norman 1980.

6.5 Conclusions about Ecological Character Changes

As outlined in Table 6-3, the review of available data and studies indicates a possible reduction in abundance of waterbirds (mainly those species that rely on or regularly use freshwater habitats), a possible reduction in abundance of key fish species such as black bream (based on commercial catch data), a possible reduction in density of seagrass assemblages and long term changes to vegetation communities in the fringing marsh wetlands of Lake Wellington (for example, from *Phragmites* wetland to *Melaleuca* and swamp scrub dominated wetlands in Dowd Morass).

Table 6-4 describes qualitatively how several of the wetland habitats of Gippsland Lakes are now considered to have a different ecological character to that determined at the time of listing, when comparing current conditions with the original wetland classification scheme of Corrick and Norman (1980).

Clydebank Morass and Lake Coleman (characterised as Deep Freshwater Marshes by Corrick and Norman 1980) have become increasingly estuarine since the time of listing with salinity levels and vegetation communities much more characteristic of 'semi-permanent saline wetlands' (similar to Lake Reeve) than 'deep freshwater marshes'. These wetlands are now managed as estuarine wetlands under the 2008 Parks Victoria Management Plan.

The causes of these observed changes to ecological character appear to be a complex combination of natural and anthropogenic factors. These factors include: long term estuarine and marine inflows from Lakes Entrance that have affected wetland salinity regimes; the regulation and diversion of freshwater from tributaries that enter the western portions of the Gippsland Lakes; historical water control structures situated in the marshes and other fringing wetlands that have modified local flow regimes; and periods of prolonged drought. In combination, these factors have contributed to long term changes in the timing of inflows and inundation regime of wetland habitats within the site. In particular, there are more irregular freshwater flows into the Lake system (as opposed to the naturally variable wetting and drying cycle), high levels of groundwater and surface water salinity inputs from the catchments and increased incidences of algal blooms in the main lagoons (DSE 2003).

Based on the above, there is no clear or demonstrable evidence that the limits of acceptable change (LAC) defined for the site have been exceeded since listing. On this basis, it is determined that an empirical change to ecological character of the site cannot be established.

7 INFORMATION GAPS, MONITORING AND EDUCATION

7.1 Information Gaps

The ECD preparation process promotes the identification of information or knowledge gaps about the Ramsar site.

General information and data gaps

In general, Ecos (unpublished) and associated analysis and findings within that document were used as a starting point for this ECD. This information was augmented with a broad literature review of published plans, strategies and studies as well as a substantial amount of raw data review and analysis using data sets sourced from various Victorian Government Departments and other organisations such as Birds Australia. This data review focussed on perceived gaps and/or verification (where possible) of the Ecos (unpublished) analysis in areas such as water quality data, waterbird data, fish catch data and similar.

Overall, in evaluating the existing data sets supplied, the study team found that while there was a significant number of data sources available and a substantial amount of work being done in the Gippsland Lakes area, it was difficult to obtain the precise, accurate, consistent and statistically robust data needed to make the accurate conclusions needed for the ECD. As such, 'hard numbers' to be used, for example, for setting an LAC, couldn't be easily derived or defended on robust scientific grounds.

Some examples are provided below:

- Recorded information on waterbird counts were undertaken at only a few sites, or only for a short period of time, or were collected in a manner that is not directly comparable across different years or sites, or had gaps where monitoring/counting was not undertaken at all (refer data review in Appendix C).
- Comprehensive seagrass mapping was undertaken by Roob and Ball (1997) for the site and used for comparative purposes as part of more recent condition assessments (as documented by Hindell 2008). However, the primary purpose of this and more recent studies¹¹ has been to assess the impact and recovery of seagrass (in terms of extent and density) from algal blooms in the lakes as opposed to repeating Roob and Ball's broad-scale resource mapping exercise (Hindell 2008).
- In terms of wetland flora, mapping layers for both the Victorian Wetland Classification System (VWCS) and Ecological Vegetation Classes (EVC) were made available to the study team. However, as previously mentioned, the classification systems on which these mapping layers are based do not have direct equivalents to Ramsar wetland types. As such, it is difficult to quantify the distribution and extent of Ramsar wetland types within the site. Furthermore, there is limited specific information on the condition of individual wetlands and/or areas within the site except in particular cases (Dowd Morass).

