

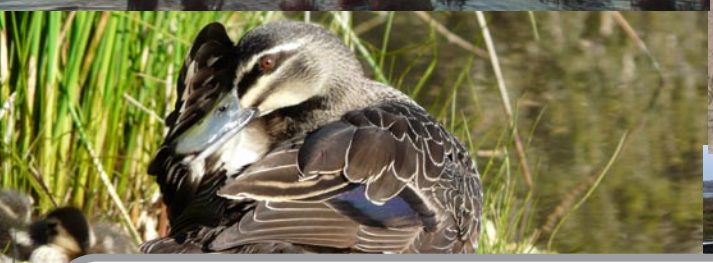




Peel-Yalgorup System Ramsar Site Management Plan Peel-Harvey Catchment Council

July 2009





PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

Australian Government

SOUTH WEST CATCHMENTS COUNCIL

Government of **Western Australia**
Peel Development Commission

Government of **Western Australia**
Department of **Environment and Conservation**

Government of **Western Australia**
Department of **Water**

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The process of stakeholder engagement undertaken in the development of this plan was led by Sustainable Development Facilitation, Barragup, Western Australia. The plan was drafted by the Peel-Harvey Catchment Council's Waterways and Wetlands Project Officer, Amanda Willmott.

The development of the management plan was overseen by members of the project's Technical Advisory Group:
Ms Jan Star AM, Peel-Harvey Catchment Council
Ms Kim Wilson, Peel-Harvey Catchment Council
Dr Michael Coote, Department of Environment and Conservation
Ms Jennifer Higbid, Department of Environment and Conservation
Dr Richard Williams, Department of Environment and Conservation
Mr Steve Dutton, Department of Environment and Conservation
Mr Alan Wright, Department of Environment and Conservation
Ms Melissa Mazella, Department of Environment and Conservation
Mr John Pride, Department for Planning and Infrastructure
Mr Bob Pond, Department of Water (Peel Waterways Centre)
Mr Brett Dunn, Department of Water
Ms Colleen Yates, Peel Development Commission
Mr Jesse Hill, Peel Development Commission
Ms Joanna Hugues-dit-Ciles, South West Catchments Council
Dr Nardia Keipert, Department of Agriculture and Food
Mr Bill Russell, Birds Australia
Mr Dick Rule, Mandurah Bird Observers
Ms Felicity Bunny, A/g Australian Government NRM Facilitator
Mr Rob Tregonning, Department of Fisheries
Mr Craig Perry, City of Mandurah
Cr Denyse Needham, Shire of Serpentine Jarrahdale
Mr Brook Devine, Shire of Harvey
Cr Bill Adams, Shire of Harvey
Mr Ian Curley, Shire of Waroona
Cr Laurie Snell, Shire of Waroona
Ms Gemma Urquhart, Shire of Murray
Ms Naomi O'Hara, Shire of Murray
Dr Nic Dunlop, Conservation Council (WA)
Ms Jeanette Muirhead, Department of Environment Water Heritage and the Arts

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Ms Thelma Crook, Greening Australia
Ms Estelle Whitford, Alcoa of Australia
Ms Darralyn Ebsary, Hotham-Williams Landcare Centre
Ms Kathryn McGuane and Mr Paul McCluskey, Department of Environment and Conservation
Mr Ken Monson, community member
Ms Jennifer Hale, consulting Aquatic Ecologist
Mr Barry Small, Friends of Mandurah and Pinjarra Canoe Trails
Mr Bill Rutherford, WA Wader Studies Group

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Contents

FIGURES

TABLES

MAPS

TEXT BOX

Photo: Amanda Willmott

Site description

Located approximately 80 km south of Perth, Western Australia, the Peel-Yalgorup System comprises the estuarine Peel Inlet and Harvey Estuary, the freshwater wetlands of lakes McLarty and Mealup, the Yalgorup National Park environment (including the saline lakes system) together with sections of fringing upland (Map 1). The Peel-Yalgorup System stretches over 60 km from north to south and approximately 10 km east to west.

The Peel-Yalgorup System was designated as a wetland of international importance in 1990, when it was added to the Ramsar List under the International Convention on Wetlands (or Ramsar Convention). Article 2.2 of the Ramsar Convention states "Wetlands should be selected for the List on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology. In the first instance, wetlands of international importance to waterfowl at any season should be included". Sites are identified by reference to a list of nine criteria. The Peel-Yalgorup System currently meets seven of the nine criteria (see Table 4).

The Peel-Yalgorup System wetlands are considered to be representative of wetlands of the Swan Coastal Plain. They form a chain of diverse habitat types, which in turn support an array of ecologically important species and communities (DEC, 2002). Although each wetland 'sub-system' (the estuary, freshwater wetlands and saline lakes) qualifies as an 'internationally important' wetland (Hale and Butcher 2007) the wetlands were together nominated as the 'Peel-Yalgorup System' under the International Convention on Wetlands in recognition of their combined values as a diverse wetland complex.

The 26,530 ha System forms part of the Swan Coastal Plain Bioregion, located in the south-west of Western Australia (Figure 1). The Swan Coastal Plain Bioregion is included within the Southwest Australia biodiversity hotspot: recognised by Conservation International as one of 34 of the world's richest and most threatened reservoirs of plant and animal life on earth (Conservation International 2008).

Despite such accolades, more than 80% of wetlands on the Swan Coastal Plain have been lost to clearing and infilling, with much of the remaining wetland area heavily modified (Balla 1994). Of the wetlands that remain, only 15% are considered as having high conservation values. These are designated 'Conservation Category wetlands' (WRC 2001) and include the wetlands that comprise the Peel-Yalgorup System.

Area covered by the plan

Revisions to the System's boundary were made in 2001 to include eight additional small sections of wetland and fringing upland (Map 1). This extension brought the area included in the Ramsar site to 26,530 ha.

The Department of Environment and Conservation (DEC) and the Peel-Harvey Catchment Council, together with the City of Mandurah and Shire of Murray, are proposing to expand the boundary of the Peel-Yalgorup System (see Strategies and Actions, p30). The proposal focuses on additional public and private land reserved for nature conservation or other compatible land uses in areas adjacent to, or contiguous with the existing Ramsar-listed estate. The proposal includes extensions to all three wetland 'subsystems' as well as the addition of a new wetland 'subsystem': Goegrup and Black Lakes on the Serpentine River.

The Australian Government requires that an ecological character description and management plan accompany new nominations and extensions to Ramsar wetlands. For this reason, the existing Peel-Yalgorup System and proposed extensions are together designated as the area covered by this plan (Map 2).

International commitments

The International Convention on Wetlands became the first international treaty for conservation of the natural environment when it was signed by contracting parties in the town of Ramsar, Iran, in 1971. The Ramsar Convention's mission is '...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' (Ramsar 2008 p1).

Under Article 3.1 of the Ramsar Convention, contracting parties, such as Australia, agree to '…formulate and implement their planning so as to promote the conservation of Ramsar-listed wetlands and as far as possible the wise use of wetlands in their territory'. This is an obligation for the Australian Government and a responsibility of stakeholders involved in managing the wetlands of the Peel-Yalgorup System (see Stakeholders, p31).

Photo: Amanda Wilmott

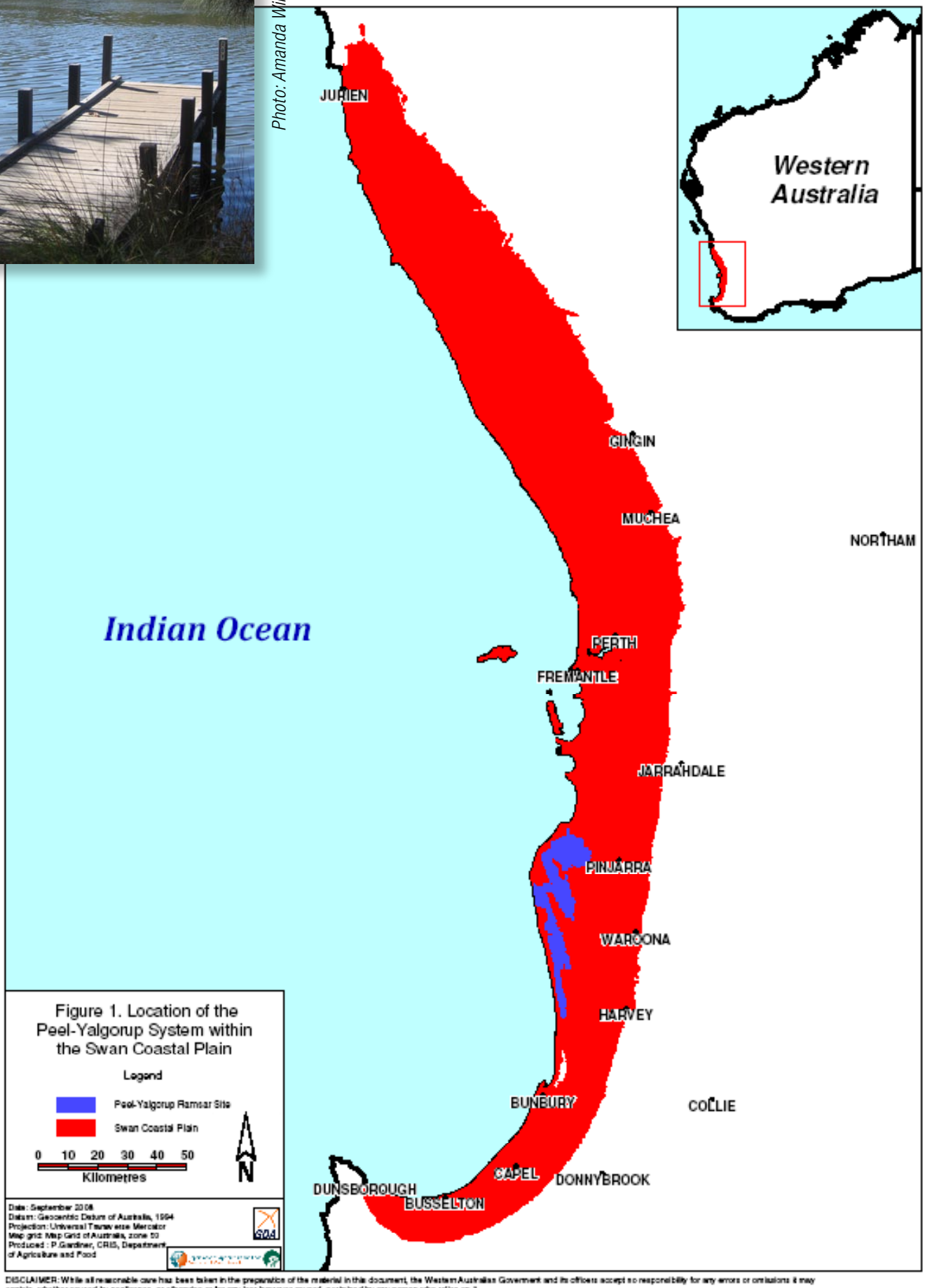

Figure 1. Location of the Peel-Yalgorup System within the Swan Coastal Plain

Date: September 2008
Datum: Geocentric Datum of Australia, 1994
Projection: Universal Transverse Mercator
Map grid: Map Grid of Australia, zone 50
Produced : P.Gardiner, CRIS, Department of Agriculture and Food

Contracting parties also commit to:

- work towards the wise use of all their wetlands through national land-use planning, appropriate policies and legislation, management actions and public education
- designate suitable wetlands for the List of Wetlands of International Importance (Ramsar List) and ensure their effective management
- cooperate internationally concerning trans-boundary wetlands, shared wetland systems, shared species and development projects that may affect wetlands (Ramsar 2008).

In addition to the Ramsar Convention, the Australian Government is a signatory to a raft of bilateral agreements aimed at improving the protection of migratory birds in the East Asian–Australasian Flyway. Bilateral agreements with China (China–Australia Migratory Bird Agreement, CAMBA), Japan (JAMBA) and the Republic of Korea (ROKAMBA) provide a framework for international collaboration in protecting habitats for migratory birds within the Flyway. The Peel-Yalgorup Ramsar site is an important habitat for the 39 species recognised through these agreements (Table 1).

Australia's international commitments are supported through the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Act protects seven matters of national environmental significance, including migratory species (s20) and the 'ecological character' of Ramsar wetlands (s16). The EPBC Act also establishes a framework for managing Ramsar sites, in the form of the Australian Ramsar Management Principles (s335). Amongst other things, the Australian Ramsar Management Principles declare that each Ramsar site should have a management plan.

Local needs for collaborative management

In reviewing management of the State's Ramsar wetlands, the Auditor General (Pearson 2006) commented that the DEC, as the lead agency for Ramsar sites in Western Australia, does not have authority to manage sites where they are not wholly vested with the Western Australian Conservation Commission; as is the case of the Peel-Yalgorup System.

Land tenure within the boundary of the Peel-Yalgorup System is complex. The estate includes numerous state government agencies and management authorities together with privately owned freehold land. Indeed, the System is unique in that it is the only Ramsar site in Western Australia for which the management responsibility for the listed estate is shared between multiple government agencies and community stakeholders. (See Management and Planning Context). The combined contribution of government and community-based stakeholders towards managing the wetlands of the Peel-Yalgorup System may explain why the wetlands, for the most part, have remained in good ecological condition (see Ecological Values p9 and Limits of acceptable change p47). However, growing threats and evidence of declining ecological health indicate the need for a coordinated and strategic plan to guide collaborative management of the Peel-Yalgorup System.

Aim of the plan

Australia's commitment to managing Ramsar-listed wetlands is supported by the legislative powers of the EPBC Act. Under the Act, the primary purpose of wetland management for declared Ramsar sites is:

- to describe and maintain the ecological character of the Ramsar site
- to formulate and implement planning that promotes:
  - wetland conservation
  - wise and sustainable use of wetlands for the benefit of humanity in a way that is compatible with the maintenance of the natural properties of the ecosystem.

The aim of this Management Plan is to set out a framework for coordinated and collaborative management that:

- works towards protecting and/or restoring the ecological character of the Peel-Yalgorup System, and
- promotes the wise use of the wetlands in the System by fostering the roles and responsibilities of local stewards.

Table 1. CAMBA, JAMBA and ROKAMBA listed species (adapted from Hale and Butcher 2007)

Waterbird species	CAMBA	JAMBA	ROKAMBA
1. Australian White Ibis		Y	
2. Cattle Egret	Y	Y	
3. Eastern Reef Egret	Y		
4. Glossy Ibis	Y		
5. White-bellied Sea-eagle	Y		
6. Asian Dowitcher	Y		Y
7. Bar-tailed Godwit	Y	Y	Y
8. Black-tailed Godwit	Y	Y	Y
9. Broad-billed Sandpiper	Y	Y	Y
10. Common Greenshank	Y	Y	Y
11. Common Sandpiper	Y	Y	Y
12. Curlew Sandpiper	Y	Y	Y
13. Eastern Curlew	Y	Y	Y
14. Great Knot	Y	Y	Y
15. Grey Plover	Y	Y	Y
16. Grey-tailed Tattler	Y	Y	Y
17. Lesser Sand Plover	Y	Y	Y
18. Little Ringed Plover			Y
19. Little Stint			Y
20. Long-toed Stint	Y	Y	Y
21. Marsh Sandpiper	Y		Y
22. Oriental Plover (rare – one record)		Y	Y
23. Oriental Pratincole (rare – one record)	Y	Y	Y
24. Pacific Golden Plover			Y
25. Pectoral Sandpiper		Y	Y
26. Pin-tailed Snipe (rare – one record)	Y	Y	Y
27. Red Knot	Y	Y	Y
28. Red-necked Stint	Y	Y	Y
29. Ruddy Turnstone (rare – one record)	Y	Y	Y
30. Ruff (rare)	Y	Y	Y
31. Sanderling	Y	Y	Y
32. Sharp-tailed Sandpiper	Y	Y	Y
33. Terek Sandpiper	Y	Y	Y
34. Whimbrel	Y	Y	Y
35. Wood Sandpiper	Y	Y	Y
36. Bridled Tern	Y	Y	
37. Caspian Tern	Y	Y	
38. Common Tern (rare)	Y	Y	Y
39. White-winged Tern			Y
Total	**32**	**30**	**32**

Vision and Management Objectives

Through a series of stakeholder and broader community workshops a vision and objectives for the future management of the Peel-Yalgorup System were established (see Appendices A & B). The following section sets out the community's management vision for the Peel-Yalgorup System and three aspirational management goals.

Vision:

The Peel-Yalgorup System is internationally recognised as a major environmental asset and is highly valued for its ecological, social, cultural and economic benefits. The diverse wetlands and waterways are managed wisely as a place and space for all to play, learn and live in a sustainable way. We acknowledge our stewardship role in the conservation and protection of the land, water, flora and fauna for the long term.

GOAL 1: The Peel-Yalgorup System will be managed in accordance with the principle of wise use, that is, the conservation of the wetlands, and human uses that are compatible with maintenance of the natural properties of the ecosystem.

GOAL 2: Community stakeholders will be engaged and supported in active environmental stewardship.

GOAL 3: The ecological character of the Peel-Yalgorup System, including services and values, will be maintained or enhanced to achieve long-term positive outcomes.

DICK RULE

Dick Rule is a member of Mandurah Bird Observers Group (MBOG) and forms part of the Ramsar Managment Plan Technical Advisory Group (TAG) informing the ecological aspect of this plan. The TAG group is involved with monitoring the limits of acceptable change as they relate to the ecological conditions of the area captured by the Ramsar Plan. "We (MBOG) are concerned about people letting dogs off leashes within bird feeding areas. The Ramsar Management Plan will help to monitor the existing bird areas, and collect data on birds in our area. The plan will set some goals so that if bird numbers begin to decrease, we will know about it and can take action. It will not only provide data for our group, but across all levels such as government departments. Because of the Ramsar Management Plan, future action is going to be based on scientific data, which is how decisions should be made, not on emotion."

> 'Wetlands are hugely diverse, but whether they are ponds, marshes, coral reefs, lakes or mangroves, their processes are based on the interaction of basic components – soil, water, plants and animals. It is these wetland *processes* that generate the products, services and attributes that are ***valued*** by humans' (Stuip et al. 2002, p6).

Ecosystem components and processes

In order to understand how the Peel-Yalgorup System operates, Hale and Butcher (2007) outlined the components and processes of the wetlands in four groups (Figure 2):

- Abiotic (physical) components
- Supporting biological components
- Habitat, and
- Key species and ecological communities.

These provide for the Peel-Yalgorup's important wetland values, including its status as a globally significant wetland. For example, the thrombolites at Lake Clifton, shown the picture below, are a *key ecological community* that constitute the listing of the System under Ramsar Criterion 3.

> Ramsar 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.*

The thrombolites exist because of the relationship between microbial species *(supporting biological components)* within the aquatic environment *(habitat)* which in turn is characterised by a precise range of salinity and nutrients *(abiotic components)* (Figure 2).

Hale and Butcher (2007) provide a detailed description of the components and processes for each wetland sub-system at the time of listing and in terms of changes that have occurred since listing. The authors also identified the critical components and processes: "the aspects of the ecology of the wetland which, if they were to be significantly altered would result in a significant change in the system" (Hale and Butcher 2007 p 41). Based on this information, a summary of the current condition of critical wetland components and processes is provided in Table 2. These form the basis for monitoring and, where necessary, managing the wetlands of the Peel-Yalgorup System.

Photo: Kim Wilson

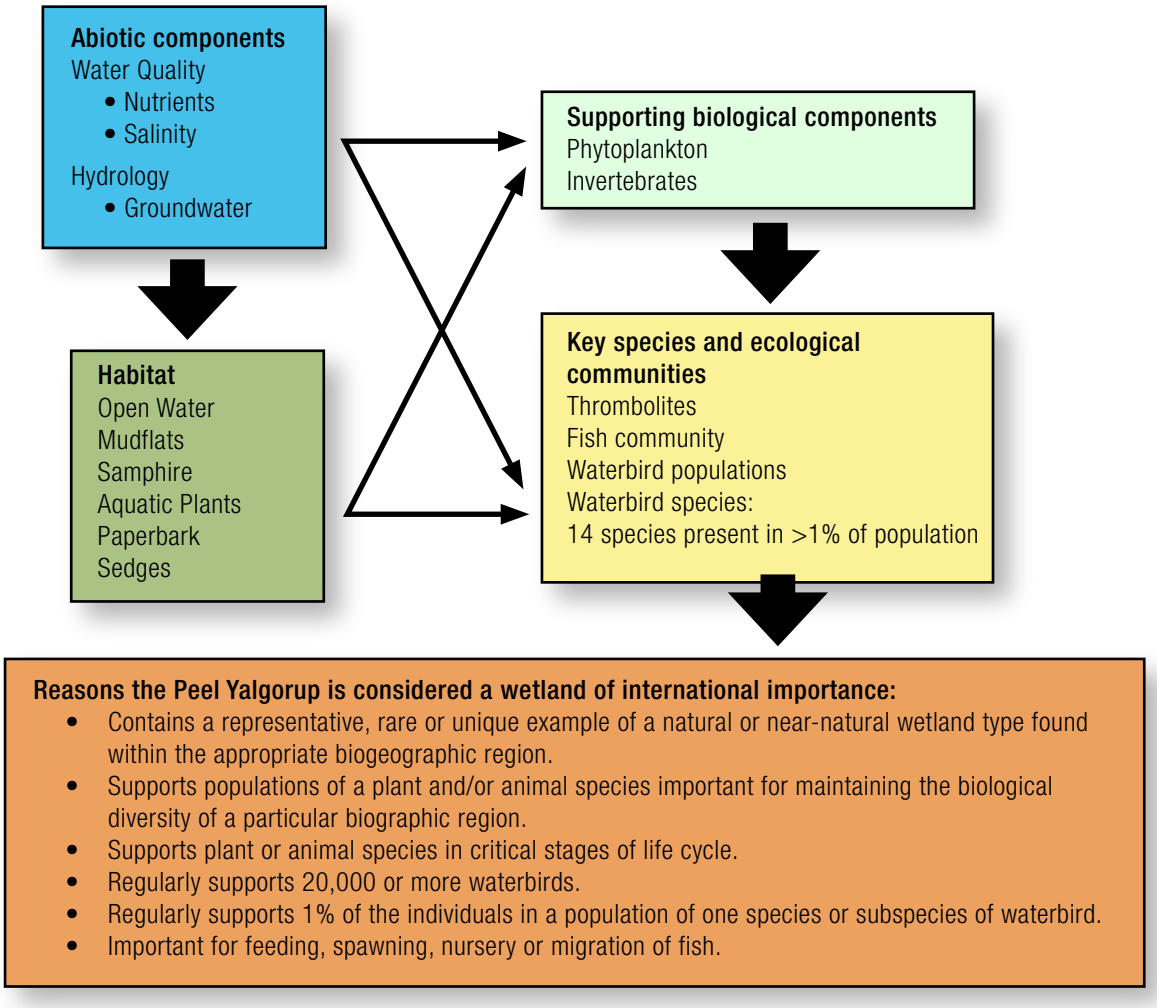

Figure 2: Critical components and processes of the ecological character of the Peel-Yalgorup System (after Hale and Butcher 2007, p16)

Photo: Alex Hams

Table 2: Current condition of critical components and processes (modified from Hale and Butcher 2007)	
Component	Description
Peel-Harvey Estuary	
Geomorphology	Shallow 'bar-built' estuary Narrow connections to the Indian Ocean via the Mandurah Channel and Dawesville Channel Organic sediments (black ooze)
Hydrology	Tidal exchange with Indian Ocean increased since construction of Dawesville Channel; estuary now considered a 'marine embayment' Highly seasonal freshwater inflows from direct precipitation and rivers Limited groundwater inflows
Water quality	High concentrations of nutrients from catchment (urban and rural) Seasonal variation in salinity, although salinity is now more marine Water column stratification
Acid sulfate soils	Monosulfidic black ooze exposed via dredging
Phytoplankton	Decreased phytoplankton biomass post Dawesville Channel
Benthic plants	Decreased macroalgae biomass post Dawesville Channel Increased extent of seagrass post Dawesville Channel
Littoral vegetation	Samphire community extent decreased Paperbark condition declining (Harvey Estuary)
Fauna	Commercially significant invertebrate taxa include Blue Manna Crabs and Western King Prawns Diverse invertebrate communities in the estuary and intertidal zones Both estuarine and marine fish species present, estuarine species possibly decreasing, marine species increasing Migratory route for some fish species High diversity and abundance of waterbirds Regularly supports > 20 000 waterbirds (150 000 recorded in 1977) Breeding recorded for 12 species of waterbirds Regularly supports > 1% of population of 11 species of waterbirds (including IUCN red-list species Fairy Tern, *Sterna nereis*) No evidence of change in waterbird abundance

Yalgorup Lakes	
Geomorphology	Shallow depressional wetlands No defined surface water inflows or outflow channels
Hydrology	Highly seasonal freshwater (predominantly groundwater) inflows No surface water outflows Suspected decrease in groundwater inflows Changes to lake levels (data deficient)
Flora	Small buffer zones, particularly to east of Lake Clifton Some areas of paperbark communities
Fauna	Significant site for waterbirds, no evidence of change in abundance Large numbers of Shelduck and Black Swans (annually) 1% of the population of 5 species of waterbirds Eight breeding species of waterbirds Fish kills at Lake Clifton have been recorded
Lakes McLarty and Mealup	
Geomorphology	Shallow depressional wetlands No defined surface water inflows or outflow channels
Hydrology	Highly seasonal freshwater (predominantly groundwater) inflows No natural surface water outflows, both lakes formerly connected to artificial drainage network Suspected decrease in groundwater inflows Changes to lake levels at Lake Mealup Increasing duration of dry period
Water quality	Naturally fresh to brackish conditions Severe acidification (pH 2.7) and nutrient enrichment at Lake Mealup Salinity and nutrients increasing at Lake McLarty
Flora	Typha in localised sections of Lake McLarty, extensive at Lake Mealup Sedges on lake margins Paperbark community at higher elevations and within Little Lake Mealup

Goegrup and Black Lakes	
Geomorphology	Riverine wetlands on the Serpentine River (Goegrup 'in-stream') Black Lakes connect to Goegrup via narrow channel
Hydrology	Highly seasonal freshwater (predominantly surface water) inflows Tidal influence from Peel Inlet
Water quality	Seasonal salinity cycle High nutrient concentrations (catchment nutrient loads) Low dissolved oxygen concentration
Flora	High phytoplankton biomass Samphire at low elevations in the littoral zone Paperbark communities at higher elevations
Fauna	Supports waterbirds (data deficient)

Ecosystem services and benefits

> Ecosystem services are defined by the Millennium Ecosystem Assessment (2000) in *Ecosystems and Human Wellbeing – Synthesis* (p. 49) as '…the benefits that people receive from ecosystems'.