¹¹ Advice from Chris Barry, Gippsland Coastal Board 2010 is that a number of further seagrass assessments (following on from those reported in Hindell 2008) have been commissioned for the Gippsland Lakes.

- Similarly, while site-specific records of flora and fauna species of conservation significance previously recorded within the Ramsar site were available, little research has been conducted on the ecology and biology of these species of significance.
- Water quality data was obtained from the EPA Victoria but is limited to the monitoring sites within the main lagoons for relevant timescales back to the date of listing. As the data spanned over such a long period, it required significant review and manipulation prior to being able to be plotted in graphs but was able to be combined effectively with flow data and forms the summary analysis that appears in Appendix B.
- Likewise, while there is comprehensive information now available in relation to the proportion of extracted versus total flows for each major river system flowing into the lakes summarised as part of the State Water Audit/Account reports published by the Victorian Government, similar information was not readily available for periods prior the 1980s and 1990s to assist in identifying trends since the date of listing.

Overall these basic data and information gaps indicate the pressing need for a much broader and more coordinated approach to acquiring and reviewing existing, baseline data sets related to the Ramsar site. This is discussed in the Monitoring Needs section (refer Section 7.2).

Specific information gaps

Cognisant of these general data gaps, in the context of the identified critical services/benefits, components and processes, Table 7-1 summarises more specific information and knowledge gaps.

Table 7-1 Summary of information/knowledge gaps

Critical CPS	Description of information/knowledge gap ¹²	
Critical components		
Habitats	(C1) Seagrass	<p>Little is known about the growth, condition or ecology of seagrasses in the Gippsland Lakes, especially in comparison with better studied temperate sites such as Corner Inlet or tropical seagrass beds in the north of Australia. Nothing is known about these topics for seagrasses in Lake Tyers.</p> <p>Although there is information on historical changes and the extent of seagrass beds in the Gippsland Lakes based on mapping in 1997 (Roob and Ball) and a further condition assessment in 2008 (Hindell), little research effort has been directed to understanding the fundamental ecology of the seagrass species or fundamental ecological processes that operate in Gippsland Lakes/Lake Tyers seagrass beds. Key knowledge gaps are:</p> <ul style="list-style-type: none"> • Causes of changes in seagrass extent over the past four decades • Rates of primary production of seagrasses and their associated algal communities • Relative roles of light limitation and nutrient limitation to seagrass growth and distributions • Sensitivity of seagrasses to environmental change, particularly altered water clarity and nutrient enrichment arising from human activities in the catchment, and altered temperature regimes consequent to climate change • Likely impacts of introduced marine weeds such as <i>Codium</i> sp.
	(C2) Saline or brackish lagoons	<p>Despite the long-term studies by the EPA and the syntheses undertaken by Harris et al. (1998), CSIRO (2001) and Cook et al. (2008), much remains to be learnt about planktonic processes in the lagoonal environments of the Gippsland Lakes. Key knowledge gaps are:</p> <ul style="list-style-type: none"> • A holistic understanding of the water quality in the Gippsland • Relative roles of light and nutrients (nitrogen and phosphorus) in controlling rates of primary production by phytoplankton • Role of phytoplankton in food webs • Impacts of altered freshwater inflows on phytoplankton community composition and productivity • The effects of fire on sediment and nutrient loads into the Lakes • Effects of the decay of algal blooms on fundamental ecosystem-scale processes, such as food-web dynamics, sediment biogeochemistry and nutrient release • Sensitivity of phytoplankton to environmental change, particularly altered water clarity and nutrient enrichment arising from human activities in the catchment, and altered temperature regimes consequent to climate change. <p>The wetland processes (hydrology and water quality) and components (such as seagrass) of Lake Tyers are regarded as a significant knowledge gap. The Lake Tyers Fisheries Reserve Management Plan (FV 2007) also identifies a range of information gaps and monitoring needs specific to recreational fisheries management.</p>
	(C3 – C5) Fringing wetlands – freshwater, brackish and saline	<p>Despite the amount of knowledge generated on some wetlands of the Gippsland Lakes Ramsar site (for example, Dowd Morass), very large knowledge gaps remain. Five were identified by Ecos (unpublished) as most critical:</p>

¹² Based on findings of the current study, from Ecos (unpublished) and other literature reviewed.