Ecosystem services include:

- provisioning services (such as commercially harvested populations of fish and crabs)
- regulating services (including flood control)
- cultural services (such as those valued by the local Indigenous community), and
- supporting services (in maintaining the function of natural systems).

The ecosystem services provided by a wetland environment become ecosystem benefits when they are successfully used to provide such gains (Dudley and Stolton 2007). Dudley and Stolton (2007, p. 3) define ecosystem benefits as '…a resource that is being used to provide direct gains (which could be in terms of money earned, subsistence resources collected or less tangible gains such as spiritual peace or mental wellbeing) to stakeholders'.

The diversity of services and benefits that wetlands provide make them extremely valuable ecosystems (Schuyt and Brander 2004). Within the Peel-Yalgorup System the abundant Blue Manna crabs in the Peel-Harvey Estuary are an iconic aquatic invertebrate and are key to the region's widely valued recreational fishery. In this instance, the wetlands in the Peel-Yalgorup System provide for Blue Manna crab populations which in turn deliver cultural and provisioning services. Table 3 provides a more comprehensive list of the extensive wetland services and benefits provided by the Peel-Yalgorup System.

SHIRLEY JOINER

Shirley Joiner is Secretary of Peel Preservation Group, an environmental group committed to preservation, conservation and land management which has made its mark on many initiatives within Peel-Harvey. "I think the group responsible for the Ramsar Management Plan has done a great job, I don't think the plan could have come out any better. Peel Preservation Group sees the estuary and surrounding waterways as the "lungs" of the Peel Region. Everything we do is filtered into our waterways, so it's important we do the right thing. The Group recently had a guest speaker who said, "Everything we do is connected to everything else". The small things we do on a daily basis are important. We need to cut down our water usage, particularly bore water. We also have to be vigilant about our rubbish disposal, refraining from tipping oil down the drain, ensuring anything we dispose of is done with consideration. If we all do the small things, this will help. It is important for the issues raised in the Ramsar Management Plan to be more than just suggestions, but that these are backed up by laws, so that we can be sure action is put into place. Peel Preservation Group accepts that people have to live life, but it is important that we all live responsibly for our environment. It is about leaving something for our grandchildren. I have a great grandchild, and I wonder – what will he see?"

Table 3: Components of the Peel-Harvey Estuary and the provision of services and benefits (from Hale and Butcher 2007, p 106-7)

BENEFIT/SERVICE	LOCATION	DIRECT COMPONENTS	INFLUENCING BIOTIC COMPONENTS	ABIOTIC COMPONENTS	THREATS AND THREATENING ACTIVITIES
Commercial Fishing	Peel-Harvey Estuary	Population of edible fish species, crabs and prawns	Seagrass distribution and extent (habitat for juvenile fish) Invertebrate populations (food source) Phytoplankton populations (food source) Piscivorus birds (predators)	Nutrient concentrations: from primary production (food sources) Eutrophication (loss of seagrass, anoxic conditions) Salinity (tolerance of species affects community composition) pH (acid conditions decrease immunity and increase disease) Toxicants (uptake and biomagnification through the food chain)	Nutrient loads from the catchment Disturbance of acid sulfate soils
Pollution Control	Peel-Harvey Estuary	Nutrient concentrations in the water and sediment	Phytoplankton biomass and its contribution to the detrital food web Benthic plant biomass	Nutrient concentrations Denitrification Dissolved oxygen concentrations Nutrient storage and release from sediments	Nutrient loads from the catchment Any actions that would reduce tidal exchange and flushing
Flood Control	Peel-Harvey Estuary				
Cultural Services: *Recreation and tourism* *Spiritual and inspirational* *Scientific and educational.*	Entire Peel-Yalgorup Ramsar site	Waterbird populations Thrombolites Fish communities Fringing vegetation and open water habitats	Habitat extent and distribution (seagrass, samphire, mudflats) Primary production (balance between maintaining productivity and eutrophication)	Water Quality: Nutrients Dissolved oxygen Water clarity Salinity Hydrology (water levels in lakes)	Nutrient loads from the catchment Disturbance of acid sulfate soils Erosion of shoreline (e.g. powerboat activities) Groundwater extraction Loss of amenity values
Ecological Services: *Contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.*	Entire Peel-Yalgorup Ramsar site	Extent and diversity of wetland types within the Peel-Yalgorup Ramsar site	Vegetation communities (samphire, paperbark woodland, benthic plants) Waterbird communities Fish and invertebrate communities	Water quality: Salinity Hydrology (water levels in lakes)	Erosion of shoreline (eg from powerboat activities) Groundwater extraction Sea level rise

Table 3: Components of the Peel-Harvey Estuary and the provision of services and benefits (from Hale and Butcher 2007, p 106-7)

BENEFIT/SERVICE	LOCATION	DIRECT COMPONENTS	INFLUENCING BIOTIC COMPONENTS	ABIOTIC COMPONENTS	THREATS AND THREATENING ACTIVITIES
Ecological Services: *Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.*	Yalgorup Lakes	Thrombolites	Phytoplankton Macroalgae Invertebrate populations Vegetated buffer zone	Water quality: Nutrients Water carity Salinity Hydrology (water levels in Lake Clifton) pH	Nutrient loads from the catchment Groundwater extraction Inadequate buffer along eastern shore
Ecological Services: *Regularly supports 20,000 or more waterbirds.*	All Entire Peel-Yalgorup Ramsar site	Fish (breeding crabs, prawns and fish, migration of Pouched Lamprey) Waterbirds (moulting of Shelduck; migratory shorebirds; breeding of 12 species)	Seagrass Invertebrates Phytoplankton Habitat extent and distribution (sedges, seagrass, samphire, mudflats, paperbark)	Water quality: Nutrients Dissolved oxygen Water clarity Salinity Hydrology	Nutrient loads from the catchment Disturbance of acid sulfate soils Groundwater extraction Artificial changes to hydrological regime (surface water increase or decrease) of freshwater Erosion of shoreline (eg powerboat activities) Disturbance of birds and nests by vehicles, people, boating and lights Commercial and recreational fishing Introduced predators (eg. foxes, cats)
Ecological Services: *Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.*	All Entire Peel-Yalgorup Ramsar site	Waterbirds	Habitat extent and distribution (seagrass, samphire, mudflats, reeds, paperbark) Phytoplankton Fish Invertebrate populations	Water quality: Nutrients Dissolved oxygen Water clarity Salinity Hydrology	Nutrient loads from the catchment Disturbance of acid sulfate soils Groundwater extraction Artificial changes to hydrological regime (surface water increase or decrease) of freshwater Erosion of shoreline (eg powerboat activities) Disturbance of birds and nests by vehicles, people, boating and lights Unsustainable commercial and recreational fishing Introduced predators (eg. foxes, cats)

Table 3: Components of the Peel-Harvey Estuary and the provision of services and benefits (from Hale and Butcher 2007, p 106-7)

BENEFIT/SERVICE	LOCATION	DIRECT COMPONENTS	INFLUENCING BIOTIC COMPONENTS	ABIOTIC COMPONENTS	THREATS AND THREATENING ACTIVITIES
Ecological Services: *Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.*	All Entire Peel-Yalgorup Ramsar site	Red-necked Avocet Red-necked Stint Red-capped Plover Hooded Plover Black-winged Stilt Banded Stilt Curlew Sandpiper Sharp-tailed Sandpiper Fairy Tern Musky Duck Grey Teal Australasian Shoveler Australian Shelduck Eurasian Coot	Habitat extent and distribution (seagrass, samphire, mudflats, sedges, paperbark) Invertebrates	Water quality: Salinity Hydrology	Disturbance of acid sulfate soils Erosion of shoreline (eg from powerboat activities) Disturbance of birds and nests by vehicles, people and boating Introduced predators (eg. foxes, cats)
Ecological Services: *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*	Peel-Harvey Estuary	Fish (Breeding crabs, prawns and fish, migration of Pouched Lamprey)	Seagrass Invertebrates Phytoplankton	Water quality: Nutrients Dissolved oxygen Water clarity Salinity Hydrology	Nutrient loads from the catchment Disturbance of acid sulfate soils Artificial changes to hydrological regime (surface water increase or decrease) of freshwater Commercial and recreational fishing
Ecological Services: *Contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region*	Entire Peel-Yalgorup Ramsar site	Extent and diversity of wetland types within the Peel-Yalgorup Ramsar site	Vegetation communities (samphire, paperbark woodland, benthic plants) Waterbird communities Fish and invertebrate communities	Water quality: Salinity Hydrology (water levels in lakes)	Erosion of shoreline (eg powerboat activities) Groundwater extraction

Criteria for listing

In maintaining the list of wetlands of international importance (the Ramsar List) the Ramsar Convention adopted the following vision:

"To develop and maintain an international network of wetlands which are important for the conservation of global biological diversity and for sustaining human life through the maintenance of their ecosystem components, processes and benefits/services"
(Ramsar 2009b, p6)

For a wetland to be accepted on the Ramsar List, the features of a wetland ecosystem must satisfy at least one of the Ramsar Convention's nine criteria. Hale and Butcher's 2007 assessment of the Peel-Yalgorup System (PYS) determined that the System meets six of the nine Criteria for Listing Internationally Important Wetlands (see Draft RIS, in Hale and Butcher 2007).

However, recent changes to the IUCN's red-list have seen the conservation status of the Fairy Tern *(Sterna nereis)* upgraded to vulnerable. This change highlights the impact of growing threats to the Fairy Tern population and emphasises the need to protect high conservation value habitats. The Peel-Yalgorup System provides important habitat for the Fairy Tern, having more than 1% of the global population recorded at the site. Hence the Peel-Yalgorup Ramsar site can now be considered to support 'vulnerable, endangered, or critically endangered species or threatened ecological communities' as per Ramsar Criterion 2.

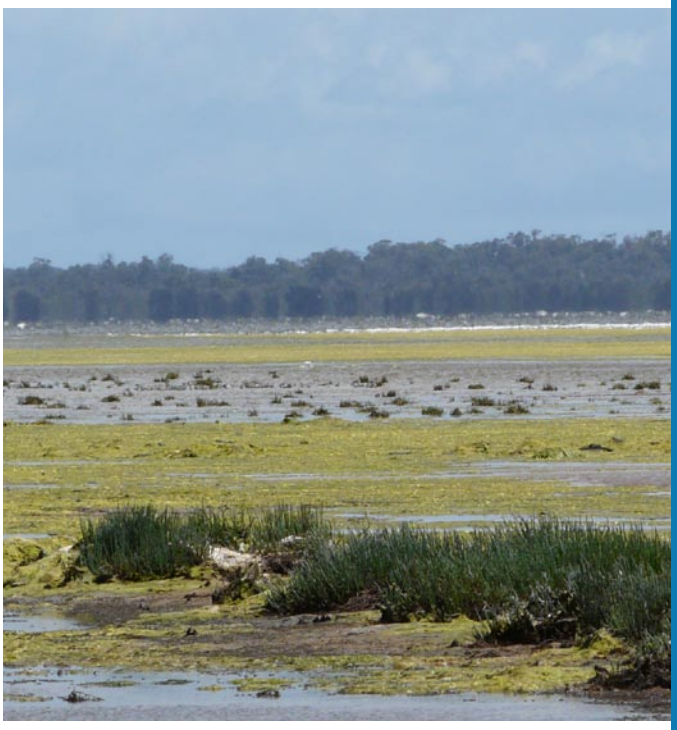

Photo: Amanda Wilmott

Table 4: Ramsar Criteria for identifying internationally important wetlands (criteria met by the PYS highlighted)

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 System includes the largest and most diverse estuarine complex in south-western Australia. The coastal saline lakes and the freshwater marshes included in the System are particularly good examples of each wetland type.
Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	The Fairy Tern *(Sterna nereis)* has recently been listed on the IUCN red list as a vulnerable (C1) species. The Lake Clifton thrombolite community is currently being assessed for listing as a threatened ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*, with a decision due in October 2009. If the community is accepted onto the Australian Government's list, the thrombolite (microbial) community of coastal brackish lakes (Lake Clifton) should be considered as satisfying Criterion 2.
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.	The System is one of only two locations in south-western Australia, and one of very few in the world, where living thrombolites occur in inland waters.
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.	Annual use by large numbers of migratory birds Drought refuge for large numbers of waterbirds (seasonally and in sporadic, large scale events) Regionally and nationally significant numbers of breeding Cormorants, small communities of breeding Pelicans; and for bioregionally important populations of breeding Hooded Plover Breeding populations of fish, crabs and prawns Moulting populations of Australian Shelduck and Musk Duck (during which the birds are flightless for a short period)
Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.	The System annually supports more than 20,000 waterbirds. The System is the most important area for waterbirds in south-western Australia and regularly supports more than 20,000 waterbirds. In 1977, over 150,000 waterbirds were recorded in the System.

Table 4: Ramsar Criteria for identifying internationally important wetlands (criteria met by the PYS highlighted)	
Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	Fourteen (14) species meet this criterion: Red-necked Avocet *Recurvirostra novaehollandiae* Red-necked Stint *Calidris ruficollis* Red-capped Plover *Charadrius ruficapillus* Hooded Plover *Thinornis rubricollis* Black-winged Stilt *Himantopus himantopus* Banded Stilt *Cladorhynchus leucocephalus* Curlew Sandpiper *Calidris ferruginea* Sharp-tailed Sandpiper *Calidris acuminata* Fairy Tern *Sterna nereis* Musk Duck *Biziura lobata* Grey Teal *Anas gracilis* Australasian Shoveler *Anas rhynchotis* Australian Shelduck *Tadorna tadornoides* Eurasian Coot *Fulica atra*
Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species of families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biodiversity.	The status of the Peel-Yalgorup System according to this criterion is unknown.
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.	Fifty (50) species of fish rely on the Peel-Yalgorup System for nursery, feeding and breeding grounds. The migratory route of the Pouched Lamprey *(Geotria australis)* includes the Peel-Harvey Estuary, a component of the System.
Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	The status of the Peel-Yalgorup System with reference to this criterion is unknown.

Photo: Alex Hams

> "Until it is widely accepted that wetland values can be significant and should be investigated prior to making development decisions, the world's wetland resources will continue to decrease despite many good intentions." (Blasco and Fokkens in Stuip et al. 2002).

Although protected areas have traditionally been established to protect landscape values, wildlife or biodiversity, there is an increasing awareness that natural areas contain other values for human communities (Dudley and Stolton 2007).

Articulating wetland values is important step in recognising the importance of the wetlands to our local communities and is a crucial step towards understanding the real costs and benefits of development. Clarifying values can also help in building support for wetland conservation and management, particularly in demonstrating the contribution of protected areas to global, national and local economies (De Groot et al. 2006).

URS (2007) describes the Peel-Harvey catchment and its waterways as being treasured by residents and tourists alike for a range of social, economic and environmental values.

The Blue Manna crabs in the Peel-Harvey estuary are an important biodiversity value in supporting the Ramsar listing for the Peel-Yalgorup System under Criterion 4.

> 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.

In addition, the Blue Manna population is a prized recreational resource for local people; it underpins an important cultural aspect of the region's community, and supports a commercial fisheries industry that in 2005–06 was worth $13.7 million to the region's economy (Peel Development Commission 2008).

With the listing in 1990 of the Peel-Yalgorup System as a wetland of international importance, the internationally important ecological values of the wetlands were officially acknowledged: "The addition of a site to the Ramsar List confers upon it the prestige of international recognition and expresses the government's commitment to take all steps necessary to ensure the maintenance of the ecological character of the site" (Ramsar 2007).

The following section sets out the socio-cultural and economic values of the Peel-Yalgorup System.

Socio-cultural values

The wetlands of the Peel-Yalgorup System are at the heart of the Peel-Harvey catchment and of the culture of the local community. The wetlands are intrinsically tied to the cultural heritage of the region's Noongar community and they underpin the modern coastal lifestyles of residents and tourists in the Peel Region.

For Noongar people, the estuary and wetlands are linked to the shaping of the landscape – of country. In particular, this involves the forming of the landscape by the Waugal's travel. The biodiversity of the wetlands was also important in attracting people to the area, in that it provided for greater choice, and hence reliability, of food sources. Many food species were also spiritually and symbolically important as totems (Dortch et al. 2007).

In a similar way, the ecological values for the wetlands and fringing coastal plain were an attractive incentive for European settlers in the Peel Region. Notably this includes productive alluvial soils and estuarine fish (Bradby 1997).

The amenity and aesthetic values of the estuary and the role of these values in underpinning modern coastal lifestyles is another important socio-cultural value associated with the wetlands. In the late 1980's the State Government was faced with the challenge of restoring the ailing estuarine environment that had been plagued by odorous algal blooms and repeated fish kills. Over $72 million was spent on constructing the Dawesville Channel in an effort to promote tidal exchange between the estuary and marine environments to reduce estuarine eutrophication.

Other evidence of socio-cultural values deriving from amenity and aesthetics is provided in more recent studies of community perceptions. The Peel 2020 Sustainability Strategy identifies community values including the 'health of the waterways and environment' and 'the regional and rural identity' as the most important values to the community (Peel Development Commission 2008) (Table 5 and Appendix A).

Table 5: A summary of key socio-cultural wetland values

Information source	Listed wetland values
An Indigenous Heritage Cultural Assessment (Dortch et al. 2007) eastern Peel-Harvey coastal catchment	Wetlands were highly important in Noongar subsistence strategies: The wetlands are crucial to Noongar subsistence, culture and livelihood: • foraging in swamps and lakes for amphibians, typha roots, edible rhizomes, crustaceans, reptiles, waterfowl and their eggs. • salt marshes surrounding the water bodies of the Harvey Inlet and Murray River are among the most productive ecosystems in the world and provide feeding and nesting grounds for migratory birds. Traditional Noongar camping areas were attractive because they were close to water, dry and elevated, with shade. Traditional knowledge: Water from paperbark trees (Melaleuca spp) could be drunk at any time of year. Bush food and medicine including yams, berries, edible roots and reeds, seeds, insects and marsupials. Tea trees for canes for use in market gardens and cray-pots. NB: It is important to note that the Noongar connection to country was over a much broader range than the area within the Ramsar site.
Planning and community consultation for the Peel Regional Park: (DPI 2005a; 2005b) community consultation at Ravenswood and Mandurah.	Values identified included: • Land and water-based recreation • Lifestyle • Aesthetic/landscape values • Fishing • Heritage – Aboriginal and European • Healthy waterways near shore • Urban living by the waterside • Accessible land • Quality of life • Recreation • Boating • Educational value • Foreshore reserves • Cultural values • Public open space • Bird watching • Remoteness from others • Blue Manna Crabs, Mullet, Mulloway, Bream and Cobbler, insect resources, amphibian and reptile species, ducks and birds, Black Swans, mammals (e.g. Possums, Kangaroos), migratory birds and eggs are sources of food.
Peel Sustainable Development Plan 2020 Issues Paper (Peel Development Commission 2002a) and Peel Sustainable Development Plan 2020 Discussion Paper (Peel Development Commission 2002b)	Participating community members recommended the following needs: • Protect and enhance open spaces and greenways • Manage waterways to ensure they are protected for future generations • Protect and conserve water resources to promote a reduction in water consumption in the region • Foster and develop education, community awareness and involvement in protecting the environment • Preserve and enhance Indigenous cultural values in the Peel environment.
The City of Mandurah's Community Charter and Strategic Plan (City of Mandurah 2005)	In reflecting on community perceptions, the City of Mandurah recommended: • Protecting environmental assets for future generations • Continuous improvement in achieving best outcomes for our community • Ensuring environmental and economic well-being.

BRUCE TATHAM

Bruce Tatham has been a commercial fisherman in the Peel Region since the 70's and as a member of the Peel Inlet Advisory Committee (previously the Peel Inlet Management Authority), plays an active role in monitoring the region's waterways. Bruce said the Dawesville Channel has changed the Peel Inlet, and is still changing it today. "In the business of commercial fishing, we have had to change from a high output level to a low output level. Whilst our management plan in the past allowed for 1,000 tonnes per year, we can now only deliver 180 tonnes per year. One of the main problems with our waterways is the bird to fish stock ratio, and the Ramsar Management Plan will manage this, through ascertaining and monitoring this issue, which needs to be addressed. The Ramsar Management Plan will also play an integral role in informing the management plan for the proposed Peel Regional Park, should it be supported by the current government. It will also look at bird migration and the best usage of the waterways. To my mind, bird migrations to the Peel Region have decreased dramatically through development – not necessarily 'progress', but 'development'. Overall planning within governance should look at the region and new initiatives so we know what our fish stocks are, and the best way to manage the waterways for the population."

Economic values

Although it has not been widely discussed in published literature, the benefits and services of the wetlands in the Peel-Yalgorup System make an important contribution to the local economy including the lifestyles and standard of living of community members.

Blue Manna crab fishing (for both commercial and recreational purposes) is a 'direct use' value of the Peel-Yalgorup System—a value placed on consumption. A quantitative measure of the importance of this wetland service can be estimated using the commercial value of the Blue Manna catch. However, measuring the importance of Blue Manna crab populations for recreation and corresponding local tourism is not quite so straightforward.

There are also 'indirect uses' of the wetlands, such as the ability of a wetland to provide flood control or nutrient filtering as well as 'non-use' values such as amenity and landscape values. These wetland values are difficult to quantitatively estimate.

In generating a better understanding of the economic value of wetland services and benefits, economists look to determine the *total economic value* of a wetland (Barbier et al. 1997). The first step in this process is identifying the types of economic values associated with the Peel-Yalgorup System (Table 6).

Table 6: Total economic value of the Peel-Yalgorup System (after Barbier et al. 1997)

Use Values		**Non-use Values**
Direct use values	*Indirect use values*	*Non-use (existence) values*
Tourism	Flood control	Biodiversity
Agriculture (cattle grazing at Lake McLarty)	Pollution control	Cultural heritage
Recreation	Climate change mitigation	Educational
Commercial fishery	Individual well-being	Amenity

Direct use values

According to Tourism Western Australia (2008), the City of Mandurah is the focal point for tourism in the Peel Region, although the broader region supports an increasing tourism industry through a network of tourist attractions. During 2005–07, the tourism industry provided for an average of 1.89 million day-trippers each year. In addition, over 400,000 holiday-makers stayed overnight, contributing $139 million to the local economy. Many cited an outdoor activity as their reason for visiting the region, including fishing (16%), water sports (11%), picnics or BBQs (11%) and bushwalking (11%).

Whilst only a small area of the Peel-Yalgorup Ramsar site is directly affected by on-site agricultural practices, the broader catchment supports one of the most diverse agricultural sectors in the state. Agricultural production is based predominantly around poultry and pigs, cattle, hay and fruit production. However, vegetables, eggs, flowers and grains are also produced in considerable quantities. The total agricultural production in 2004/05 was $114.9 million, which was 2.2% of the State total (C. Yates, Peel Development Commission pers. comm.).

Within the Peel-Yalgorup System, grazing is thought to have had an important role in shaping the ecological values of the Lake McLarty system. Cattle-grazing is suspected to have helped maintain open mudflats on the lake fringes, providing an important habitat for waterbirds, including migratory waders. Recommendations from the DEC's Lake McLarty Management Plan (DEC 2008) include the need for further research into the use of grazing as a management tool in maintaining mudflat habitats.

Direct use values associated with the Peel-Yalgorup System also include the provision of other food and materials, key to which is the commercial estuarine fishery, estimated to be worth more than $1 million/year (URS 2007). In 2004, the composition of the commercial catch included the Blue Manna crab, prawns and both estuarine and marine fish. The industry is regulated by the Western Australian Department of Fisheries through annual licences, closed seasons and catch limits. This is complemented by industry-imposed restrictions including no-fish zones (B. Tatham, commercial fisherman, pers. comm.).

Dortch et al. (2007) identified a list of species traditionally taken by Noongar people, many of which continue to be taken as part of the estuarine commercial fishery in Western Australia which in 2004 was worth an estimated $700,000 (Smith and Brown 2008) (Table 7). This fact demonstrates how wetland components (fish species) and wetland services and benefits (edible fish populations) can be valued for multiple reasons (both socio-cultural and economic values). It also demonstrates the need to effectively balance competing uses or demands on the wetlands, in order to maintain or preserve wetland values into the future.

Table 7: Socio-cultural and economic values of fishes: fish species traditionally taken by Noongar people and their current value as part of the commercial estuarine fishery in Western Australia (Peel-Harvey and Swan–Canning) (after Dortch et al. 2007 and Smith and Brown 2008)

Common Name	Scientific Name	Commercial fishery catch (2004)
Black Bream	*Acanthopagrus butcheri*	4.3 t
Cobbler	*Cnidoglanus macrocephalus*	1.5 t
King George Whiting	*Sillaginodes punctata*	1.6 t
Sea Mullet	*Mugil cephalus*	74.2 t
Yelloweye Mullet	*Aldrichetta forsteri*	49.5 t

Indirect use values

There is no published evidence of the importance of the four indirect use values listed in Table 6: flood control, pollution control, climate change mitigation and individual well-being, for local communities in the Peel area. Further research is required to identify the contribution of these services to community well-being.

Non-use (existence) values

Non-use or existence values associated with the Peel-Yalgorup System include biodiversity, cultural heritage, education and amenity.

The System's biodiversity values are affirmed with the listing of the System as a Ramsar site and could be estimated (quantitatively) by describing the importance of protecting a site if it was not used or seen by a single person, but provided lasting habitat or refuge for important flora and fauna (ECS, 2008). There is no published literature that quantifies this value of the Peel-Yalgorup.

The cultural heritage values are gaining better recognition as the wider community is becoming more aware of the cultural importance of the wetlands for local indigenous community. However, there is no quantified estimate of the important cultural heritage values of the wetlands.

The wetlands of the Peel-Yalgorup have been widely studied. The wetlands, in particular the Peel-Harvey Estuary are the focus of numerous research projects, yet a dedicated local wetlands/waterways research and educational facility has not been established. The proposed Peel Waterways Institute has been investigated as a possible centre for future wetlands research.

Amenity, highly valued by visitors and residents, has not been comprehensively studied for the Peel-Yalgorup as a whole. A recent study undertaken by Economic Consulting Services (2008) estimated the existence value of the estuary by calculating the comparative value of waterfront properties with nearby (non-waterfront) properties. The authors valued foreshore amenity at $4 757 000 000 (Net Present Value).

Since the Peel-Yalgorup System was Ramsar-listed in 1990, wetland threats have continued to impact on the ecological character of the System. The effects of eutrophication, for example, caused significant changes to the qualities of the estuary, in the form of algal blooms and fish kills. Even the subsequent management program has affected the ecological character of the estuary, resulting in "fundamental and permanent changes to ecological components of the system" (Hale and Butcher 2007 p119).

Hale and Butcher (2007) provide a useful analysis of wetland threats by describing the threats to the Peel-Yalgorup in three parts: the Threatening Activity (or anthropogenic source), the Induced Threat (or stress) and the resulting Impact on Natural Asset (Figure 3). This three-step approach is continued in the following sections in a more detailed assessment of wetland threats.

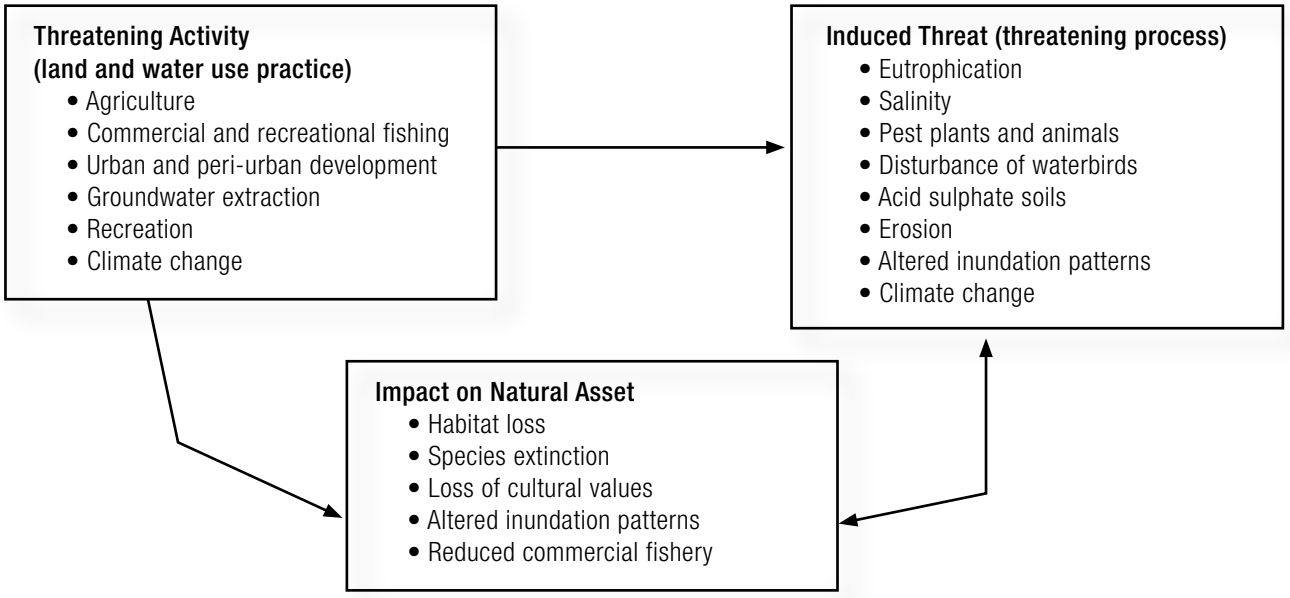

Figure 3: Threats to the ecological character of the Peel-Yalgorup System (modified from Hale and Butcher 2007, p 119)

Assessment method

Having identified that the Peel-Yalgorup System faces growing threats, that management intervention is needed, and that six threatening activities or 'sources' are critical to this management problem, the next step was to further investigate the relationship between the 'source' and the induced threat or 'stress'.

The Nature Conservancy (2007) points out that this step is important for identifying the factors that are affecting the landscape or ecosystem so that the conservation action can be concentrated where it is most needed.

The relationship between sources and stresses was assessed using The Nature Conservancy's Conservation Action Planning Tool, with the aim of providing a prioritized analysis of stresses and sources. The tool uses a criteria-based ranking method to provide an objective analysis, which in turn helps users to identify the critical factors affecting the landscape or ecosystem (TNC 2007). The CAP program was chosen as an appropriate tool on the basis that it has been widely used for community-based conservation planning (in Australia and overseas) and that the software provides a simple but objective method of assessment.

A stepwise approach was taken following the method of TNC (2007):

- Each wetland sub-system was reviewed with respect to the current condition of its key components and processes (see Table 2, p11) and limits of acceptable change (see Ecological monitoring p47).
- Induced threats or 'stresses' were identified where key components or processes were suspected or known to be in poor condition or outside the prescribed limits of acceptable change.

- Stress rating criteria and stress rank were then calculated, where each stress was rated in terms of the anticipated scope and severity that can reasonably be expected within the planning horizon (eg.10 years).

- Threatening activities or 'source' of each stress was then identified.

- A source of stress rating criteria and threat rank was calculated where each source was rated against irreversibility and contribution criteria.

- The threat summary was then reviewed and discussed by project Technical Advisory Group.

The results of this assessment are discussed in the sections below.

Threatening activities (the source)

Threatening activities describe the source of wetland threats – the proximate threat. They are the resource use practices that must be actively managed in order to promote wise use of the wetland and protection of the wetlands' ecological character.

Hale and Butcher (2007) identified six critical threatening activities affecting the Peel-Yalgorup System:

- Agriculture: while efforts to combat nutrient enrichment in the Peel-Harvey Estuary have been the focus of management efforts for over 20 years, nutrient loads in the Peel-Harvey Catchment's three major waterways (the Serpentine, Murray and Harvey rivers) continue as a significant source of nutrients to the estuarine system.

- Commercial and recreational fishing: estuarine and marine species underpin a significant commercial and recreational fishery centred on the Peel-Harvey Estuary. The commercial fishery includes Blue Manna crabs, Sea Mullet and Yellow Eye Mullet. Commercial and recreational fisheries are closely managed by the Department of Fisheries; however, unlawful overfishing threatens the population of edible species.

- Urban development: population growth and accompanying urban and peri-urban development have increased significantly within the last decade without proper management. Urban development, both current and proposed, is likely to bring significant threats to the ecological character of the Peel-Yalgorup System. Historical urban and peri-urban development has resulted in:
  - Clearing of native vegetation
  - Greater urban stormwater nutrient loads
  - Increased recreational pressures
  - Disturbance of acid sulphate soils, and
  - Waterbird disturbance.

- Groundwater extraction: the impacts of groundwater extraction on the groundwater-dependant ecosystems of the Peel-Yalgorup System are not well documented. Anecdotal evidence suggests that groundwater extraction could be contributing to altered hydrology (reduced extent and duration of flooding) within the Lake McLarty system and the Yalgorup Lakes, although more information is needed.

- Recreation, in the form of people with domestic animals, pedestrians, 4WD vehicles, motorbikes and boat users have varying impacts on the wetlands of the System. A number of key threatening processes are resulting from continued recreational pressure on the wetlands in the System, including waterbird disturbance and foreshore erosion, and to a lesser extent, litter and other forms of waterborne pollution.

- Climate change: although the severity of predicted climate change effects and the contribution of anthropogenic sources of carbon dioxide to the climate change problem continue to be debated, the need for planning – for even the more conservative changes to the regional climate – is certain. Sea level rise, frequency and intensity of storm events and reduced rainfall must be considered in the contexts of biodiversity conservation and supporting services such as flood control.

Contribution and irreversibility

Each of the six threatening activities was ranked for each wetland subsystem and for the System as a whole (Table 8). This part of the assessment considers the contribution and irreversibility of each 'source' on each resulting 'stress', where:

- Irreversibility is the feasibility of restoring the original condition.
- Contribution is the expected contribution of the source, acting alone, to the full expression of stress under current circumstances (TNC 2007).

Table 8: Threatening activities acting on the Peel-Yalgorup System wetlands

	Peel Inlet and Harvey Estuary	Yalgorup Lakes	Lakes McLarty and Mealup	Goegrup and Black Lakes	Overall Threat Rank
Climate change	High	High	Very High	High	Very High
Agriculture	High	High	Very High		High
Urban and peri-urban development	High	High	High	High	High
Groundwater extraction		Very High	Medium	Medium	High
Recreation	Medium	High	Medium	Low	Medium
Commercial and recreational fishing	Medium				Low
Overall Threat Status	High	Very High	Very High	High	Very High

Induced threats (the stress)

Induced threats (stresses) are the effect of threatening human activities on the wetlands' components and processes. Where threatening activities continue to take place, the stress on the wetlands must be actively managed.

Stresses affecting the wetlands of the Peel-Yalgorup System were identified in the planning process through consultation with members of the Peel-Yalgorup Ramsar Site Technical Advisory Group and through interpretation of the current conditions of the wetlands' components and processes (see Ecological Values p9). Each stress was ranked on the basis of severity and scope to give an overall threat ranking (Table 9), where:

- **severity** is the level of damage to the natural asset that can be reasonably expected within 10 years under current circumstances.
- **scope** is the spatial scope of impact on the natural asset that can reasonably be expected within 10 years under current circumstances (TNC 2007).

Table 9: Induced threats (stresses) to the ecological character of the Peel-Yalgorup System wetlands

	Stresses	Peel Inlet and Harvey Estuary	Yalgorup Lakes	Lakes McLarty and Mealup	Goegrup and Black Lakes
1	Acidification	Medium		Very High	Low
2	Increased nutrient concentrations	High	High	High	High
3	Decreased waterbird abundance or diversity	High	Medium	High	Medium
4	Decreased duration and extent of inundation	Low	High	High	
5	Decreased freshwater inflows		High		High
6	Decreased number of breeding waterbirds	Medium	High		Medium
7	Increased salinity		High	Medium	
8	Increased phytoplankton biomass	Low			High
9	Declining thrombolite community condition		High		
10	Increased typha extent			High	
11	Decreased extent and condition of paperbark community	Medium			Medium
12	Decreased samphire extent	Medium			Medium
13	Increased frequency of fish kills		Medium		Low
14	Decreased population of commercially harvested fish species	Medium			
15	Decreased seagrass community extent	Medium			
16	Increased salinity (river mouths)	Medium			
17	Increased frequency of Nodularia blooms				Low

Photo: Steve Dutton

Preventing impacts on the Peel-Yalgorup System

As Hale and Butcher (2007) explained, the consequence of altered critical components and processes is an impact on the key species and communities of the wetlands and, in turn, the ecological, socio-cultural and economic values of the System. Management action is required to address the very high and high priority threats to the wetlands of the Peel-Yalgorup System.

Acidification

Anecdotal evidence suggests that surface water pH in Lake Meaup is as low as pH 3 (Heidi Bucktin, Department of Environment and Conservation, pers. comm) and that surface water levels and extent of flooding have declined significantly in recent years (Peter Wilmot, LMPS, pers. comm.). It is likely that acidification is affecting the open water and fringing habitats of the Peel-Yalgorup System affecting the presence and abundance of waterbirds and other higher order species. The extent and severity of acidification at Lake Mealup is unknown.

Action: Determine cause and extent of acidification in surface and groundwater at Lake Mealup and investigate options for remediation.

The Peel-Harvey Estuary and Goegrup Lakes are defined as acid sulfate soil risk areas (Sullivan et al. 2006). New research is required to determine the impact and extent of acidification, and the impact this is having on supporting biological components including aquatic invertebrates, as well as further investigation into the presence of acid signals in groundwater drainage to the estuary (Keiryn Kilminster, Department of Water pers. comm.)

Action: Determine the cause and extent of acid drainage into the Peel-Harvey Estuary and the risk to aquatic fauna.

Increased nutrient concentrations and or Increased phytoplankton biomass

With the construction of the Dawesville Channel, impacts of eutrophication (including algal blooms and noxious odours) have been markedly reduced by greater flushing of the estuary through increased tidal exchange. However, high nutrient loads from the catchment's three major drainage systems: the Murray, Serpentine and Harvey Rivers still threaten the environmental values of the estuary and foreshore.

Action: Implement the recommendations of the Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey (EPA 2008).

Nutrient concentrations in the surface waters of the Yalgorup Lakes, Lake McLarty and Lake Mealup are anecdotally reported to have increased. Further information is required to determine the changes in surface water nutrient concentrations and the impact of these changes on key species and communities.

Action: Collect baseline data on nutrient concentrations for the Yalgorup Lakes System and the Lakes McLarty and Mealup.

Nutrient concentrations, coupled with altered hydrology and impacts from invasive species (black bream) may also be threatening the Lake Clifton thrombolites.

Action: investigate impacts of nutrients, hydrology and black bream on the thrombolite community of Lake Clifton.

Decreased waterbird abundance and diversity

Waterbird monitoring is currently undertaken by volunteers through local and national groups, including the Western Australian Wader Studies Group, Mandurah Bird Observers and Birds Australia. Annual Shorebird 2020 counts in January/February form a key part of population estimates for the waterbirds of the Peel-Yalgorup System. The success of these monitoring programs relies on providing increased support to volunteer community groups.

Action: Provide support to local volunteers to undertake key waterbird monitoring programs.

Reduced number of breeding waterbirds

Little is known about breeding populations of waterbird species and the frequency of breeding events. In particular, monitoring of the Yalgorup population of Hooded Plovers relies on the voluntary effort of local community members. Successful breeding was recorded in 2008 and 2009 by this community monitoring program (Bill Russell, community member, pers. comm). Similarly, breeding of other key species, including nesting attempts by the Fairy Tern, was recorded by local community members. Two breeding attempts were recorded in the 2008-09 season – both unsuccessful (Dick Rule, Mandurah Bird Observers, pers. comm). Further research is required to determine successful breeding of Cormorants, which in the past were recorded as breeding in Austin Bay and which are now known to breed at Len Howard Reserve.

Action: Provide support to local volunteers to undertake monitoring of waterbird breeding including Cormorants, Fairy Terns and Hooded Plovers (as per Hale 2008), along with Fairy Tern nesting events.

Decreased duration and extent of inundation/Decreased freshwater inflows

Altered lake hydrology in the form of decreasing flooding duration and extent is of key concern at Lake Mealup, with impacts on aquatic and fringing habitats already in evidence. Similarly, altered hydrology may be impacting on the thrombolite community of Lake Clifton. Urgent action is required to better understand the groundwater hydrology of both environments and the contribution of groundwater extraction to altered surface water hydrology.

Action: Determine current conditions of flood duration and extent at Lake Mealup and within Lake Clifton together with an assessment of likely impacts on key species and communities within each ecosystem.

Invasive species management: typha control

Early aerial photography (c1945) shows Lake Mealup as a large open waterbody, free from the typha orientalis which now dominates the emergent vegetation of the Lake. The habitat values of the open water and fringing environments at Lake Mealup are currently severely degraded. Action to remediate the loss of habitat value is required.

Action: Implement typha control measures at Lake Mealup.

Summary of knowledge gaps

Comprehensive baseline data is urgently required in order to determine the current status of wetland threats and to assess the risks posed by threatening processes and the contribution of the six threat sources (Table 10).

Table 10: Knowledge gaps – immediate priority

Research need	Wetland subsystem
Threatening activities	
Land use change: impact on groundwater hydrology	System wide
Impact of unsympathetic culture in the broader community and options to facilitate behaviour change	System wide
Climate change: impacts on biodiversity including habitat condition and extent	System wide
Recreation: impact on habitat condition and extent	Peel-Inlet and Harvey Estuary
Threatening processes	
Acid sulfate soil exposure	McLarty System; Peel-Harvey Estuary
Hydrological regime (decreased flooding duration and extent)	Yalgorup Lakes; McLarty System
Water quality (increasing nutrients and salinity)	System wide
Littoral and fringing vegetation habitat condition and extent	System wide
Avian species diversity and population dynamics	System wide
Altered microbial community composition of the Lake Clifton thrombolites	Yalgorup Lakes
Impacts on wetland values	
Comprehensive risk assessment on indigenous cultural values, recreational use values and economic values of the Peel-Yalgorup System (including a comprehensive baseline assessment of cultural values)	System wide

Strategies and Actions

This section sets out a program of collaborative management for the Peel-Yalgorup System Ramsar site. The program takes into account the current management context and gives consideration to the complex land tenure and stakeholder network (see Management and Planning Context). The program is arranged around the long-term (20-year) vision and aspirational goals for the Peel-Yalgorup System (see Vision and Management Objectives).

A series of strategies and action steps are prescribed within each goal (Table 11) with corresponding 5-year outcomes set out in a program logic. These outcomes are listed below. These strategies and actions have been designed within a context of an uncertain funding future. With the absence of committed long-term funding for Ramsar site management for the Peel-Yalgorup System, this plan relies heavily on collaborating with partner stakeholders and other, complementary, management programs for mutual gain.

GOAL 1: The Peel-Yalgorup System will be managed in accordance with the principle of wise use, that is, the conservation of the wetlands and human uses that are compatible with maintenance of the natural properties of the ecosystem:

- all identified management stakeholders are committed to a formal collaborative management process
- the boundary of the Peel-Yalgorup System is clearly defined with an explicit, multiple-use zoning plan published
- all new land developments in the Peel-Harvey Coastal Catchment demonstrate a net environmental benefit (no loss of environmental values) from pre-development condition
- no loss of remnant vegetation in the Peel-Harvey Catchment from 2009 extent.