Critical CPS	Description of information/knowledge gap ¹²	
		<ul style="list-style-type: none"> • Detailed and quantitative information on the ecology (for example, wetting and drying cycles and their salinity regimes) of many wetlands in the Ramsar site. • Although the recent mapping of vegetation by Parks Victoria in the larger wetlands has been conducted, there is no spatially informed and consistent vegetation data for many of the other wetlands. • Key ecological processes, such as rates of primary production, relative importance of vascular plants compared with benthic microalgae in whole-of-wetland primary production, decomposition pathways for organic matter, and food-web structure, are virtually unstudied except for Dowd Morass. Even in Dowd Morass, the knowledge is patchy for many of these processes (Boon et al. 2008). • Likely responses of individual wetlands to altered environmental conditions, such as increased water permanency, increased salinity, soil acidification etc, are not well understood beyond broad generalizations. • At the level of individual species, critical information is lacking on fundamental topics such as salinity responses, conditions required for sexual recruitment, longevity of adults. Detailed information is available for swamp paperbark and, to a lesser extent, common reed, however, basic regenerative characteristics of other common taxa is not available.
Species/Groups	(C6) Waterbirds	<p>Currently there are no estimates of the total number of waterbirds of particular species in the Gippsland Lakes Ramsar site. Without such information its importance as a Ramsar site that possibly supports one per cent of the individuals in a population of one species or subspecies of waterbird (Ramsar Criterion 6) cannot be determined.</p> <p>Data reviewed as part of the current study supplied by DSE and Birds Australia showed that the database was largely incomplete and did not provide consistent or quality data over time across the site.</p> <p>While qualitative information is available about key life-cycle habitats for avifauna within the broader site (such as locations of breeding colonies, spawning sites, etc), these are not quantified or regulatory monitored. In the context of future monitoring, the key information needs would be addressed through sampling in accordance with the following:</p> <ul style="list-style-type: none"> • Migratory shorebirds - Early and late summer monitoring events at key roost sites and feeding grounds (to be conducted annually), with particular attention directed to surveys for common greenshank, red-necked stint, sharp-tailed sandpiper, and Latham's snipe (as species which may provide useful surrogates for numbers of other shorebirds using the site, of site habitat usage, and as indicators of changes in ecological character). • Non-migratory waterbirds – Late-winter and late-summer monitoring events at key roost sites and feeding grounds (to be conducted annually) to target black swan, great cormorant, little black cormorant, great egret, Australian shoveler, musk duck, chestnut teal, Australasian grebe, purple swamphen, Eurasian coot, black-winged stilt and red-necked avocet (as species which either currently exceed the one per cent threshold and/or provide useful surrogate for numbers of other waterbirds using the site of site habitat usage, and as indicators of changes in ecological character).
	(C7) Threatened frogs	<p>No accurate information on the distribution of growling grass frogs and green and golden bell frogs is available. These two species naturally hybridise where their distributions overlap, such as in the Gippsland Lakes. Whether the hybridisation that is occurring is influenced by ecological changes to the lakes due to anthropogenic effects is not known.</p> <p>Research is needed to identify key threatened frog populations and for those populations, monitor presence/absence, breeding evidence (tadpoles and metamorphs), and maintenance of parapatry between threatened frog taxa and congeneric sibling species during optimum breeding conditions until</p>