GOAL 2: The ecological character of the Peel-Yalgorup System, including services and values, will be maintained or enhanced to achieve long-term positive outcomes:

- the condition of the Lake Clifton thrombolite community is maintained or improved, as per limits of acceptable change
- the population dynamics of estuarine and marine fauna are established and protected at 2009 condition
- shorebird populations are maintained or increased from 2009 condition
- breeding waterbird populations are maintained from 2009 condition
- the condition and extent of the Peel-Yalgorup System's six main habitat types is maintained or improved (open water, mudflats, aquatic plants, samphire, paperbark, sedges) from 2007 extent.

GOAL 3: Community stakeholders will be engaged and supported in active environmental stewardship:

- 50 % of the local community is aware of the internationally important values of the Peel-Yalgorup System
- waterbird monitoring and on-ground works are implemented by local community groups, in accordance with the priorities identified in the Ecological Character Description.

Photo: Amanda Wilmott

Table 11: Goals, strategies and actions

Recommendations	Priority	Key Stakeholders	Timeframe of Commencement
Strategy: Peel-Yalgorup System 'Management Advisory Group' established with formal support and representation from Federal, State and Local governments, industry and community stakeholders			
Establish and support a Technical Advisory Group. The Technical Advisory group will: • provide technical advice regarding on-going management of the Ramsar site and assessment of management techniques • comprise representatives from all key stakeholder groups including primary stakeholders, Local Government stakeholders and catchment management organisations • have written support of State and Local Government stakeholders.	High	All primary and local government stakeholders PHCC SWCC	1
Coordinate regular (at least every six months) Management Advisory Group meetings.	High	Peel-Harvey Catchment Council	1
Strategy: Review the boundary of the Peel-Yalgorup System to ensure maximum protection of the System's ecological, socio-cultural and economic values			
Establish a Zoning Plan to protect the ecological and socio-cultural values of the Peel-Yalgorup System.	High	All primary stakeholders	2
Seek funding for the production of a Management Plan for Aboriginal and European heritage in the Peel region (as per Goegrup and Black Lakes Action Plan Recommendation 52).	Medium	SWALSC and an appropriate Peel Region Aboriginal Group with input from regional elders	2
Establish guidelines for reviewing the boundary of the Peel-Yalgorup System before preparing a proposal to the Western Australian State Government.	High	Peel-Harvey Catchment Council, Shire of Murray, City of Mandurah	1
Strategy: Prepare new (or revise existing) environmental guide for land-use planning and environmental impact assessment at all levels of government decision-making (Local, State and Federal Government)			
Peel region scheme text amended (or subordinate planning tool prepared) to give greater protection to the ecological, socio-cultural and economic values of the Peel-Yalgorup System.	Medium	Department for Planning and Infrastructure	1
State Government formally adopt guidance for determination of wetland buffers.	Medium	DPI, DEC	2
Incorporate key international and national Ramsar site management obligations and recommendations in local planning policies and strategies in the Shires of Murray, Waroona and Harvey and in the City of Mandurah.	High	PHCC	2
Prepare strategic assessment guidelines for matters of national environmental significance associated with the Peel-Yalgorup System.	High	DEWHA	2

Recommendations	Priority	Key Stakeholders	Timeframe of Commencement
Strategy: Review groundwater resource allocation: Lake McLarty System and Yalgorup Lakes			
Undertake regional scale hydrological assessment surrounding the Lake McLarty System.	High	DoW	1
Review groundwater allocation limits in the Southwest regional groundwater area (Lake Clifton subarea).	High	DoW	2
Strategy: Protect fringing and terrestrial environments in good condition			
Undertaken high priority site-specific management actions (see Table 12, 'wetland action plans' and 'other plans'.	High	-	ongoing
Undertake further investigation into nutrient concentrations and eutrophication risk at Goegrup and Black lakes.	High	SWALSC, DoW	1
Establish tourism and recreational carrying capacity of the Peel-Waterways.	Medium	DoW, DPI Marine, PIMC	1
Control typha at Lake Mealup.	High	LMPS, PHCC	1
Prepare and implementation an Interim Management Guideline for Lake Mealup.	High	LMPS, DEC	1
Determine cause and extent of acid drainage in the Peel-Harvey Estuary.	High	DoW	1
Collect baseline data on nutrient concentration in Yalgorup Lakes and McLarty System.	High	DEC, PHCC	1
Investigate cattle grazing as a management tool for Lake McLarty.	Medium	DAFWA, DEC	1
Strategy: Reduce nutrient loads to the Peel Harvey Estuary and Goegrup & Black Lakes by 50 % of 2009 levels			
Implement recommendations of the Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey Catchment – Phosphorous Managment (EPA 2008).	High	-	ongoing

Recommendations	Priority	Key Stakeholders	Timeframe of Commencement
Strategy: Economic valuation of the Peel-Yalgorup System			
Undertake a wetland valuation session to improve knowledge and communication of wetland values.	Low	PHCC PWC	1
Strategy: Catchment scale behaviour change investigation			
Scope options for a large scale behaviour change project to improve stewardship and conservation of local wetlands and waterways.	High	PHCC PWC PDC	1
Strategy: Strategic awareness raising project			
Prepare a communication, education and public awareness-raising (CEPA) strategy to promote the international importance of the Peel-Yalgorup Ramsar Site, and our commitments to the Ramsar Convention for wetland 'wise use'.	High	PHCC, DEWHA, DEC, DOW	1
Implement high priority CEPA actions, as per CEPA strategy.	TBD*	To be determined	2
Prepare a report card to the local community on the current status of ecological health of the Ramsar site .	High	DEC, DOW, PHCC	Annually
Provide capacity-building support to local volunteer community groups, particularly for waterbird monitoring (see 'Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar site') (Hale 2007).	High	PHCC, community groups	1
Foundational activities: establish a comprehensive baseline data set			
Implement recommendations of the 'Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar site', including monitoring coordination and data storage.	High	DEC, DoW, Mandurah Bird Observers, Birds Australia, WA Wader Studies Group; Western Australian Marine Science Institute, DOF, PHCC	1
Report monitoring results against limits of acceptable change to Technical Advisory Group, Australian and Western Australian Governments and other stakeholders where appropriate (e.g. local governments).	High	DEC, DEWHA, PHCC	Annually
Prepare an action strategy for components and processes reported to be outside the relevant limits of acceptable change (as per 'Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar site').	High	DEC, DoW, PHCC, DEWHA	As required
Undertake a management effectiveness assessment and report achievement of management plan recommendations to Technical Advisory Group.	High	PHCC	As required
Review the prescribed limits of acceptable change using first year monitoring data.	High	DEC, DoW, PHCC	Annually
Review management plan recommendations and revise when necessary, releasing new amendments to the management plan as updated 'versions' where required.	High	DEC, DoW, PHCC	Annually

*TBD: To be determined

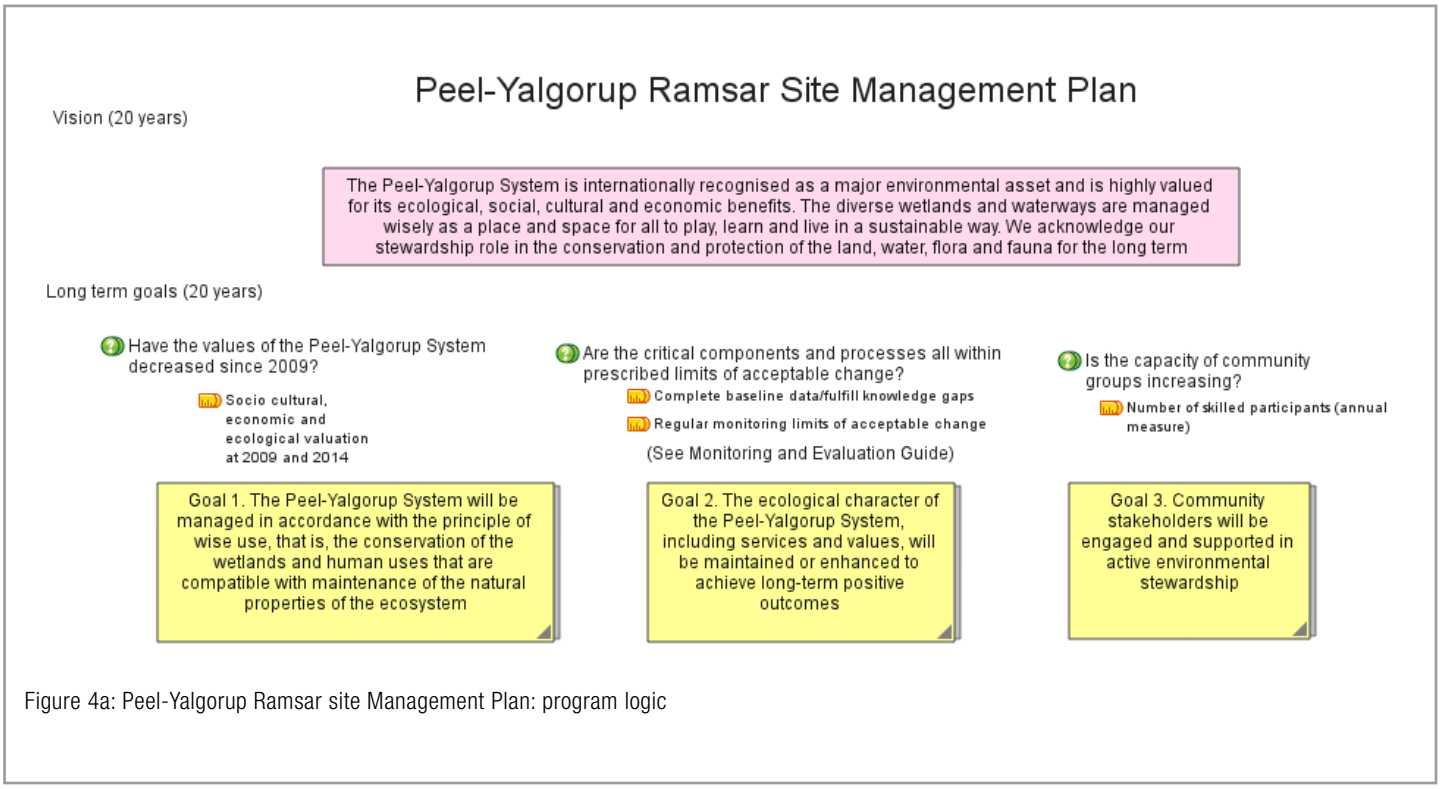

Figure 4a: Peel-Yalgorup Ramsar site Management Plan: program logic

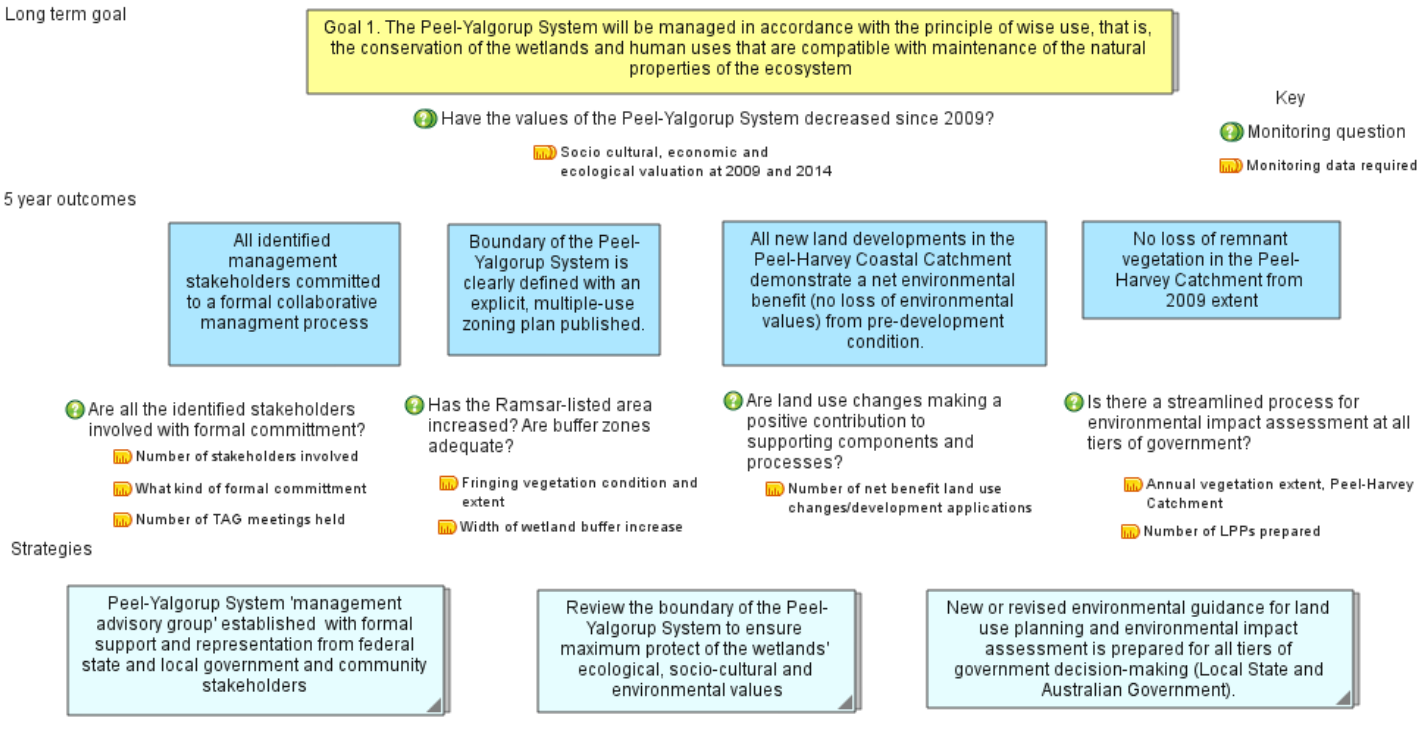

Figure 4b: Program logic for Goal 1

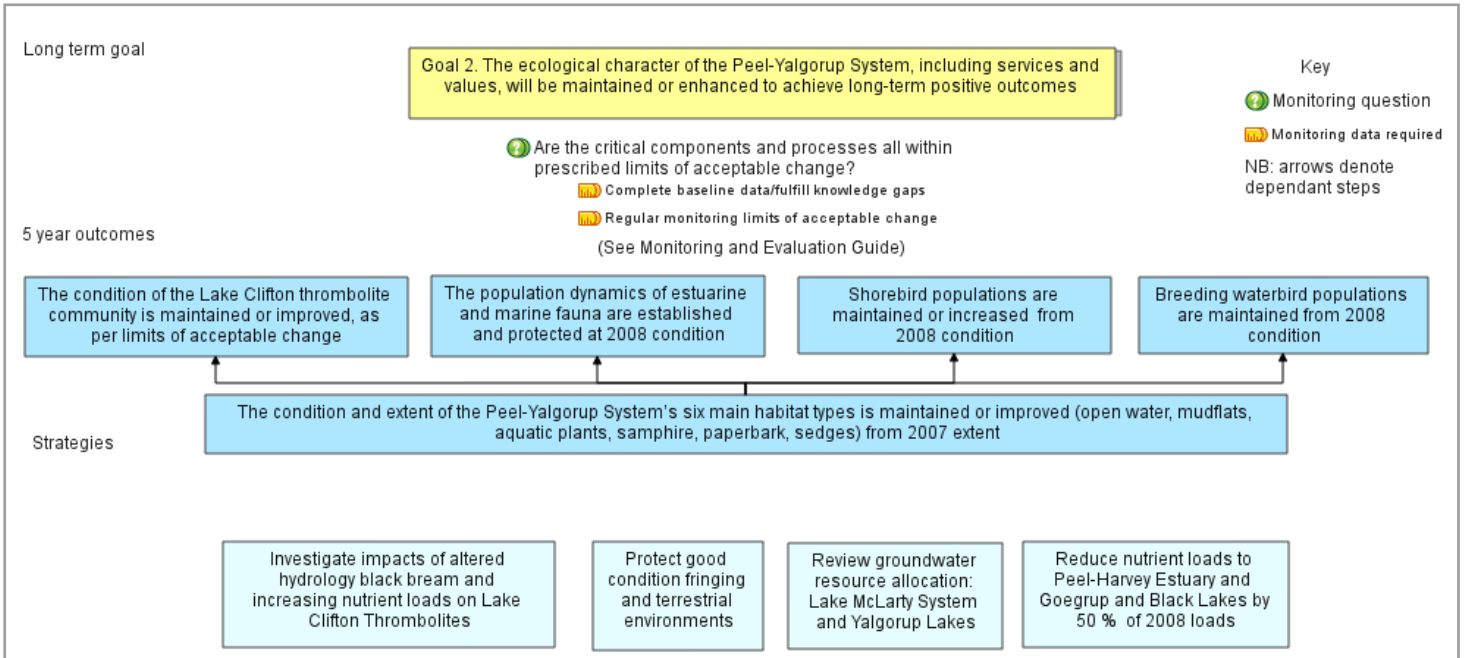

Figure 4c: Program logic for Goal 2

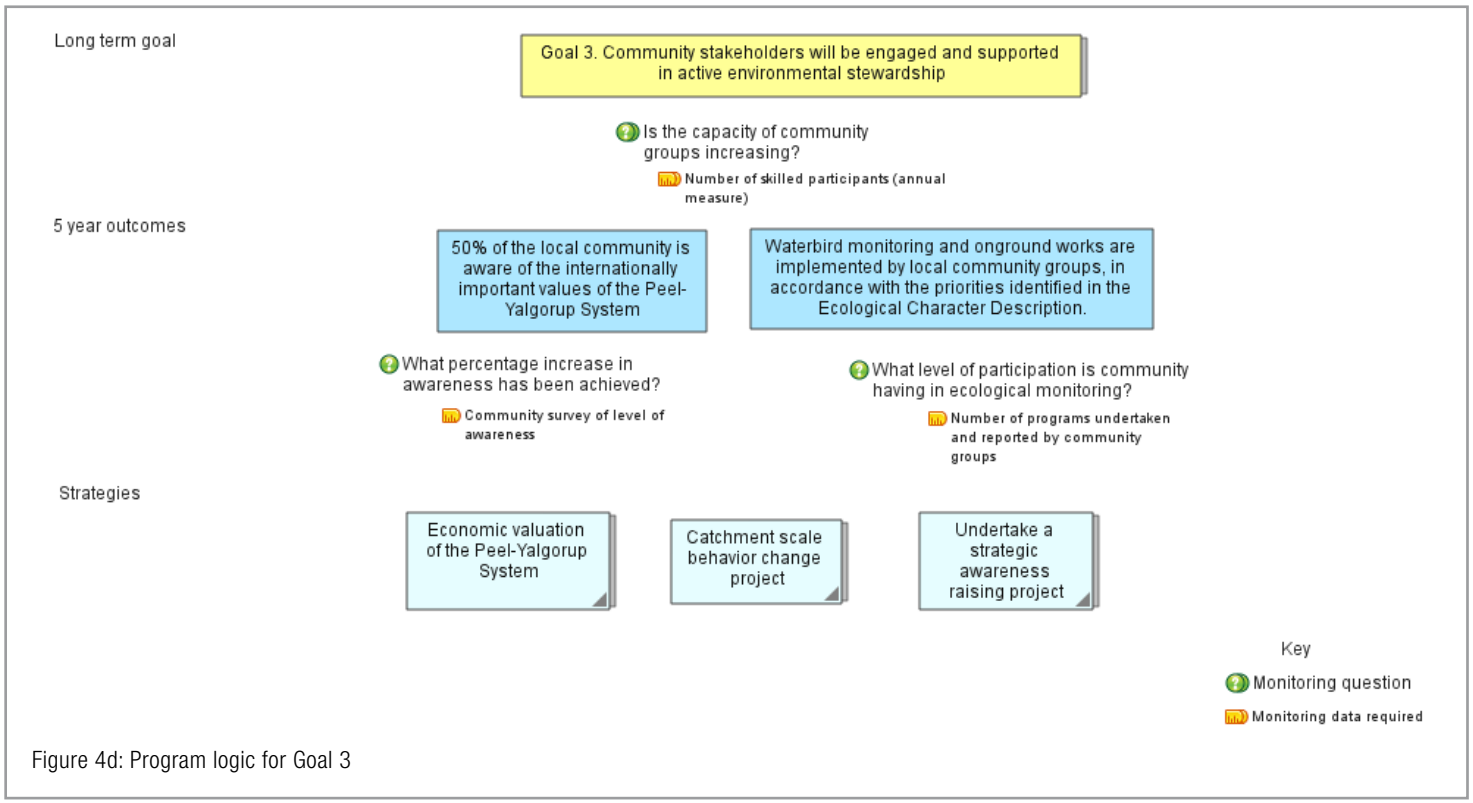

Figure 4d: Program logic for Goal 3

This Management Plan provides an overarching, whole-of-system guide for the multiple government and community stakeholders involved in managing the wetlands in the Peel-Yalgorup System.

This Plan builds on the strengths of an existing management framework comprising numerous 'local' and sub-system scale action plans. This Plan was also created within local, regional, state and national policy contexts which directly and indirectly influence the way in which the Peel-Yalgorup System should be managed.

The following section describes the roles and responsibilities of stakeholders, the policy and legislative context and the existing management framework that will link the implementation of this Plan to physical changes on the ground.

Current management context

Supporting this Plan are several local area action plans dealing with individual or groups of wetlands that form part of the Peel-Yalgorup System. They include plans produced by government and community stakeholders and address various spatial scales (Table 12).

Peel Inlet and Harvey Estuary

The Department of Water is currently reviewing its 1992 Western Foreshore of the Peel-Harvey Estuary, Draft Management Plan and Peel Inlet Management Program (Waterways Commission 1992a & b). This will direct on-ground action to restore and protect the ecological values of the estuarine system and will complement the City of Mandurah's suite of foreshore management and concept plans which exist for the foreshore reserves in the City of Mandurah.

In addition, the Water Quality Improvement Plan (EPA 2008) is now in place as a mechanism to improve water quality and diminish eutrophication of the Peel Inlet and Harvey Estuary, although its success will depend on the level of resources invested in its implementation. It builds on earlier plans established as part of the planning process for the Dawesville channel, principally the Peel Inlet and Harvey Estuary Management Strategy (Kinhill Consulting Engineers Pty Ltd 1988).

Yalgorup Lakes

The Department of Conservation and Land Management (now Department of Environment and Conservation) prepared the Yalgorup National Park Management Plan 1995–2005 (1995) with goals for conservation, recreation, community relations, commercial and other uses, interaction with nearby lands and waters and research and monitoring. The Plan lists management priorities, including 'High Priority Group 1' (relevant to protecting the conservation values of Lake Clifton and the thrombolite community) and 'High Priority Group 2' (protecting the National Park's broader conservation values). The Department is currently reviewing this plan, and is expected to provide an updated version as a matter of priority.

The Interim Recovery Plan No. 153 for the Lake Clifton Thrombolite community, produced by the Department of Environment and Conservation (Luu et al. 2004) presents recommendations aimed at protecting and enhancing the conservation values of the Lake Clifton thrombolite community. Implementation this plan is a high priority, with the plan due for review in 2009.

Goegrup and Black Lakes

The South West Aboriginal Land and Sea Council's Goegrup and Black Lakes Action Plan (Ecoscape et al. 2006) focuses on the ecological and cultural heritage values of the Goegrup and Black Lakes environment. The plan highlights the impacts of population pressure on the Lakes and responds with an approach to restoring ecological values. The plan:

- aims to improve the state of the environment by addressing targets such as reducing sedimentation and erosion; restoring the bushland around the lakes; conserving the biodiversity of the lakes, and
- includes an implementation plan, with detailed activities, specific timeframes and costings.

The plan places strong emphasis on restoration, revegetation, weed control, disease management, water quality improvement and fire management.

Lake McLarty System

The Lake McLarty Nature Reserve Management Plan No. 60 was released in June 2008 by the Department of Environment and Conservation. The plan focuses on the two 'class A' reserves that comprise the 219 ha of Lake McLarty Nature Reserve.

The plan identifies the key values for the site including its cultural heritage, its importance as a freshwater lake within the Peel-Yalgorup Ramsar site and the protection of migratory birds which use the lake under the JAMBA (Japan), CAMBA (China) and ROKAMBA (Republic of Korea) migratory bird agreements. Community involvement is highlighted. Key actions relate to:

- consolidating the land tenure and securing additions to the reserve where possible
- monitoring and managing the lake's water levels
- managing water quality
- maintaining shorebird habitat
- controlling feral predators and pests
- maintaining and rehabilitating where necessary the vegetation biodiversity including weed control
- disease and fire management
- visitor access and use.

A plan for the bushland surrounding Lake Mealup is also in place, having been prepared by the National Trust WA in consultation with Lake Mealup Preservation Society. As the name suggests, the focus of the plan is on the terrestrial environment adjacent to the Lake. An Interim Management Guideline for the wetland features of the Lake environment is now being prepared by the Department of Environment and Conservation in partnership with Lake Mealup Preservation Society as a means of addressing the declining condition of the Lake. The Interim Management Guideline is expected to be released in 2010.

Table 12: Wetland action plans (* denotes plans currently under review or revision)

Peel Inlet – Harvey Estuary	Peel Inlet and Harvey Estuary Management Strategy; Environmental Review and Management Program - Stage 2 (Kinhill Engineers Pty Ltd 1988)
	Western Foreshore of the Peel Inlet Management Plan (Waterways Commission 1992a)
	Peel Inlet Management Programme (Waterway Commission 1992b)*
	Economic Development and Recreation Management Plan (Everall Consulting Biologists 2002)
	Conservation Reserve Environmental Management Program, Mariners Cove (Bowman Bishaw & Gorham 2005)
	Draft Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System (EPA 2008)
	Various foreshore reserve management plans (City of Mandurah)
Yalgorup Lakes	Yalgorup National Park Management Plan 1995-2005 (CALM 1995)*
	Interim Recovery Plan 153 (Luu et al. 2004) for the Lake Clifton Thrombolite community
Goegrup and Black Lakes	Serpentine River Management Plan Stage 1 – Goegrup Lake to Barragup Bridge (WRC 1998)
	Goegrup and Black Lakes Action Plan (Ecoscape and O'Conner 2006)
	Lower Serpentine River Action Plan (City of Mandurah 2007)
Lake McLarty System	Management Plan for Covenanted Bushland at Lake Mealup, Pinjarra (LMPS and National Trust 2003)
	Lake McLarty Nature Reserve Management Plan (DEC 2008)
	Lake Mealup Interim Management Guideline (DEC and LMPS in prep)

Stakeholders

A diverse range of stakeholders influence or are affected by the ways in which the wetlands in the System are managed. Stakeholder groups include organisations with direct management responsibilities, Indigenous custodians, local governments, state government agencies, individual community members, local interest groups and community based organisations. (Table 13 and Appendix B)

Table 13: Peel-Yalgorup System management stakeholders

Stakeholder group	**Comprised of**
Organisations with direct roles responsibilities for wetlands in the Peel-Yalgorup System	Department of Environment and Conservation Department of Environment Water Heritage and the Arts (Australian Government) Department of Fisheries Department of Planning Department of Transport (Recreational Boating) Department of Water Lake Mealup Preservation Society Inc. Peel Development Commission Peel-Harvey Catchment Council
Indigenous custodians	Bilya Noongar Indigenous Organisation Peel Region Indigenous Reference Group Winjan Aboriginal Corporation
Local government municipalities in which the Ramsar site is located	City of Mandurah Shire of Harvey Shire of Murray Shire of Waroona
State government agencies with duties or responsibilities that may impact upon the way in which the wetlands are managed	Department of Agriculture and Food Department of Environment and Conservation Department of Sport and Recreation Department of Water Peel Development Commission Tourism WA Western Australian Conservation Commission Western Australia Planning Commission Water Corporation

Table 13: Peel-Yalgorup System management stakeholders continued.	
Locally based advocacy groups and/or community groups	Birds Australia (Western Australia) Canoe Trail Friends of Mandurah and Pinjarra Inc. City of Mandurah Bushcare City of Mandurah Coastcare groups Corio Landcare Group Friends of Ramsar Action Group for the Yalgorup Lakes Environment (FRAGYLE) Friends of Rivers Peel (FoR Peel) Hotham Catchment Landcare Lake Clifton Sporting and Progress Association Lake Mealup Preservation Society Inc. Landcare District Committees Mandurah Bird Observers Narrogin–Williams Landcare Peel Preservation Group Serpentine Jarrahdale Landcare Centre (Landcare S-J) Southern Estuary Progress Association Waroona Landcare Centre Waterside Residents Association Western Australian Naturalists Club
Catchment management stakeholders	Greening Australia Shire of Serpentine Jarrahdale Shire of Boddington Shire of Cockburn Shire of Kwinana Shire of Cuballing Shire of Wandering Shire of Williams Town of Rockingham South West Catchments Council
Business and industry	Includes tourism, housing and development, mining, commerce and agriculture/silviculture/horticulture
Regional or state level advocacy groups	Conservation Council WA Greening Australia (WA) WWF

Government stakeholders

Land tenure within the Peel-Yalgorup System is complex (Map 3). Various state government agencies have management responsibility for the wetlands of the System including the Department of Environment and Conservation, Department for Planning and Infrastructure and the Department of Water. Other government stakeholders also have responsibility for ensuring the implementation of our international commitments.

As a signatory to the Ramsar Convention, the **Australian Government** accepts responsibility for the wise use of Australia's important wetlands. A bilateral agreement between the Commonwealth Government and the Western Australian Government was developed to deliver the first stage of the Natural Heritage Trust (NHT) in which Ramsar site management became the joint responsibility of both State and Australian Governments, with financial support provided by the Australian Government. More recently, the Commonwealth set out new priorities for natural resource management though its Caring for our Country initiative. The initiative will see investment directed towards short-term targets that ultimately contribute to the achievement 5-year outcomes, including: *delivering actions that sustain the environmental values of prioirty sites in the Ramsar estate, particularly sites in northern and remote Australia.*

Caring for our Country will see continued investment by the Australian Government in protecting the ecological character of Australia's Ramsar sites. The Caring for our Country Business Plan 2009-2010 sets out priorities for investment in natural resource managment, including short-term targets (Commonwealth of Australia 2009).

In fulfilling its commitment to the Ramsar Convention, the Commonwealth enacted the *Environment Protection and Biodiversity Conservation Act (1999)* as a tool for protecting the ecological character of Australia's Ramsar sites (see Policy and Governance Framework).

Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) recognises the well-established role of the Western Australian Government in the implementation of the Ramsar Convention and the fulfilment of its objectives. Under action 2.9 of the Strategy for Implementation, the **Department of Environment and Conservation** (DEC, formerly CALM) is given responsibility for fulfilling the State Government's responsibilities under international agreements relating to wetlands and migratory waterbirds. Under action 2.10 DEC is given responsibility under international agreements relating to assistance for wetland purchase, management and research, training of relevant staff and monitoring. This policy gives the lead to DEC for implementation of the Ramsar Convention and other complementary international policy.

Under the *Conservation and Land Management Act 1984*, (CALM Act) DEC has a dual function with respect to the Peel-Yalgorup System in also coordinating the management of reserved land vested with the Conservation Commission. This includes the Yalgorup National Park, Kooljerrenup Reserve,Lake McLarty Nature Reserve (including parts of Lake Mealup) and Creery Islands.

The CALM Act establishes the **Conservation Commission** of Western Australia (Conservation Commission). The Act governs the declaration and management of protected areas and, in the process, imposes certain obligations relating to management planning for these areas. The Act specifies (s54-56) that:

- the Conservation Commission is responsible for the preparation of management plans, through the agency of the Department, for all land vested in it
- a management plan must contain a statement of policies or guidelines to be followed in the management of the area, and a summary of the operations proposed to be taken over the life of the plan;
- a management plan for a national park or conservation park shall be designed to *"…fulfil so much of the demand for recreation by members of the public as is consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora and fauna and the preservation of any feature of archaeological, historic or scientific interest";* and
- a management plan for a nature reserve shall be designed to *"…to maintain and restore the natural environment, and to protect, care for, and promote the study of, indigenous flora and fauna, and to preserve any feature of archaeological, historic or scientific interest"*.

In relation to management plans for the lands vested in it, the functions of the Conservation Commission under section 19(1)(g) of the CALM Act are:

- to develop guidelines for monitoring and assessing the implementation of the management plans by the Department;
- to set performance criteria for assessing and auditing the performance of the Department in carrying out and complying with management plan(s); and
- to assess and audit the performance of the Department in carrying out and complying with management plan(s).

The CALM Act also covers such matters as defining categories of lands and waters managed by DEC, establishing controlling bodies, establishing and defining the functions of DEC and the controlling bodies, management planning and auditing, permits, licences, contracts, leases, offences and enforcement.

In addition to the CALM Act, there are other controlling legislation affecting the Department's activities or conferring specific powers on the Department.

The *Wildlife Conservation Act 1950* provides for specific protection of native flora and fauna on all lands and waters within the State boundaries. DEC is responsible for the administration of this Act and associated regulations for the conservation and protection of indigenous flora and fauna on all lands and waters within the State. It is probable that during the life of this management plan the Government will replace the Wildlife Conservation Act with new legislation to protect biodiversity. To that end, a consultation paper, outlining the intent of the proposed *Biodiversity Conservation Act,* was released in December 2002. The proposed legislation will seek *inter alia* to:

- strengthen special protection for identified threatened species, and extend this protection to threatened ecological communities;
- adopt common categorization for threatened species and ecological communities consistent with World Conservation Union (IUCN) standards; and
- list key threatening processes and enable regulations to be made to control threatening processes where they are impacting on biodiversity conservation.

The *Environmental Protection Act 1986* (EP Act) provides for protection of the environment across the State. The Act provides for the development of Environmental Protection Policies and the assessment of development proposals and planning schemes for potential environmental impacts. Any activity likely to have a significant effect on the environment can be referred to the **Environmental Protection Authority.** The Authority must then recommend whether the proposal be considered either informally or publicly.

Western Australian Planning Commission (WAPC) is the authority responsible for strategic land-use planning in Western Australia. In this respect, WAPC has prepared the following strategic plans for the region that encompass the Peel-Yalgorup Ramsar site:

- Inner Peel Region Structure Plan, 1997;
- Coastal and Lakelands Planning Strategy, 1997;
- Directions 2031 (in prep).

Among other things, these propose the protection of extensive areas within statutory reservations, including the Ramsar site and proposed extensions.

WAPC is also the authority responsible for the Peel Region Scheme (PRS) and Greater Bunbury Region Scheme (GBRS). Under these statutory planning schemes, the Ramsar site and proposed extensions are protected by the Regional Open Space (ROS) (Map 5) and waterways reservations. The purpose of the ROS reservation is to protect the natural environment, provide recreational opportunities, safeguard important landscapes and provide for public access. WAPC has controlled the use and development of the reserved areas for this purpose since the PRS and GBRS came into effect, in 2003 and 2007 respectively. Also, WAPC is progressively acquiring all private land (and waterways) within these reservations for direct protection through the schemes and manages such land pending its transfer to a permanent managing authority.

Department of Planning serves WAPC in relation to the above regional planning and land acquisition functions. It also manages unallocated Crown land within the area. It also controls subdivision on adjoining private land. Additionally, the Department of Transport has responsibilities in relation to infrastructure management, including boating facilities, moorings and jetties.

Under the Waterways Conservation Act 1976, **Department of Water** (DoW) is vested with responsibility for managing the Peel Inlet Management Area (Map 4) which includes the estuarine and freshwater sections of the Peel-Yalgorup Ramsar site.

To this end, the powers and functions of DoW are to:

- prepare and review management programs
- control pollution
- provide schemes directed at the abatement, control and prevention of litter and other forms of pollution
- arrange and establish public infrastructure facilities in cooperation with state and local agencies
- assess and issue approvals and licences for a broad range of activities in the waterways (such as dredging, reclamation, disposal of matter, retaining walls)
- provide advice on regional and strategic planning and development processes
- have regard to the terms of any relevant management program for the area in making its recommendations and in generally exercising its powers (Everall Consulting Biologists 2002).

DoW also oversees the Peel Inlet Management Council. The Council's main focus is on the Peel Inlet Management Area, although it plays a broader role in promoting the values and benefits of waterways and wetlands, working in partnership with stakeholders in the community and supporting effective and efficient management of natural resources in the Peel-Harvey catchment. The Council is an advisory committee established under the Water Agencies (Powers) Act 1984, reporting to Department of Water, and ultimately is an advisory committee of the Minister for Water Resources.

The Department's functions and powers closely align with the operations of other land and water management agencies. Since the Waterways Conservation Act 1976 was enacted, many of the powers and functions of the Department have been superseded by other complementary legislation. For example, the Environmental Protection Act 1986 includes provisions for pollution control under the jurisdiction of Department of Environment and Conservation. DoW has statutory management responsibilities for Lake McLarty (as part of the declared Peel Inlet Management Area), yet management functions at the Lake are largely overseen by the Department of Environment and Conservation.

Western Australian water resources legislation is currently undergoing review which may result in changes to the power and functions of DoW in managing the wetlands in the Peel Inlet Management Area.

Community stakeholders

Community-based stakeholders include organisations of varying size and with a range of roles and responsibilities.

Lake Mealup Preservation Society Inc. owns freehold land which is managed for the purpose of conservation. The whole of the Society's 123.68 ha property is protected as covenanted bushland through National Trust of Australia (WA) and is managed under its Management Plan for Covenanted Bushland at Lake Mealup, Pinjarra (LMPS 2003).

The Peel-Harvey Catchment Council (PHCC) plays a facilitating and coordinating role in natural resource management within the Peel-Harvey region. PHCC is an incorporated body comprising members of the community, as well as representatives of State and Local Government agencies. In 2005, PHCC prepared the Peel-Harvey Catchment Natural Resource Management Plan (draft for public comment) with a focus on priority assets and threats. The plan includes recommendations for priority project areas, including 'development of a management plan for the Ramsar-listed Peel-Yalgorup wetland system' (PHCC 2005 p. 56). The PHCC is responsible for the preparation of this management plan, under contract to the Commonwealth Government and South West Catchments Council.

The Peel-Yalgorup System falls within four local government areas: the City of Mandurah and the Shires of Murray, Waroona and Harvey. All four local authorities have management responsibilities for conservation and recreation reserves inside or adjacent to the Ramsar site (Figure 5).

In addition, there is extensive community participation in conservation-based community groups. The roles of these groups include protective works (such as planting, fencing and weed control), monitoring and research, awareness-raising and campaigning. Coordinated management of the Peel-Yalgorup System will provide an opportunity for local community groups to benefit from better communication of the regional, national and international importance of their contribution.

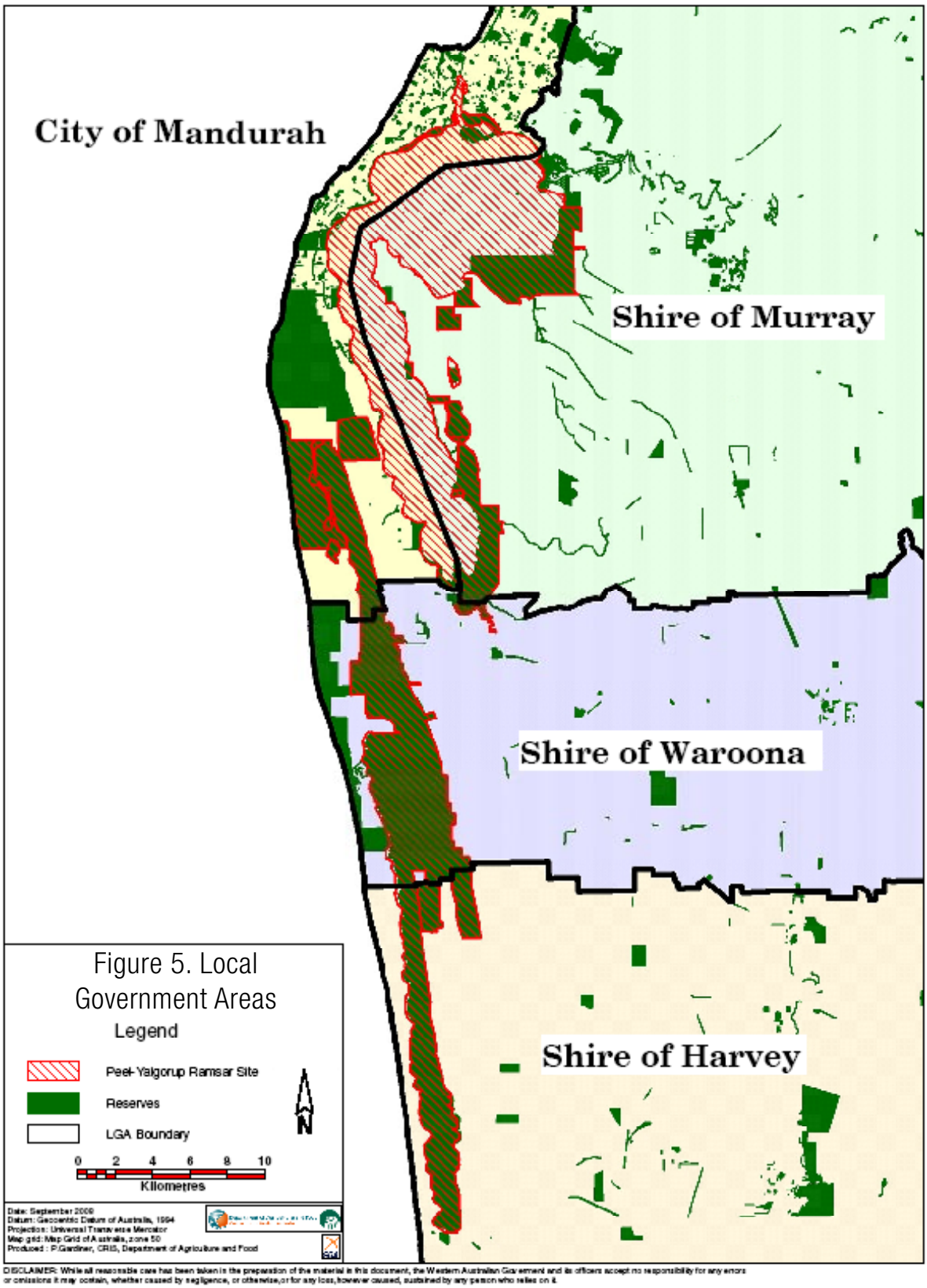

Figure 5. Local Government Areas

Policy and governance framework

Land-use planning policy

> 'Policies, institutions and governance aspects influence the kind of values that will be taken into account in decision-making and management measures.' (De Groot et al. 2006 p. 8).

A number of policy tools – aimed at protecting the Peel-Yalgorup System's wetland values—are already in place (Table 14). The following section provides a discussion of relevant policy tools in within the context of anthropogenic sources of threats.

Table 14: Policy framework: threats to the wetlands of the Peel-Yalgorup System

Threatening activity	Existing policy documents	Policy gaps
Agriculture	Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPA 1992a) Environmental Protection (Peel Inlet–Harvey Estuary Catchment) Policy 1992 (EPA 1992b) Peel Inlet and Harvey Estuary Management Strategy: Environmental Review and Management Program for the Peel-Harvey Estuary (1998) Draft Peel-Harvey Catchment Council NRM Plan (PHCC 2005) Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System (EPA 2008) Fertiliser Action Plan (JGFIWP 2007)	Sediment and siltation
Fisheries (commercial and recreational)	Environmental Protection (Peel Inlet–Harvey Estuary Catchment) Policy 1992 (EPA 1992b) West Coast Estuarine Fisheries Management Plan (Smith and Brown 2008)	
Urban and peri-urban development	Environmental Protection (Peel Inlet–Harvey Estuary Catchment) Policy 1992 (EPA 1992b) Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPA 1992a) Inner Peel Region Structure Plan (WAPC 1997) Coastal and Lakelands Planning Strategy (WAPC 1999a) State Planning Policy No. 2.1 Peel-Harvey (Coastal Plain Catchment) (WAPC 1999b) EPA Guidance Statement No. 28 (Protection of the Lake Clifton Catchment) State of Planning Policy 2.6 State Coastal Planning (EPA 1998) Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (EPA 2004) Stormwater Management Manual for Western Australia (DoW 2004) State Planning Policy No. 2.9: Water Resources (WAPC 2006) Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System (EPA 2008) Fertiliser Action Plan (JGFIWP 2007) EPA Guidance Statement No. 33 (EPA 2008) Water Sensitive Urban Design Technical Guidelines (PDC 2008) Various Local Planning Policies for the four local municipalities	Planning strategy for the Peel region (equivalent to Coastal and Lakelands Planning Strategy) Transparent guidelines for buffer determination specific to the Peel region
Recreation	Environmental Protection (Peel-Harvey Catchment) Policy 1992 Peel Waterways Economic Development and Recreation Management Plan (Everall Consulting Biologists 2002)	Estuary zoning plan or policy with reference to draft use classifications (Peel Regional Park)
Water resource management (including groundwater extraction)	State Water Strategy (DoW 2003) PHCC Drainage Reform Plan (Del Marco 2007) Murray River drainage and water management planning (DoW in prep) Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System (EPA 2008)	Review groundwater allocation from Lake Clifton subarea

Having established urban and peri-urban development as a key threat to the Peel-Yalgorup Ramsar site (Table 8), effective land-use planning policy and an adequately resourced planning system will prove crucial to protecting the ecological character of the Peel-Yalgorup Ramsar site.

The Yalgorup Lakes environment is strategically covered by the Coastal and Lakelands Planning Strategy and management of the Ramsar-listed area is undertaken in line with the Yalgorup National Park Plan. However, the Peel region is without a corresponding planning strategy. Furthermore, there is no equivalent up-to-date management plan for the estuarine portion of the Peel-Yalgorup System, although the Department of Water has recently announced its intention to revise its 1992 management program for the Peel-Inlet Management Area (see Table 12).

This gap is in part filled by the State of Play (URS 2007). This document provides guidance for land-use planning in the area adjacent to the estuary and Lakes McLarty and Mealup.

Furthermore, the Lake McLarty Nature Reserve Management Plan (DEC 2008, p. 12) outlines the position of DEC and the Western Australian Conservation Commission on future subdivisions surrounding the Lake: '…the Department and Conservation Commission will recommend that any future subdivisions will be subject to the principle of 'net conservation benefit'. The plan also recommends environmental conditions for proponents of nearby subdivisions.

Guidelines for wise use of the Peel-Yalgorup System

Finding a balance between competing demands on the wetlands of the Peel-Yalgorup System is a major goal of this management plan. In order to achieve this outcome, clearly defined boundaries and guidelines for land-use planning are required. The following guidelines build on the recommendations of the Department of Environment and Conservation's Lake McLarty Nature Reserve Management Plan (2008 p. 12). These guidelines aim to ensure that there is no 'net' loss of ecological, social or cultural values resulting from new developments.