Critical CPS	Description of information/knowledge gap ¹²	
		markers/trends of population variability are evident. Quarterly monitor water quality for key population sites (for example, salinity, dissolved oxygen, nitrate levels, and other toxicants). Annual monitoring of fringing vegetation (aquatic macrophytes and littoral vegetation).
	(C8) Threatened flora	The presence and key habitats within the site for these species is an information gap. Ecologic and biologic requirements of species are also unknown such as habitats, fire, population dynamics and breeding biology.
Critical processes		
(P1) Hydrological processes	<p>Much remains unknown about the detailed functioning of physical and biological processes in the system and that most systems currently depend directly and indirectly on the salinity regime. Improved knowledge is being obtained through more detailed studies currently being undertaken as part of the Environmental Water Requirements study for the East and West Gippsland Catchment Management Authorities. Following the Stage 1 and Stage 2 Scoping Studies (refer Tilleard et al. 2009 and Tilleard and Ladson 2010), it is understood that a range of more detailed studies are planned to be carried out including detailed hydrological studies of the lower Latrobe River.</p> <p>There is a poor understanding of how groundwater processes interact with surface water wetlands and in particular how saline groundwater drives salinity levels in the fringing brackish wetlands. This remains a significant knowledge gap.</p>	
(P2) Waterbird breeding	Waterbird breeding success – Annual assessment of waterbird breeding success (and habitat characteristics) at key sites is required, including: Lake Coleman and Tucker Swamp (Australian pelican); Bunga Arm (little tern, fairy tern, hooded plover); Macleod Morass (Australian white ibis and straw-necked ibis); Sale Common (black swan); Lake Wellington-Dowd Morass (little black cormorant, Australian white ibis, Royal Spoonbill and straw-necked ibis; and Lake Tyers (fairy tern and little tern).	
Critical services/benefits		
(S1) Threatened species	<p>See critical components for threatened flora and fauna species.</p> <p>The patterns of usage of the site by Australian grayling is unknown. The following are key information gaps:</p> <ul style="list-style-type: none"> • Key sites and important habitats within the site requiring further protection and management • Impacts of flow regime changes on local populations (and establishment of environment flow objectives to meet requirements) • Water quality tolerances (and established of water quality objectives to meet requirements) • Population trends in space and time. <p>The usage of the site by painted snipe and Australasian bittern is unknown in part due to the cryptic nature of the birds. Some historical site records and the presence of suitable habitat is a useful starting point for future monitoring.</p>	
(S2) Fisheries resource values	<p>There are significant catch and effort data arising out of the commercial fishery in Gippsland Lakes and some survey information from the recreational fishery but detailed population and recruitment data is absent from the systems. Commercial fish catch data reviewed as part of the current study indicated that this was not a comprehensive or complete data set with considerable anomalies.</p> <p>This lack of information will become more significant if the Bay and Inlet Fishery continues to shift towards a more recreationally based fishery as it has done so in the past. In addition the impacts of climate change are poorly understood on the fish and fisheries of Victoria. More detailed information is required on the following:</p> <ul style="list-style-type: none"> • The major environmental determinants of fish recruitment for the key species • The habitats that are most important for fish populations • The relationship between spawning and recruitment, and the environmental intermediaries • The flow levels that are required to maintain estuarine conditions in the estuaries, and the spatial scale that the species should be managed • The implications for biodiversity and genetic diversity of estuarine constriction and whether it has the potential to increase the likelihood of hybridisation between estuary perch and bass • The extent to which species' life cycles are disrupted by loss of connectivity to higher regions of 	

Critical CPS	Description of information/knowledge gap ¹²
	catchment.

7.2 Monitoring Needs

In the context of the site’s status as a Ramsar site and in the context of the current ECD study, the primary monitoring needs relate to the need to assess the suitability of limits of acceptable change (versus natural variability) and to assess more definitively if changes to ecological character have occurred or are being approached. Principally, this monitoring should relate to:

- Broad-scale observation/monitoring of wetland habitat extent at representative wetland types within the site (noting that a logical precursor to this would be to establish a better correlation between Victorian wetland mapping and the Ramsar wetland type classification system).
- Habitat condition monitoring which should occur both as:
 - long term analysis of vegetation community structure including identified trends in vegetation patterns in the freshwater fringing wetlands (proliferation of common reed and cumbungi); brackish fringing wetlands (transition of common reed to swamp paperbark to saltmarsh species); and hypersaline wetlands (maintenance of traditional saltmarsh communities as opposed to largely unvegetated salt flats)
 - monitoring underlying wetland ecosystem processes such as hydrological process (both surface and groundwater), water quality and surrogate biological indicators for these processes.
- More targeted surveys of the threatened flora and fauna species (perhaps on a five year or ten year basis) to assess presence/absence or population changes of noteworthy species or communities identified in the critical components. Specifically this should target presence and usage of the site (at various spatial scales) by threatened frogs (Component 7), threatened flora species (Component 8) and other threatened species (Australian snipe, Australasian bittern, and Australian grayling – relevant to Service 1).
- More regular counts of all waterbirds in accordance with the monitoring regime envisioned by the LAC (refer critical Component 6).
- More regular counts of breeding waterbirds at identified breeding colony sites (refer location and description of sites in the discussion of critical Process 2).
- Continued and more intensive survey and monitoring of recreationally and commercially important fish stocks including key nursery area and spawning sites (refer critical Service/Benefit 2).