Guidelines:

1. The geomorphic wetland boundary *of Wetland Buffers* (Essential Environmental Services 2005) and the EPA's Guidance Statement No 33;
2. fully revegetated setback zones, and an agreed and resourced plan for ongoing management of vegetated buffers, as a condition of development approval,
3. physical separation of private subdivisions from adjacent wetland areas by vehicle-access track and dog-proof fencing, as a condition of development approval,
4. public access associated with new urban and rural-residential developments limited to clearly designated access areas and walkways including fencing and gates to prevent domestic animal access in areas of high conservation value, and
5. best management practices for water-sensitive urban design applied in all new development applications and assessments.

Photo: Tony Kirkby

Planning process

Having long recognised the extensive and diverse range of management stakeholders, together with the need for effective communication and collaboration, the Peel-Harvey Catchment Council ensured that the preparation of this management plan encompassed broad stakeholder and community engagement.

A step-wise approach was established using guidance from the Ramsar Convention and from examples and case studies of other Ramsar sites in Australia and overseas. The key features of the approach included:

- *implementing a participatory and collaborative management approach*, including stakeholder mapping, establishing or continuing partnerships with State government agencies and local community groups; forming a Technical Advisory Group (comprising representatives of key stakeholder agencies and organisations), encouraging broader community engagement through workshops, public lectures and presentations along with other awareness raising actions (see Appendix B);
- *reviewing existing information about the ecological features* of the system (presented in the Ecological Character Description for the Peel-Yalgorup System) as per the recommendations of the Ramsar Convention and the EPBC Act;
- *investigating the current management context* including legislative and policy framework and local scale management programs;
- *identifying wetland values* by examining community perceptions and published literature, where available
- *prioritising wetland threats* to the ecological character of the System and its effective management, and
- *establishing an adaptive management approach* using test cases, pilot studies, review of best management practices and proposed regular reviews of the management plan, where funding permits.

This Plan takes a broad-scale focus in preparing recommendations for managing the wetlands together as a system. In this regard, the management plan is complemented by:

- Ecological Character Description for the Peel-Yalgorup System
- Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar Site (Hale 2008)
- A revised Ramsar Information Sheet (in preparation).

In addressing more specific needs at the local level this Plan refers to local scale management plans, where they exist (Figure 6).

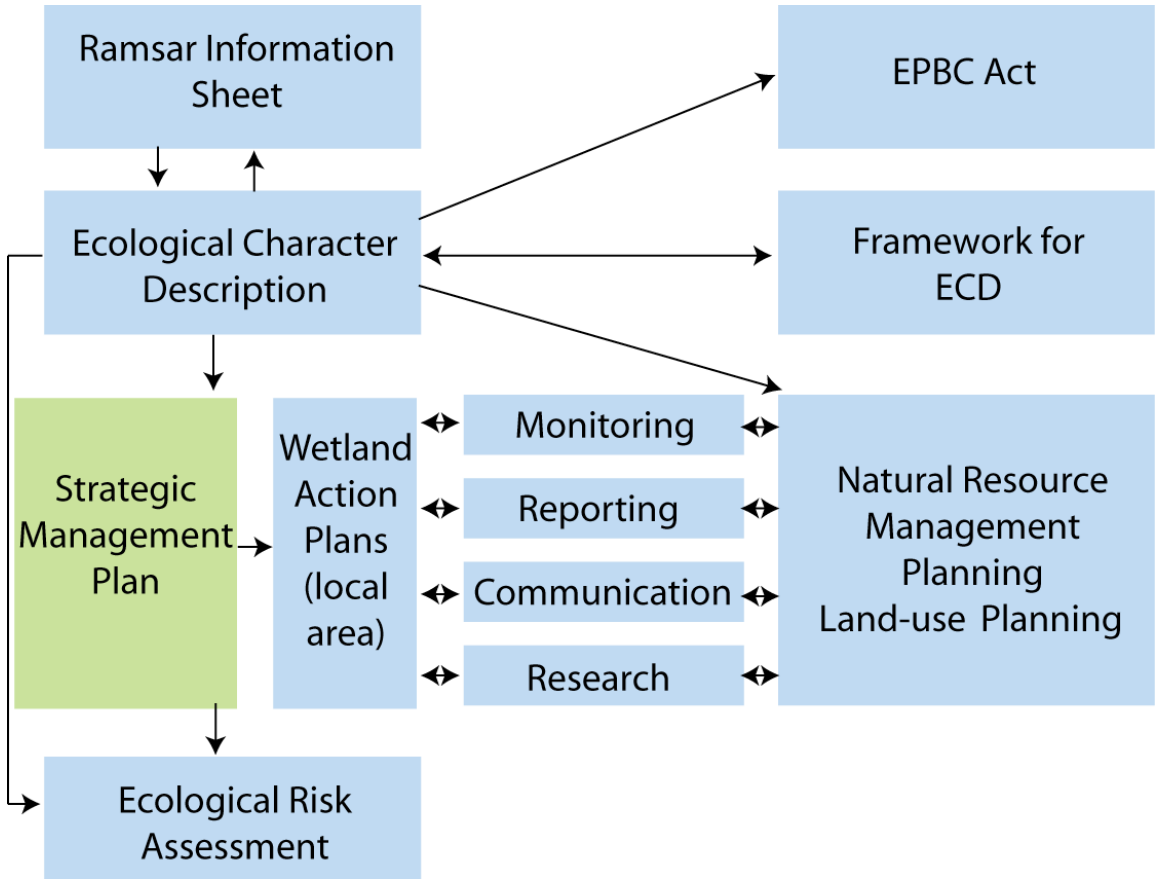

Figure 6. Conceptual framework for managing Ramsar sites in Australia (modified from Hale and Butcher 2007)

This section deals with two key elements of monitoring and evaluation:
1. Ecological Monitoring – to detect changes to the ecological character of the wetlands
2. Management Evaluation – within the context of adaptive management; to test review and continually revise the management program.

Ecological monitoring

Limits of acceptable change

By setting limits of acceptable change, wetland managers are able to identify changes in the ecological character of a wetland that are caused by human-induced impacts such as pollution or technological development (DEWHA 2008). Limits of acceptable change provide trigger values to alert managers of an unacceptable change in the ecological character of the wetland and the need for wetland managers to intervene (Hale and Butcher 2007).

For example, unusual changes in the numbers of Blue Manna crabs caught in the estuary may in part be a response to natural cycles – the *natural variability* of a population. The limits of acceptable change for Blue Manna crabs in the Peel-Yalgorup System (Peel-Harvey Estuary), 'median commercial CPUE blue swimmer crabs >= 1.0 kg/trap lift/yr, is set at a point which takes into account the natural variability of the population, but which is indicative of an unnatural change in the ecological character of the System.

Recent observations, published information and expert advice from the Peel-Yalgorup Ramsar Site Technical Advisory Group indicate that a number of parameters are currently outside the relevant limit of acceptable change (Table 15), including:

- salinity and nutrient concentrations in Yalgorup Lakes,
- typha and water quality (nutrients, pH and salinity) within the Lake McLarty System (specifically Lake Mealup), and
- water quality (nutrients) and phytoplankton at Goegrup and Black Lakes.

Table 15: Limits of acceptable change for the Peel-Yalgorup Ramsar site (after Hale and Butcher 2007). Parameters outside the prescribed limits are highlighted in red.

Component		Limit of Acceptable Change	Current status
Peel-Harvey Estuary	Nutrients	TP < 30 µg/L (maximum).	
		Median concentrations PO_4, NH_4, NO_x – all < 10 µg/L.	
	Dissolved oxygen	70% – 80% saturation.	
	pH	pH > 7 at all times.	
	Salinity	Winter salinity in the centre of the Peel Inlet and Harvey Estuary < 30 ppt for a minimum of 3 months. Water in the Harvey River mouth over winter < 3 ppt.	
	Phytoplankton	Chlorophyll a – median concentrations < 10 µg/L.	
	Seagrass	Current extent and biomass unknown.	Current Status Unknown
	Macroalgae	Current extent and biomass unknown.	Current Status Unknown
	Samphire	Current extent and biomass unknown.	Current Status Unknown
	Paperbark	Current extent and biomass unknown.	Current Status Unknown
	Invertebrates	Median CPUE* blue swimmer crabs >= 1.0 kg/trap lift/yr (commercial fishing).	
	Fish	Insufficient data to establish baseline.	Current Status Unknown

Component		Limit of Acceptable Change	Current status
Yalgorup Lakes	Nutrients	PO_4, NH_4, NO_x – median concentrations < 10 µg/L.	Current Status Unknown
	Salinity	Lake Clifton salinity < 35 ppt maximum and < 25 ppt during winter and spring.	
	Groundwater discharge	Data deficient.	Current Status Unknown
	pH	pH > 7 at all times.	Current Status Unknown
	Phytoplankton	Data deficient. Baseline must be set before limits can be made.	Current Status Unknown
	Macroalgae	Data deficient. Suggest no sustained epiphytic macroalgal growth on Thrombolites at Lake Clifton.	Current Status Unknown
	Invertebrates	Data deficient. Invertebrate populations sufficient to sustain waterbird populations should be maintained.	Current Status Unknown
	Fish	Data deficient. Baseline must be set before limits can be made.	Current Status Unknown
Lake McLarty System	Nutrients	PO_4 < 30 µg/L NH_4 < 40 µg/L NO_x < 100 µg/L All to be applied only when water levels are > 500 mm.	
	Salinity	Salinity under rush and sedge communities < 1 ppt. Salinity under paperbark communities < 0.5 ppt.	
	pH	pH > 7 at all times in Lake McLarty. Natural pH is between 7.2 and 8.5 for McLarty, but has declined to between 3.1 and 4 for Lake Mealup. A limit for Lake Mealup has not been set, but will need to be based on further investigative work.	
	Phytoplankton	Baseline must be set before limits can be made.	Current Status Unknown
	Aquatic plants	Greater than 50% of open water not covered in floating aquatic plants.	
	Littoral vegetation	Typha limited to < 20% of the wetland area. Freshwater sedges covering a minimum of 20% of the wetland area.	Current Status Unknown
	Paperbark	Data deficient. No decline in paperbark health or extent.	Current Status Unknown
	Invertebrates	Limit of acceptable change not able to be set. Invertebrate populations sufficient to sustain waterbird populations should be maintained.	Current Status Unknown
Lakes Goegrup and Black	Nutrients	PO_4, NH_4, NO_x – median concentrations < 10 µg/L.	
	pH	pH > 7 at all times.	Current Status Unknown
	Salinity	Data deficient.	Current Status Unknown
	Phytoplankton	Data deficient. Limit should be lower than current conditions. Further investigations should be undertaken in order to set realistic limits.	
	Samphire	Data deficient. Extent and distribution of samphire within patterns of natural variation.	Current Status Unknown
	Paperbark	No change in the condition of paperbark communities. Fringing areas of freshwater (47 ha) and saltwater paperbark (145 ha) communities. No loss of extent of paperbark communities.	Current Status Unknown Current Status Unknown
	Invertebrates	Data deficient. Invertebrate populations sufficient to sustain waterbird populations should be maintained.	Current Status Unknown
	Fish	Data deficient. Baseline must be set before limits can be made.	Current Status Unknown
	Waterbirds	Data deficient. Baseline must be set before limits can be made.	Current Status Unknown

= no evidence to indicate parameter is outside limit

Current Status Unknown = current condition unknown

= parameter may be beyond limits, further investigation required

* = catch per unit effort

Monitoring and evaluation guide

The 'Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar site' (Hale 2007) was prepared to accompany this management plan with the following objectives:

- inform management of the site against the limit(s) of acceptable change as detailed in the Ecological Character Description
- guide data collection in order to establish baseline conditions
- inform the refinement and review of the limit(s) of acceptable change.

The guide will underpin monitoring of the resource condition and well as the achievement of Management Goal 3: The ecological character of the Peel-Yalgorup System, including services and values, will be maintained or enhanced to achieve long-term positive outcomes.

Summary of knowledge gaps

In many instances, a lack of data has prohibited the setting of a trigger value or limit of acceptable change. Moreover, incomplete understanding of processes and threats (Hale and Butcher 2007) has prevented limits being set (see Wetland Threats). A list of priority monitoring needs and areas for further research are set out in the Ecological Character Description (Hale and Butcher 2007) and are reproduced below (Text Box 1 and Table 16).

Text Box 1:

Research needs identified in the Ecological Character Description for the Peel-Yalgorup Ramsar site

1. Acid sulphate sediments – High Priority
Based on the severity and extent of acid sulphate soils found by Sullivan et al. (2006) in their preliminary investigation of the Peel Inlet, they recommended an immediate investigation of the extent of disturbed acid sulphate soils, the actual and potential future impact of these soils and identification of remedial actions. In addition, the high concentrations of selenium associated with these soils also require investigation*. Given that this is a threat that is located within the Ramsar site and has the potential to negatively impact on the ecological character of the site, the recommended investigations of Sullivan et al. (2006) are considered a high priority.

2. Threats to the thrombolites at Lake Clifton – High Priority
The thrombolites at Lake Clifton represent a unique community. Increasing nutrients, increased salinity, Cladophora and Black Bream have all been identified as potential threats to the thrombolites at Lake Clifton. However, there is much about their ecological tolerances that remains unknown. As such, investigations into the actual threats to and condition of the thrombolites are considered a high priority.

3. Cattle grazing at Lakes McLarty and Mealup – High Priority
Controlled grazing is used as a management technique at Lake McLarty. However, there is evidence of increased eutrophication and altered vegetation communities at this wetland. Experience from other wetlands in Australia has indicated that cattle can cause damage to wetland systems and result in changes to ecological character. As such a targeted investigation into the effect of cattle grazing on the wetland is considered a high priority.

4. Effect of vegetation changes on non-wading waterbirds at Lake McLarty – Medium Priority
The vegetation at Lake McLarty has changed dramatically since the time of listing, with a loss of the once dominant sedge community. Although this may have benefited wading species of waterbird, it has potentially had a negative impact on others. Specifically, the Australasian Bittern was formerly a regular inhabitant and probable breeding species within the Ramsar site (R. Jaesch, Wetlands International, pers. comm.). With the loss of the sedges, it is likely that Australasian Bittern no longer inhabits the lake. This is consistent with an ongoing decline in the western population of Australasian Bittern, driven by habitat loss and changes. Given that there are many other areas within the Ramsar site that provide habitat for migratory waders, but none that offer the sedgeland habitat, an investigation into the effects on non-wading birds and the Australasian Bittern is considered a priority.

** Selenium concentrations are no-longer considered to be a significant threat (Kieryn Kilminster, pers. comm.).*

Table 16 Peel-Yalgorup System monitoring needs (Hale and Butcher 2007)

Component/Process	Purpose	Indicator	Priority
Peel-Harvey Estuary			
Water quality	Detection of change	pH, salinity, dissolved oxygen, turbidity, secchi depth, total and dissolved nutrients, chlorophyll a	High
Phytoplankton	Detection of change	Identification and enumeration	Medium
Aquatic plants	Establishment of a baseline and then detection of change	Distribution, composition and biomass	High
Littoral vegetation	Establishment of a baseline and then detection of change	Extent and condition of samphire and paperbark communities	High
Invertebrates	Establishment of a baseline and then detection of change	Composition and abundance	Low
Fish	Establishment of a baseline and then detection of change	Composition and abundance (protocol of Loneragan et al. 1986)	Medium
Waterbirds	Establishment of a baseline and then detection of change	Ground and aerial surveys of waterbird species and abundance Targeted surveys of breeding Emphasis on rigorous, objective-driven monitoring design	High
Yalgorup Lakes			
Hydrology	Establishment of a baseline and then detection of change	Lake and aquifer levels	High
Water quality	Establishment of a baseline and then detection of change	pH, salinity, dissolved oxygen, turbidity, total and dissolved nutrients, chlorophyll a	High
Aquatic plants	Establishment of a baseline and then detection of change	Distribution and composition	Medium
Littoral vegetation	Establishment of a baseline and then detection of change	Extent and condition of samphire and paperbark communities	Low
Invertebrates	Establishment of a baseline and then detection of change	Composition and abundance	Low
Fish	Establishment of a baseline and then detection of change	Composition and abundance	Low
Waterbirds	Detection of change	Ground and aerial surveys of waterbird species and abundance Targeted surveys of breeding Emphasis on rigorous, objective driven monitoring design	High
Lake McLarty System			
Hydrology	Establishment of a baseline and then detection of change	Lake and aquifer levels	High
Water quality	Establishment of a baseline and then detection of change	pH, salinity, dissolved oxygen, turbidity, total and dissolved nutrients, chlorophyll a	High
Littoral vegetation	Establishment of a baseline and then detection of change	Extent and condition of sedge, samphire and paperbark communities	High
Invertebrates	Establishment of a baseline and then detection of change	Composition and abundance	Low
Waterbirds	Detection of change	Ground and aerial surveys of waterbird species and abundance Targeted surveys of breeding Emphasis on rigorous, objective-driven monitoring design	High

Table 16 Peel-Yalgorup System monitoring needs (Hale and Butcher 2007)

Component/Process	Purpose	Indicator	Priority
Goegrup and Black Lakes			
Water quality	Establishment of a baseline and then detection of change	pH, salinity, dissolved oxygen, turbidity, secchi depth, total and dissolved nutrients, chlorophyll a	High
Phytoplankton	Detection of change	Identification and enumeration	Medium
Littoral vegetation	Detection of change	Extent and condition of samphire and paperbark communities	Medium
Invertebrates	Establishment of a baseline and then detection of change	Composition and abundance	Low
Fish	Establishment of a baseline and then detection of change	Composition and abundance (protocol of Loneragan et al. (1986)	Medium
Waterbirds	Establishment of a baseline and then detection of change	Ground and aerial surveys of waterbird species and abundance Targeted surveys of breeding Emphasis on rigorous, objective-driven monitoring design	High

Photo: Alex Hams

Glossary

After Department of Environment and Water (2007).

Administrative authority	an agency within each Contracting Party charged by the national government with oversight of implementation of the Ramsar Convention within its territory [http://www.ramsar.org/about/about_glossary.htm].
Adverse conditions	ecological conditions unusually hostile to the survival of plant or animal species, such as occur during severe weather like prolonged drought, flooding, cold (Ramsar Convention 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 2002a, Resolution VIII.6).
Baseline	condition at a starting point. For Ramsar wetlands it will usually be the time of listing of a Ramsar site (Lambert and Elix 2006).
Benchmark	a standard or point of reference (ANZECC and ARMCANZ 2000b). a pre-determined state to be achieved or maintained (based on the values to be protected) (Lambert and Elix 2006).
Benefits	benefits/services are defined in accordance with the Millennium Ecosystem Assessment definition of ecosystem services: 'the benefits that people receive from ecosystems' (Ramsar Convention 2005a, Resolution IX.1 Annex A). 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 (Ramsar Convention 2005b).
Biological diversity	the variability among living organisms from all sources including 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. This definition is based on the definition in Article 2 of the Convention on Biological Diversity (Ramsar Convention 2005b).
Catchment	total area draining into a river, reservoir or other body of water (ANZECC and ARMCANZ 2000a).
Change in ecological character	the human-induced adverse alteration of any ecosystem component, process, and/or ecosystem benefit/service (Ramsar Convention 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 2000a).
Community composition	all the types of taxa present in a community (ANZECC and ARMCANZ 2000a).
Community structure	all the types of taxa present in a community and their relative abundances (ANZECC and ARMCANZ 2000a).
Conceptual model	a wetland conceptual model expresses ideas about components and processes deemed important for wetland ecosystems (Gross 2003).

Contracting parties	countries that are Member States to the Ramsar Convention on Wetlands. There were 153 as at September 2006. Membership in the Convention is open to all states that are members of the United Nations, one of the UN specialised agencies, or the International Atomic Energy Agency, or is a Party to the Statute of the International Court of Justice [http://www.ramsar.org/key_cp_e.htm].
Critical stage	stages of the life cycle of wetland-dependent species (breeding, migration stopovers, moulting) which if interrupted or prevented from occurring may threaten the long-term conservation of the species (Ramsar Convention 2005b).
Ecological character	the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time. The phrase 'at a given point in time' refers to Resolution VI.1 paragraph 2.1, which states that 'It is essential that the ecological character of a site be described by the Contracting Party concerned at the time of designation for the Ramsar List, by completion of the Information Sheet on Ramsar Wetlands (as adopted by Recommendation IV. 7)'.
Ecological communities	any naturally occurring group of species inhabiting a common environment, interacting with each other especially through food relationships and relatively independent of other groups. Ecological communities may be of varying sizes, and larger ones may contain smaller ones (Ramsar Convention 2005b).
Ecosystems	the complex of living communities (including human communities) and non-living environment (ecosystem components) interacting (through ecological processes) as a functional unit which provides a variety of benefits to people (ecosystem services). (Millennium Ecosystem Assessment 2005).
Ecosystem components	the physical, chemical and biological parts of a wetland (from large scale to very small scale, e.g. habitat, species, genes) (Millennium Ecosystem Assessment 2005).
Ecosystem processes	the changes or reactions which occur naturally within wetland systems. They may be physical, chemical or biological (Ramsar Convention 1996, Resolution VI.1 Annex A). They include all those processes that occur between organisms and within and between populations and communities, including interactions with the non-living environment, that result in existing ecosystems and bring about changes in ecosystems over time (Australian Heritage Commission 2002).
Ecosystem services	the benefits that people receive or obtain from an ecosystem. The components of ecosystem services are provisioning (e.g. food, water), regulating (e.g. flood control), cultural (e.g. spiritual, recreational), and supporting (e.g. nutrient cycling, ecological value). (Millennium Ecosystem Assessment 2005a). See also 'Benefits'.
Ecologically sustainable development	development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ANZECC and ARMCANZ 2000a).
Fluvial geomorphology	the study of water-shaped landforms (Gordon et al. 1999).
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 (Ramsar Convention 2005b).
Indigenous species	a species that originates and occurs naturally in a particular country (Ramsar Convention 2005b).
Introduced (non-native) species	a species that does not originate or occur naturally in a particular country (Ramsar Convention 2005b).

List of Wetlands of International Importance ('the Ramsar List')	the list of wetlands 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 [http://www.ramsar.org/about/about_glossary.htm].
Monitoring	collecting specific information for management purposes in response to hypotheses derived from assessment activities, and using these monitoring results for implementing management (Ramsar Convention 2002, Resolution VIII.6).
Piscivorus	fish-eating.
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' [http://www.ramsar.org/about/about_glossary.htm].
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. http://www.ramsar.org/about/about_glossary.htm
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 more commonly used [http://www.ramsar.org/index_very_key_docs.htm].
Ramsar Information Sheet (RIS)	the form upon which Contracting Parties record relevant data on proposed wetland(s) of international importance for inclusion in the Ramsar Sites Database. Includes identifying details like geographical coordinates and surface area; criteria for inclusion in the Ramsar List; wetland types , hydrological, ecological and socioeconomic issues; ownership and jurisdictions; and conservation measures taken and needed (http://www.ramsar.org/about/about_glossary.htm).
Ramsar List	the List of Wetlands of International Importance [http://www.ramsar.org/about/about_glossary.htm].
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 [http://www.ramsar.org/about/about_glossary.htm].
Ramsar Sites Database	repository of ecological, biological, socio-economic and political data and maps with boundaries on all Ramsar sites, maintained by Wetlands International in Wageningen, the Netherlands, under contract to the Convention [http://www.ramsar.org/about/about_glossary.htm].
Wetland	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 (Ramsar Convention 1987).
Wetland Assessment	the identification of the status of and threats to wetlands as a basis for the collection of more specific information through monitoring activities (Finlayson et al. 2001; Ramsar Convention 2002a).
Wetland Ecological Risk Assessment	a quantitative or qualitative evaluation of the actual or potential adverse effects of stressors on a wetland ecosystem (DEW 2007).
Wetland types	defined by the Ramsar Convention's wetland classification system [http://www.ramsar.org/ris/key_ris.htm#type].