7.3 Communication, Education, Participation and Awareness Messages

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

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

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

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

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

One of the ten objectives of the strategic management plan for the Gippsland Lakes Ramsar site, Objective 8 is to 'promote community awareness and understanding and provide opportunities for involvement in management' (DSE 2003). The management objective is supported by nine site management strategies in the management plan.

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

- The ecological character of the site is underpinned by a set of critical components, processes and services/benefits identified within this ECD. These include a diverse range of wetland habitats, the presence of nationally-threatened wetland fauna, the usage of the site for breeding and other life cycle functions by many species of waterbirds.
- The diversity of habitat types found within the site is the result of a variable salinity regime which is influenced by marine inflows and catchment flooding. Maintenance of the freshwater and brackish fringing wetland habitats of the site are particularly critical to maintenance of the site's ecological character.
- While the ecological character of the site has been largely maintained since listing, possible ecological character changes that require further research and monitoring include reduction in the abundance and density of freshwater-dependent waterbirds, the reduction in the abundance of key fish species (black bream), reduction in the density of seagrass assemblages and long term changes to the vegetation communities in the fringing wetlands of Lake Wellington (for example, from *Phragmites* wetland to *Melaleuca* and swamp scrub dominated wetlands).
- Broad-scale ecological health monitoring is needed for the site in order to inform proper management. This should focus on the LAC and knowledge gaps outlined in this ECD.

7.4 Conclusions

The current study has sought to synthesise an extensive amount of historic and current information about the wetland values of the Gippsland Lakes Ramsar site into an Ecological Character Description (ECD) document that is consistent with the National ECD Framework.

As part of the site overview, the study has reviewed the Ramsar Nomination Criteria under which the site was listed as a Wetland of International Importance and to review the applicability of the revised and new criteria under the Convention that have been added since the site was originally listed in 1982. In this context, the site is now seen as meeting six of the nine Nomination Criteria recognising its representative wetland habitats at a bioregional level, threatened wetland species, support for key life-cycle functions such as waterbird breeding values, its importance for supporting substantial numbers of waterbirds and fish nursery and spawning habitats.

Eight critical components, two critical processes and two critical services/benefits as well as a range of supporting components, processes and services of the site have been identified. Limits of acceptable change (LAC) have been derived to provide guidance to site managers about the tolerances of these critical components, processes and services/benefits to anthropogenic change.

Due to a lack of comprehensive data to form a baseline and generally poor understanding of the natural variability of key parameters, the bulk of the LAC are based on best professional judgement of the authors. As this is the 1st ECD undertaken for the site, subsequent resource assessments should use these LAC as a starting point that is to be reviewed and revised as improved information about trends in extent and condition of key parameters becomes known.

A review of available data and specific studies on the site (and comparison against relevant LAC) demonstrate that an ecological character change is possible for some critical components since site listing in 1982. Relevant studies show a possible reduction in abundance and density of waterbirds (mainly those species that rely on or regularly use freshwater habitats), a possible reduction in abundance of key fish species such as black bream (based on commercial catch data only), possible reduction in density of seagrass assemblages and long term changes to vegetation communities in the fringing marsh wetlands of Lake Wellington (for example from *Phragmites* wetland to *Melaleuca* and swamp scrub dominated wetlands in Dowd Morass). The extent to which the changes are a result of natural and/or anthropogenic change (or a combination of both) is not able to be determined based on the current data set.

There is no clear or demonstrable evidence that the LAC defined for the site have been exceeded since listing. On this basis, it is determined that an empirical change to ecological character of the site cannot be established.

The summary of information gaps and monitoring needs identified in the document should assist in decision-making about future priorities recognising those elements of the Gippsland Lakes that are directly relevant to Ramsar listing.