Wise use of wetlands	the maintenance of the ecological character of wetlands, achieved through the implementation of ecosystem approaches within the context of sustainable development (Ramsar Convention 2005a Resolution IX.1 Annex A). The phrase 'within the context of sustainable development' is intended to recognise that whilst some wetland development is inevitable and that many developments have important benefits to society, developments can be facilitated in sustainable ways by approaches elaborated under the Convention. It is not appropriate to imply that development is an objective for every wetland.

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Photo: Bill Russell

Appendix A: Community Values

a summary of community consultation on wetlands in the Peel-Harvey Region

Purpose and Process	Participants	Relevant findings
Peel Regional Park Plan: working paper final report (ERM 2005a) and Peel Regional Park Plan: Community Workshops Outcomes Report (ERM 2005b)		
The Peel Regional Park working paper provided background information for stakeholders at community consultation workshops in April 2005. The outcomes report summarises key issues identified through stakeholder consultation and pertinent background information.	Representatives of wide ranging interest groups: community, recreation, heritage, environment, business, ratepayers and committee representatives, government agencies and utilities.	Outcomes of the community consultation workshops: • values of the Peel Regional Park identified • specific issues were ranked as high, medium or low priority • discussion of land tenure, acquisition and compensation concerns • visions established for the future of the Peel Regional Park. Key Issues: Six general issues emerged from the December 2003 consultations: environmental, landscape, social, economic, management and land tenure. Specific issues included the conservation and protection of Ramsar wetlands and the protection and management of foreshores. Each specific issue was rated as high, medium or low priority. High priority issues identified at both the Mandurah and Ravenswood workshops included: • conservation and protection of waterways and wetlands (including water quality) and provision of buffer zones • protection of conservation values of the Park • provision of adequate boating facilities • protection of native vegetation. Vision: Ravenswood: The Peel Regional Park is a unique and healthy waterways environment of great biodiversity, valued by the community with a balance of conservation, recreation and social assets, and should be managed in a sustainable manner. Mandurah: The Peel Regional Park is an area that has cultural, historical, recreational, ecological and economic value that will be managed sustainably to preserve and restore its integrity for the benefit of existing and future generations.

Purpose and Process	Participants	Relevant findings
Indigenous Heritage of Peel-Harvey Region, a review of previous research and archival data (Dortch et al 2006)		
This document outlines knowledge of the Aboriginal cultural landscape in the Peel-Harvey region. It forms the first phase of a broader, ongoing process. Phase 1 included preliminary consultation, a review of previous studies detailing the project's environmental and cultural context and mapping of recorded heritage sites.	Peel-Harvey Catchment Council, Peel Development Commission, South West Aboriginal Land and Sea Council, South West Catchments Council, Bilya Noongar Organisation Inc., Department of Indigenous Affairs, Tourism Western Australia, Department of Environment and Conservation.	Provides a summary of the Indigenous community's views and visions of current land management practices. Provides a detailed proposal for a heritage trail along the eastern foreshore of Peel-Harvey Estuary.
Indigenous Heritage of Peel-Harvey Region: regional cultural heritage model (Dortch et al 2007)		
This document outlines Phase 4 of the Indigenous cultural landscape assessment and builds on the previous phases by developing a regional cultural heritage model.	Indigenous custodians.	The report describes the cultural heritage landscape as being in good condition. However, future changes to the landscape, including proposed urban development create threats to Noongar access to country and bring risks of damage to sites. Indigenous custodians of the Noongar community must be involved at every level: from land management to on-ground options. Three ways were identified by Noongar custodians to revitalise the cultural heritage landscape of the Study area: • development of a Noongar cultural heritage trail • development of Noongar cultural heritage centre • Noongar input into land management.
An Indigenous heritage management plan for the eastern foreshores of the Peel and Harvey Inlets (Cuthbert et al 2007)		
This document summarises Phase 5 of the cultural assessment project.	Noongar custodians, state and local government agencies.	Document outlines 33 specific management actions are grouped under the following headings: • project management • protection of Aboriginal sites • protection of natural resources and the cultural heritage landscape • acquisition of land • heritage trail • cultural centre. Key opportunities: • open space planning and conservation corridor • route of heritage trail recommended by custodians • indicative alignment of heritage trail.
Peel 2020 Sustainability Strategy: Peel 2020 Vision (Peel Development Commission, unpublished)		
Summarises environmental, economic and social aspirations developed through community consultation. Also provides a vision for each aspiration and a Peel 2020 vision framework.	Consultation with a broad cross-section of the local community.	This report summarise the development of a Peel 2020 vision framework and summarises seven 'whole of partnership' first steps including: • regional land-use planning to protect the landscape and community diversity • building a sense of caring and stewardship for the land.

Purpose and Process	Participants	Relevant findings
Peel Sustainable Development Plan 2020 Issues Paper (Peel Development Commission 2002a) and Peel Sustainable Development Plan 2020 Discussion Paper (Peel Development Commission 2002b)		
The two documents provide the first steps towards a sustainable development plan for the Peel Region (to 2020). The plan was not produced in isolation. It recognises efforts already undertaken to address key issues. It builds on previous efforts to identify issues, priorities and strategic actions. The Serpentine and Murray rivers are rated as two of the 'sickest' rivers in the State. Aim: to seek agreement on collaborative actions and promote role of stakeholders in implementing the sustainable development plan.	Consultation with established groups and individuals representing the local community.	The Issues Paper (the basis for the broadly circulated Discussion Paper) contains goals, indicators and short- and medium-term actions for priority issues, including: • transport infrastructure • land-use planning • Indigenous communities • youth issues • education and skills development • governance.
Peel Sustainable Development Strategy 2020 Phase 1 (Peel Development Commission 2002c) and Peel 2020 Sustainability Strategy, Final Report (Peel Development Commission 2006)		
Builds on consultative documents to provide a strategy for sustainable development in the Peel Region.	Active working groups including representatives of community, government, industry and non-government organisations. Open public comment period.	Immediate-, short-, medium- and long-term actions were identified. In addition to the issues identified in the Issues Paper (see above) the Strategy identified environmental, economic and socio-cultural priorities. Specific environmental priorities included: • balancing population demands with environmental requirements • long-term integrated regional and local planning to protect • the whole catchment • improving water management • protecting biodiversity threatened by rapid development • implementing opportunities for conservations and development for long-term positive impact.
The Peel 2020 Project: Where Are We Now? an environmental, social and economic overview of the Peel Region (Peel Development Commission 2005)		
An overview of the status of the Peel 2020 planning process.	Working groups, specific consultation and written agency responses.	Identified the status of major issues within three key themes: environmental (Our Environment), social (Our Community) and economic (Our Economy) and provided a baseline for consideration of future trends. With respect to the environment: range of stakeholder programs including establishment of Peel-Harvey Catchment Council, $2.1 million State/Federal Government Coastal Catchment Initiative. Actions in place included: Peel Bush Plan, Coastal Catchments Initiative, implementation of Economic Development and Recreation Management Plan. Planning processes included: Peel Waterways Institute and the Pinjarra-Brunswick Sustainable Communities Strategy.

Purpose and Process	Participants	Relevant findings
Bushland Protection Strategy discussion paper (City of Mandurah 2003)		
Response by City of Mandurah to the public's call for bushland protection.	Public consultation with local community members.	The plan was prompted in recognition of important bushland values after loss of native flora and fauna was rated by the community as an important concern (fourth in a survey undertaken by the City in 1997). Similarly, retention of native bushland was the highest priority noted in the *Indicators of a Sustainable Community* survey (City of Mandurah, 2001). The City of Mandurah considers bush to be a major community resource and part of the city's heritage. It recognises the environmental, social, cultural and economic value of local native vegetation. The strategy sets out assessment criteria for prioritising bushland reserves and identifies funding opportunities to aid bushland protection. Anticipated outcomes of bushland protection: • maintain and enhance Mandurah's character and livability • protect biodiversity and maintain ecological processes • maintain sustainable ecosystems • reduce habitat loss and/or degradation • buffer significant habitat areas from the impacts of urbanisation • provide an ecologically sustainable resource for compatible ecotourism, nature-based recreation and community education.
Peel SISTEM; Peel Strategic Information System (Peel Development Commission 2000)		
The Peel Strategic Information System builds on the Peel Economic Development Strategy (Peel Development Commission 1996). The Peel SISTEM is an interactive, online database developed in response to community demand for an accessible strategy document. It details the progress of development initiatives across all sectors and areas of the region.	Local and state organisations as well as all levels of community.	The database offers current information on the implementation of the Peel Economic Development Strategy. The strategy deals with ten key areas: 1. agriculture 2. mining 3. industry and commerce 4. tourism 5. fishing and aquaculture 6. forestry and forest products 7. environment 8. water resources 9. community and social infrastructure 10. public infrastructure. The vision for the environment sector: to better manage and protect the region's unique environment, effecting repairs where possible. The environment sector has eight key objectives including conservation of the region's flora and fauna. Vision for the water resources sector: to ensure that the region's surface and ground water resources are managed and protected and to ensure a sustainable and adequate water supply. This sector has six key objectives including better management of water catchment areas. The database specifies progress (current, planned or required) against each activity set out in the strategy. Key achievements are included for all sectors. In 2000, key achievements for the environment sectors included formation of the Peel-Harvey Catchment Coordinating Council (PHCCC), and the 'Save the Serpentine' Project.

Purpose and Process	Participants	Relevant findings
Economic Development and Recreation Management Plan for the Peel Waterways (Everall Consulting Biologists 2002)		
The Economic Development and and Recreation Management Plan (EDRMP) was established with a goal of achieving clear and planned use of the waterways. It builds on the Draft Strategic Plan 2000–2005 (PIMA 1999) for the Peel Inlet Management Area but was prepared in the knowledge that a future management plan for the (proposed) Peel Regional Park would provide overarching strategies for managing the waterways. It was envisaged that the EDRMP would help guide the Peel Regional Park planning process by providing general strategies for environmental management (particularly with respect to recreational use). Community consultation included workshops, a questionnaire, meetings with stakeholders, media/awareness raising.	Peel region community and state government.	The EDRMP identifies current and potential employment, economic development and recreation opportunities associated with the region's waterways. It also evaluates current and future development opportunities. Predictions of population growth and environmental change were identified as the main threats to sustainability of the recreation resources of the waterways. A recommendation of this plan is to encourage the private sector to participate in remediation, management and provision of recreational services for the waterways. The key finding of this report is that without corrective action, the Peel waterways will not be able to sustain the increased recreational demands of population growth. Rehabilitation of parts of the environment is required before increased recreational use can be accommodated. Strategic directions of the plan: 1. Ensure land east of the estuary to Peel Highway Deviation is properly planned. 2. Encourage large-scale reafforestation and revegetation programs on public and private lands east of estuary, along rivers and as buffers. 3. Rehabilitate and enhance riparian habitats on rivers and fish habitats. 4. Review major strategic sites around waterways to ensure planning reflects the highest and best usage for regional needs in the future. 5. Relocate some facilities and provide new ones in appropriate areas to redirect use pressures that are damaging the environment. 6. Encourage new opportunities in recreation and environmental awareness in areas which can sustain such use. 7. Promote community awareness and participation in management and leadership in rehabilitation, research, education, eco-tourism and the economic development of waterways. 8. Conduct scientific research into all aspects of waterways management and maintenance and restoration of a healthy ecosystem. Policy areas include marine conservation, foreshore recreation, river environs, town centre-waterways precinct, general purpose marine, catchment management, heritage conservation, special boating areas, low wash zone and strategic sites. Criteria for all policy areas: • no adverse impacts • use is sustainable • proposals or uses meet overall objectives of the policy area • proposals or uses meet applicable guidelines, policy or guidelines. A retrieval matrix identifies uses which are compatible (under controlled conditions) or not compatible with the objectives for the waterways. For example, angling is rated as a use compatible with marine conservation, foreshore recreation, river environs, town centre-waterways, general purpose marine, catchment management and low wash zone, but incompatible with special boating areas.

Purpose and Process	Participants	Relevant findings
Peel Away the Mask: A Study of the Social Condition of the Peel Region (Lucks and Durack 2001)		
This study provides a snapshot of the social condition of the Peel region with the aim of identifying the current condition of a community and to assess priorities for action. The study was developed around five 'quality of life' indicators used by the United Nations: health and community services; housing, safety and security; education; income and employment.	Special interest groups; Aboriginal people; organisations; individuals (community members), regional agencies.	Findings justified urgent action and more specific research into major gap areas related to five 'quality of life' indicators. The environment/wetlands were not a specific focus although relevant results including the following: • Housing is closely linked to the social, economic and environmental challenges facing the Peel region (a primary research finding). • Advertising of housing estates attracting many people to the region promotes the concept that it is a place of increasing urban sprawl (a secondary data finding).
Peel Regional Park Plan Draft Use Classifications (Department Planning and Infrastructure, unpublished)		
Details concepts for the Peel Regional Park as a basis for subsequent proposals for land/water use classification and guidelines.		Key recommendations: The upper reaches of Serpentine River (including adjacent terrestrial environment) contain some of the most intact conservation and landscape values in the Peel Regional Park. Protection of these values is a high priority. Conservation values should be protected while providing opportunities for recreation and enjoyment in the proposed Amarillo Estate. The protection and enhancement of values of the lower Serpentine River and foreshores should be a priority. The protection of landscape values of the delta islands of Murray River are high priority. The land on the southern and eastern shores of Peel Inlet has high conservation values that require protection. The Creery Wetlands have very high conservation and landscape values that need to be protected. The natural values of Harvey River need to be improved to achieve landscape, recreation and environmental benefits while retaining its drainage function. Planning in reserves south of the Dawesville Channel should focus on landscape value and passive recreation. Although the entire Park has high landscape value, four areas are recognised as 'landscape icons' for the Peel Regional Park: • upper reaches of the Serpentine River • Murray River Delta Islands • upper reaches of the Murray River • eastern side of the Harvey Estuary. Classifications for implementing policies and guidelines – Conservation (management access only): full emphasis on conservation. Designated areas include upper reaches of Serpentine River, Creery Wetlands and Channel Islands, Lakes McLarty and Mealup, parts of the Murray River delta and the southern/eastern shores of the Peel-Harvey Estuary. Conservation (limited access): applies to a high proportion of land and waterways in Peel Regional Park including Goegrup and Black Lakes, North Yunderup wetlands, Culeenup Island, Creery Wetlands, Len Howard Conservation Park, forest on the eastern side of Harvey Estuary and Island Point area. Conservation (nature appreciation): recultivation of remnant natural values with general access. Includes Ward Point, Murray Lakes floodway, Dandalup River. *(continued next page)*

Purpose and Process	Participants	Relevant findings
Peel Regional Park Plan Draft Use Classifications (Department Planning and Infrastructure, unpublished) Continued		
		Multiple Use (natural theme): applies to a high proportion of waterway fringes, predominantly along Murray and Harvey rivers Multiple Use (urban parkland): emphasis on leisure and recreation uses. Many of these areas coincide with existing urban development, many of which provide habitats for birdlife. Includes foreshore areas at Novara, Coodanup, Nairns and Ravenswood. Leisure Activity and Open Space Areas: recognises that the growing population requires new areas of open space. Softer landscape to be maintained, greater use of exotic plants and trees but remnant vegetation will be protected. Includes Ravenswood Fields. Landscape Protection Area (pastoral theme): Preservation of pastoral landscape providing for passive recreation. Includes areas located on Murray River at Ravenswood and Pinjarra.

Photo: Amanda Wilmott

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Photo: Bill Russell

Appendix B: Stages in the Peel-Yalgorup Ramsar site management planning process

Stakeholder engagement began in June 2007 with the aim of improving the collaboration between various government, non-government and community stakeholders in managing the wetlands in the Ramsar listed wetland system and to ensure that the management planning process was considerate of broad-ranging existing and future needs. In July 2007 Sustainable Development Facilitation was contracted by the Peel–Harvey Catchment Council (PHCC) to guide stakeholder engagement in the management planning process for the Peel–Yalgorup Ramsar site.

The stakeholder engagement process was underpinned by key stages:

1. Scoping
2. Identifying the Stakeholders
3. Consultation and Community Engagement
4. Analysis
5. Building Commitment
6. Formulating the Management Plan.

Stage 1: Scoping

Initial meetings between PHCC staff Kim Wilson and Amanda Willmott and Sustainable Development Facilitation were held in July and August 2007. The aim of the initial meetings was to uncover the opportunities for stakeholder involvement in the management planning process.

Consideration was given to:

- relevant planning and consultation processes previously undertaken in the Peel region (such as Peel 2020, Peel Infrastructure Study and the State of Play: Eastern Estuary Environmental Assessment)
- the short timeframe for preparation of a Peel–Yalgorup Ramsar site management plan.

It was decided that building from previous consultations would address these considerations while also minimise duplication and consultation fatigue.

A literature review (See Appendix A) was undertaken with the aim of generating a better understanding of previous consultations, stakeholder mapping/dynamics and key findings. In particular, key findings relating to community values and community perceptions of threats and management issues were examined.

Additional considerations in shaping the process of stakeholder engagement included:

- the need to couple stakeholder engagement with awareness raising, particularly among decision-makers in biodiversity conservation and land-use planning
- opportunities for connecting with decision-makers, through direct contact or secondary contact via partner organisations, and through the wider general public.

As a result of this scoping stage, it was decided to focus primarily on key decision-makers and management stakeholders with a view to broaden the collaboration with the wider community after the release of the management plan.

Stage 2: Identifying the Stakeholders

The PHCC's community database of approximately 300 individuals was used to identify likely stakeholders. Together, Sustainable Development Facilitation and the PHCC identified 'stakeholder groups' by clarifying each group's roles and responsibilities in managing the Peel–Yalgorup System and their anticipated level of interest in participating in the management planning process. (See Table 13)

Stakeholders identified included the following

- principal stakeholders (organisations with direct management responsibility)
- community groups
- community natural resource management groups
- local governments with direct management responsibilities
- local governments (within the broader Peel–Harvey Catchment)
- locally-based advocacy groups
- broader-level advocacy groups
- Indigenous custodians
- government agencies with direct management responsibilities
- government agencies (whose actions/core business may affect the management or ecological health of the wetlands)
- business.

The first step towards establishing an engaged stakeholder network was direct communication by way of a questionnaire and letter of invitation to participate. In early October 2007, 245 key stakeholders were mailed a questionnaire and electronic presentation featuring background information on the Ramsar Convention, the features of the Peel–Yalgorup Ramsar site and the driving forces for preparation of a site-specific management plan. The questionnaire asked respondents to consider their roles and responsibilities in relation to the protection of the Peel–Yalgorup Ramsar site.

The response rate to the questionnaire (29%) included a promising response from locally-based advocacy groups (78%), broader-level advocacy groups (62%) and government agencies with direct management responsibility (50%).

The Peel–Yalgorup Ramsar Site Technical Advisory Group (TAG), established in June 2007, was convened in a meeting in November 2007 to consider the questionnaire results and the responses of various stakeholders. After considering questionnaire feedback, TAG group members identified six management priorities for the Peel-Yalgorup Ramsar site as shown in Table A1.

Table A1: Management priorities
1. Clear Guiding Principles: recommendation for action, statutory processes
2. High Level Strategic Commitment: State/Federal, Local Government, Planning Agencies
3. Community Engagement: leading to political pressure and local action
4. Performance Targets and Monitoring: ensuring a flexible and tailored management approach
5. Increased Resources: incuding Enterprise and Business Involvement
6. Clear Boundaries: what is part of the System, extend, define, agree, promote, promoting the role of the System as part as part of the larger catchment.

Stage 3: Consultation and Community Engagement

Community workshop
On 7 December 2007, approximately 100 community, government, business and NGO representatives attended the management planning workshop for the Peel-Yalgorup Ramsar site at the Coodanup Community Centre in Mandurah. The workshop featured a presentation and feedback session where participants formed small groups to discuss the management priorities for the Ramsar-listed Peel-Yalgorup System.

The workshop was held as part of the PHCC's Annual Community Forum to provide greater opportunity for stakeholder attendance and to minimise stakeholder consultation fatigue.

The workshop was given high priority in the Annual Community Forum agenda, running in the morning for two hours. Participants in the workshop included stakeholders of the Ramsar planning process and PHCC guests who had been invited to attend the full day event. This mix of participants provided access to a broad community audience.

The workshop aimed to:

1. Clarify and re-affirm the management vision for the Peel–Yalgorup Ramsar site.
2. Identify the objectives and management priorities that will feed into a strategic and action-oriented management plan.
3. Build commitment for management planning and stewardship for the wetlands in the system.

Community lectures and public presentations
PHCC conducted a series of public lectures to inform and educate the public about the Ramsar Convention and the internationally important Peel–Yalgorup System. Three public lectures were undertaken during the planning process:

- June 2007, to discuss the preparation of an ecological character description.
- January 2008, to discuss the findings of the draft *Ecological Character Description for the Peel-Yalgorup Ramsar Site* (Hale and Butcher, 2007).
- July 2008, to discuss the management planning process.

In addition, officers of the PHCC made contact with the four local governments with direct influence on the management of the System: the City of Mandurah and the Shires of Murray, Waroona and Harvey.

Public awareness (displays)
Public awareness displays were created at a variety of events including Crabfest (2006, 2007 and 2008); providing an ideal venue and context to survey local people and determine the level of community awareness about the Ramsar Convention and the wetlands in the Peel–Yalgorup System.

Passers-by at the PHCC stand were invited to place a sticker on butchers' paper to indicate their level of understanding about 'Ramsar' and about the international importance of the wetlands in the Peel–Yalgorup System.

Over 80% of respondents were unaware of the international importance of the Peel–Harvey Estuary. More than 100 people were surveyed over the two-day event.

Local media
The local media have formed an integral part of the awareness raising actions undertaken as part of the planning process.

For example, the results of the informal survey conducted at Crabfest were used as a basis for a media article that was published in the Coastal Times newspaper on 28 March 2008. The purpose of the article was to inform the local community about the Ramsar Convention and to highlight the value of the Peel–Yalgorup System and that they are living in an area which contains an internationally significant wetland area.

Stage 4: Analysis

Vision
Giving consideration to the results of previous community consultations (see Stage 1) a draft vision was prepared as a basis for consultation during the management planning community workshop for the Peel-Yalgorup Ramsar site (see Stage 3).

> We value the Peel–Yalgorup Wetland System for its biodiversity and ecology, and worldwide recognition as a major environmental asset. Its diverse waterways must be used wisely and its flora and fauna must be conserved and protected for long term positive impact.

Comments from participants were centred on the following key points.

- Greater emphasis should be placed on wetland 'services' (how the wetlands are used by communities).
- The human element should be encouraged as a means of giving the vision more meaning and passion.
- The term 'impact' is often perceived negatively; alternatives such as 'outcomes' were suggested.

The final vision: The Peel-Yalgorup is internationally recognised as a major environmental asset and is highly valued for its ecological, social, cultural and economic benefits. The diverse wetlands and waterways are managed wisely as a place and space for all to play, learn and live in a sustainable way. We acknowledge our stewardship role in the conservation and protection of the land, water, flora and fauna for the long term.

Management priorities
Participants were asked to rank management priorities (Table A1) before engaging in group discussion. Following the set discussion time, individuals were asked to re-prioritise. This step was taken to gauge the impact of group discussion and collaboration. The results revealed, in some instances, marked changes to individual rankings taken before and after the group discussion.

Feedback included the following key points:

- Clear guiding principles are the highest priority: they are critical to establishing effective planning objectives.
- Secondary to clear guiding principles are high level strategic commitment and the need for clear boundaries.
- Community engagement is important for ensuring successful management.

Interpretation of the results was straightforward. Once clear objectives and policies are established the next logical steps were to define where the objectives need to be carried out and to lobby for strategic commitment to build support for the management of the wetlands. Most of the written comments from the workshop suggested that building high level strategic commitment is essential.

Establishing and carrying out a community engagement process was considered to be of high importance because it is the catalyst to develop wider support and build awareness of the importance of 'stewardship'.

A number of comments indicated indecision in ranking clear boundaries and high level strategic commitment. Comments such as 'we need to know what is protected' and 'we need to know where' were examples of why some people thought clear boundaries ought to rank higher than high level strategic commitment. For others, however, clear boundaries were not viewed as such a critical priority. Comments such as 'don't set (the boundaries) in concrete, be flexible' and 'there's only one target' suggests that some participants perceived high level strategic commitment to be of higher importance.

While performance targets and monitoring were considered to be important, comments indicated these were lower in priority although evaluation was recognised as an important part of the ensuing management plan.

Few comments were made on the level of resourcing for managing the Ramsar site. Yet raising awareness and behaviour change will be crucial to achieving management aims. One respondent queried whether any increase in resources is required at all.

Table A2: Management priorities (based on wide community consultation)
1. Clear Guiding Principles: recommendation for action, statutory processes
2. High Level Strategic Commitment: State, Federal and Local Governments (including planning agencies)
3. Community Engagement: leading to political pressure and local action
4. Clear Boundaries: what is part of the System, extend, define, agree, promote
5. Performance Targets and Monitoring: implementing adaptive management
6. Increased Resources: including enterprise and business involvement

In addition to the six priorities, a number of additional priorities were raised by groups and individuals participating in the survey. They included raising community awareness through media support, awareness-raising among State and Federal politicians, education, climate change, Indigenous consultation, stewardship, research and development, restricting urban development and regulation/policing. Table 2 presents the re-ordered list of management priorities.

Stage 5: Building Commitment

Having recognised the importance of building high level strategic commitment, a plan to engage with representatives of Federal, State and Local Government was established. A TAG meeting was held on 15 April 2008 to determine the best way to build and gain long-term commitment and support for the final plan. It was decided agencies would be asked to pledge their support and commitment to the process in writing. A subsequent planning session between PHCC and Sustainable Development Facilitation determined the details of this approach.

In late May 2008, ten key stakeholders were contacted: City of Mandurah, the shires of Harvey, Waroona and Murray, Peel Development Commission, Department for Planning and Infrastructure, Department of Water, Department of Agriculture and Food Western Australia, Department of Fisheries, Department of Environment and Conservation and the Western Australian Planning Commission.

Individualised letters to each stakeholder referred to the actions already undertaken by each organisation in fulfilling its management or planning roles. There was also an emphasis on the fragmented management of the wetlands that comprise the Ramsar site and the need for ongoing collaboration. Each letter included the following request to:

- provide in-principle support for the development of the draft management plan, and
- identify if and how the management plan could be structured to assist with each agency's operations and enable, where possible, greater alignment between Ramsar site management and government policy tools.

Responses received from key stakeholders indicated a favourable response to the preparation of the management plan. There was also strong support from the stakeholders regarding the integration of the management plan with their own specific policies, operations and legislation. The PHCC will continue to work collaboratively with the key stakeholders to ensure that the management plan guides and supports their planning and development work.

By September 2008 responses had been received from:

- Ian Curley, Chief Executive Officer, Shire of Waroona (11 June 2008)
- Kim Taylor, Director General, Department of Water (16 June 2008)
- Maree De Lacey, Chief Executive Officer, Peel Development Commission (26 June 2008)
- Ian Longson, Director General, Department of Agriculture and Food (24 June 2008)
- Jim Sharp, A/g Director General, Department of Environment and Conservation (2 July 2008).

At the time of writing, no response had been received from:

- Western Australian Planning Commission
- Department for Planning and Infrastructure
- Department of Fisheries
- Shire of Harvey
- Shire of Murray
- City of Mandurah.

Stage 6: Formulating the Management Plan

A process of engagement has continued with the TAG in Stage 6 with a meeting held on 27 June 2008 to review the first draft management plan and to check the alignment of the plan with existing, local scale management programs.

Subsequent TAG meetings were held in December 2008 and July 2009 to review the progress of the plan towards a final draft. This process also involved significant input from the Commonwealth Government's technical reference panel.

Originally, a second Community Forum was planned for Stage 6. However, due to an extension of funding it was decided to postpone the forum until a later date so that future community engagement may focus on the implementation of the plan and regular reviews of implementation success. PHCC is committed to an ongoing process of community engagement and awareness-raising about the importance of the Peel-Yalgorup Ramsar Site Management Plan.

The final stage of the the management plans formulation involves gaining official support from government stakeholders, including the DEC and the Commonwealth Government.

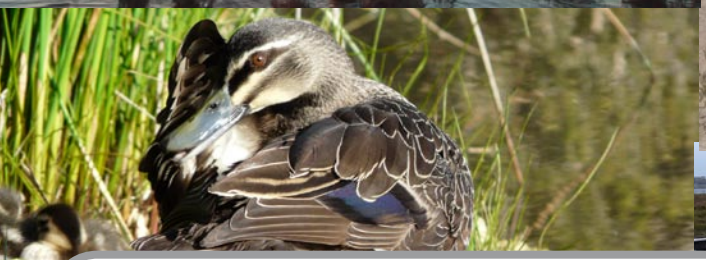






Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar Site





PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

Australian Government

SOUTH WEST CATCHMENTS COUNCIL

Government of **Western Australia**
Peel Development Commission

Government of **Western Australia**
Department of **Environment and Conservation**

Government of **Western Australia**
Department of **Water**

Monitoring Guide

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Disclaimer

This report should be referenced as:
Hale, J 2008, Monitoring and Evaluation Guide for the Peel-Yalgorup Ramsar Site. A report to the Peel-Harvey Catchment Council and the Department of Environment and Conservation.

Contents

FIGURES

TABLES

Introduction

The Peel-Yalgorup wetland system is designated as a wetland of international importance under the Ramsar Convention. Consistent with the obligations under this convention, an ecological character description (ECD) has recently been completed for the site (Hale and Butcher 2007) and a management plan has been developed.

Central to the management plan will be a monitoring and evaluation program that will inform management activities and assess the ecological character of the site against limits of acceptable change. As always, resources for the management and monitoring are limited and therefore it is essential that a carefully coordinated monitoring and evaluation guide be developed.

Monitoring, by definition, is undertaken to inform management and consequently the design of a program is dependent on the management objectives. This monitoring and evaluation guide for the Peel-Yalgorup Ramsar site is based on the overall management aim of managing the site to maintain its ecological character and, more specifically, on Objective 3 of the management plan:

> *Long term positive outcomes are achieved for the Peel-Yalgorup Ramsar System where the ecological character of the Peel-Yalgorup System, including services and values, is maintained or improved.*

Therefore the objective of this project is to:

- develop a monitoring and evaluation guide for the Peel-Yalgorup Ramsar site to:
- inform management of the site against Limits of Acceptable Changes (LAC) as detailed in the ECD
- set baseline conditions, where there is currently information gaps, upon which Limits of Acceptable Change (LAC) can be based
- inform the refinement and review of LAC.

Specifically, this project comprises the following outputs (as summarised from the terms of reference):

- monitoring actions listed in order of priority
- scheduling of monitoring actions (timing and intervals for repeat measurements)
- responsible organisation/s for each action
- estimated costs for each action
- links to Limits of Acceptable Change
- recommendations for data management
- recommendations for linkage with management decisions.

Context

Site

The Peel-Yalgorup Ramsar site comprises the Peel-Harvey Estuary, The Yalgorup Lakes and lakes McLarty and Mealup in south-west Western Australia (Figure 1). In addition to the officially designated Ramsar site, this monitoring guide includes lakes Goegrup and Black, which are planned as extensions to the site in the near future (Hale and Butcher 2007). The site was first designated as a wetland of international importance in 1990 and currently meets six of the criteria for listing under the Ramsar Convention (Table 1).

Table 1: Criteria for identifying wetlands of international importance that are met by the Peel-Yalgorup Ramsar site (adapted from Hale and Butcher 2007).

Ramsar Criteria	Peel-Yalgorup Justification
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 site includes the largest and most diverse estuarine complex in south-western Australia and also particularly good examples of coastal saline lakes and freshwater marshes.
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.	The site is one of only two locations in south-western Australia and one of very few in the world where living thrombolites occur in inland waters.
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.	The site supports an array of species and communities during critical life stages including: large numbers of migratory birds; breeding of waterbirds, fish, crabs and prawns; drought refuge for waterbirds, fish and invertebrates; and waterfowl such as Shelducks and Musk Ducks during moulting.
Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.	The site comprises the most important area for waterbirds in south-western Australia, supporting in excess of 20,000 waterbirds annually, with greater than 150,000 individuals recorded at one time (February 1977). Numbers exceeding 20,000 birds have been recorded in all comprehensive surveys conducted in the 1990s in the Peel-Harvey Estuary.
Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	According to the 4th edition of Waterbird Population Estimates, the site regularly supports 1% of the population of: Red-necked Avocet, Red-necked Stint, Red-capped Plover, Hooded Plover, Black-winged Stilt, Banded Stilt, Curlew Sandpiper, Sharp-tailed Sandpiper, Fairy Tern, Musk Duck, Grey Teal, Australasian Shoveler, Australian Shelduck and Eurasian Coot.
Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, a spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	The Peel-Yalgorup Ramsar site is important as a nursery and/or breeding and/or feeding ground for at least 50 species of fish as well as the commercially significant Blue Swimmer Crab and Western King Prawn. In addition, the Peel-Harvey Estuary is a migratory route for the Pouched Lamprey *(Geotria australis)*.

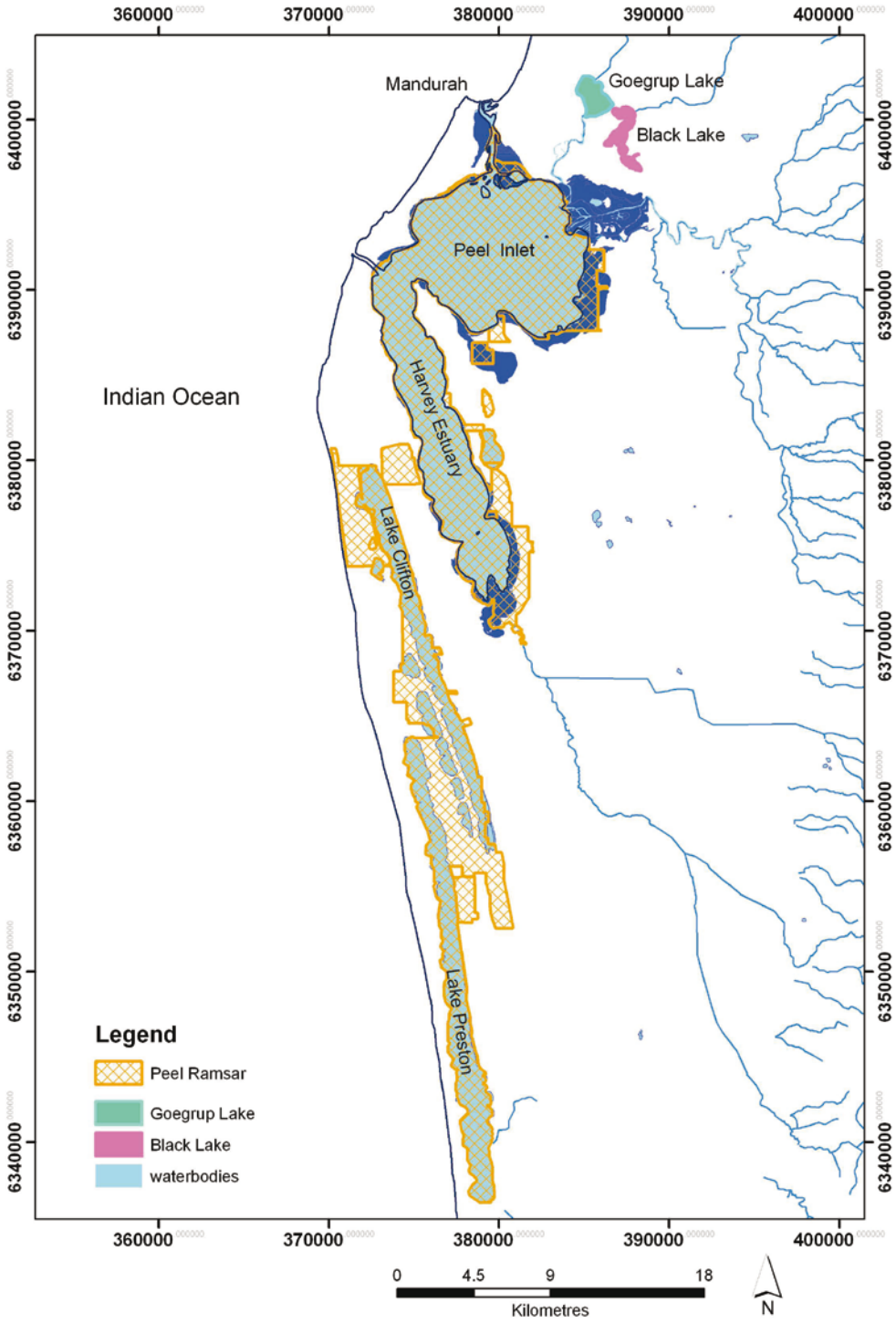

Figure 1: Area to which this monitoring and evaluation guide applies: the Peel-Yalgorup Ramsar site and lakes Goegrup and Black.

The act of designating a wetland as a Ramsar site carries with it certain obligations, including managing the site to retain its 'ecological character' and having procedures in place to detect if any threatening processes are likely to, or have, altered the 'ecological character'. Central to this is the development of an Ecological Character Description, which provides a detailed description of the site and sets Limits of Acceptable Change (LAC). LAC are defined as the variation within specific ecosystem components and processes that are considered acceptable for maintaining the ecological character of the site (Phillips and Muller 2006). Simply stated they are 'the lines in the sand' with respect to specific components and processes (e.g. water quality, waterbird communities) within which the system must be managed. Although monitoring is not a specific obligation under the Ramsar Convention, in order to ascertain whether the ecological character of the site is being protected and the LAC met, a monitoring program is required.

Limits of Acceptable Change

This monitoring and evaluation guide builds on the approach and outputs of the Ecological Character Description (ECD) for the Peel-Yalgorup Ramsar site (Hale and Butcher 2008). It links monitoring programs with the LAC (both for assessing condition of the site against LAC and for informing the review and refinement of LAC). The primary aim of the LAC is to detect significant changes in ecological character in time to instigate a management response (i.e. before the change in ecological character is irrevocable). The ECD recognises that LAC cannot be set nor monitored against for every component and process within the system. Rather, a strategic, three-tiered hierarchical approach has been adopted, which targets the primary determinants of the ecological character of the Peel-Yalgorup Ramsar site (Figure 2).

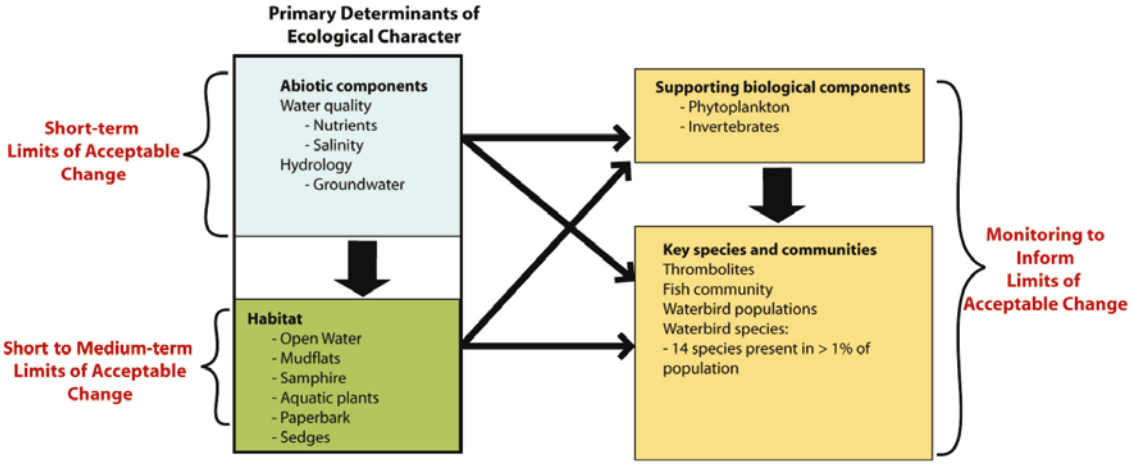

Figure 2. SEQ Figure: Hierarchical system for setting limits of acceptable change (Hale and Butcher 2008).

The three levels of LAC (and corresponding monitoring) are:

1. Key abiotic factors in the system (Abiotic components) - the easiest to monitor and detect change in the short term. LAC were set as 'trigger' values based on a combination of natural variability (from historical data), nationally accepted standards e.g. ANZECC water quality guidelines (ANZECC 2000a,2000b) and known tolerances for specific species. The ECD recommended that these be the most intensively monitored aspects of the system and include water quality and hydrological measures.
2. Primary response to the abiotic components and processes (habitats and supporting biological components) - primary production (phytoplankton) and key plant communities. LAC were set based on existing conditions (with respect to extent and community type) and habitat requirements of key faunal species and communities. It was suggested that monitoring of these components and processes aims to detect change over medium time scales.
3. Key faunal components (key species and communities) – the most difficult to set LAC for and monitor against. The ECD suggested a strategic approach to monitoring of fauna in the Peel-Yalgorup Ramsar site, with the selection of a small number of programs targeted at the aspects of the system that are linked to the criteria for which the system was listed as a wetland of international importance.

(adapted from Hale and Butcher 2008)

Monitoring program design

The Ramsar Wise Use Handbook 11 (Ramsar, 2007) provides a framework for designing and implementing a wetland monitoring program (Figure 3). Although this framework is not a prescriptive methodology, it provides guidance on what should be considered in program design. Elements of this framework have been adopted and adapted in the development of the monitoring and evaluation guide for the Peel-Yalgorup Ramsar site (Table 2).

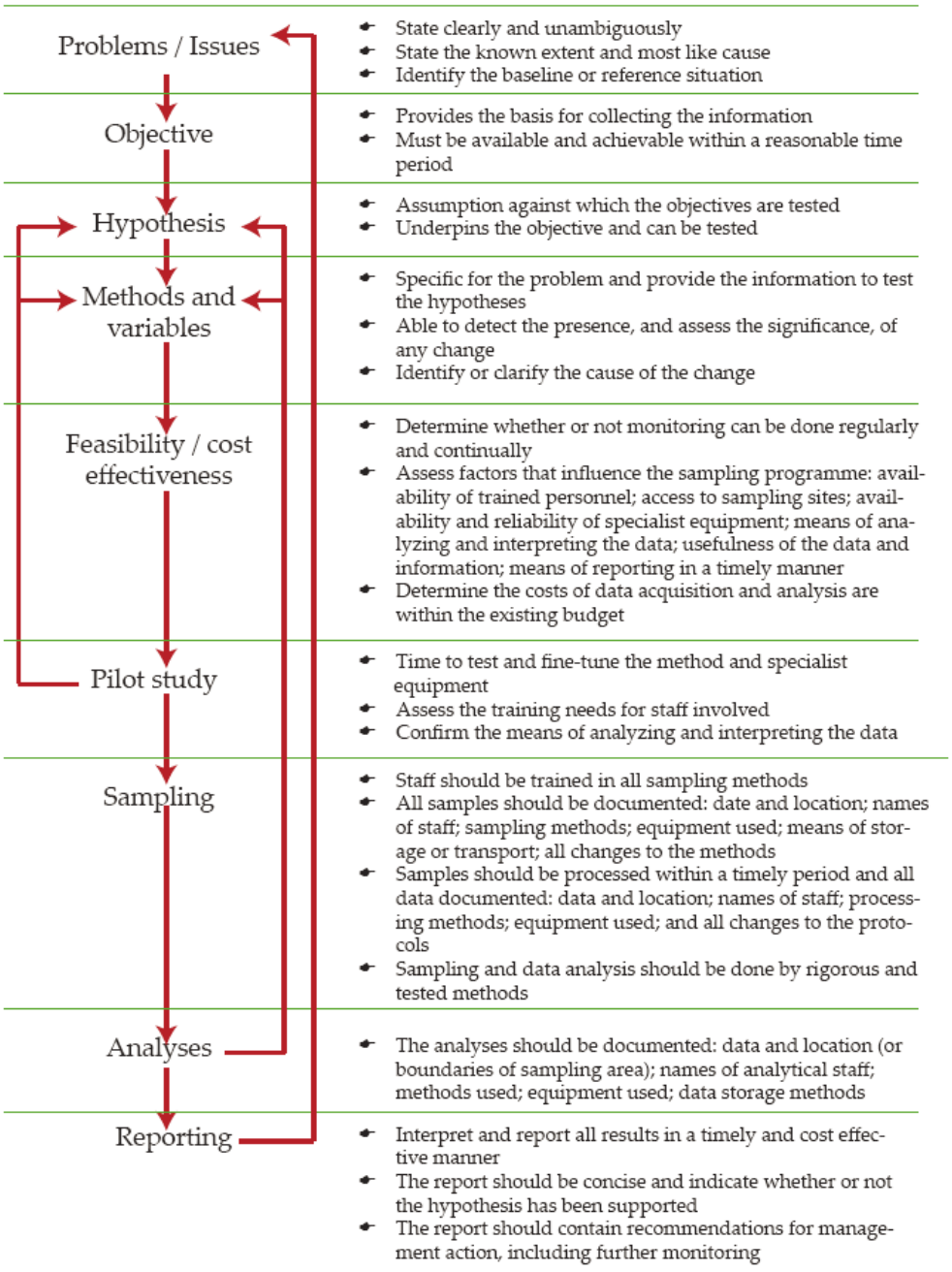

Figure 3. Framework for designing a wetland monitoring program (Ramsar Wise Use Handbook 11, 2007)

This monitoring and evaluation guide has been developed with consideration of the monitoring recommendations contained within the ECD as well as current and historical monitoring programs. It should be noted, however, that although every effort has been made to consider existing programs, as with much natural resource monitoring in Australia, there is no integrated monitoring program for the Peel-Yalgorup site and many programs are run in isolation with little dissemination of findings. As such, it is likely that there are additional programs in existence that are not recognised in this monitoring and evaluation guide. However, the format of the monitoring guide provided here is such that additional existing programs should be able to be easily retrofitted. The monitoring guide design and links to the Ramsar framework are provided in Table 2.

Table 2: Elements of this monitoring and evaluation guide

Elements of the Monitoring Guide	Description / Considerations	Corresponding Ramsar Framework Element
Rationale	Describes the need for the monitoring program Links to relevant LAC	Problems/Issues
Objectives	The broad objectives of the monitoring program Specific, measurable and testable hypotheses where relevant	Objectives and Hypothesis
Current and historical programs	Any existing, relevant programs Provides information on potential responsibilities Informs monitoring design by ensuring that future data is collected in a manner to allow comparisons over time with existing and historical data	No direct link but incorporates some aspects of 'Pilot Study'
Monitoring method	Where possible based on standard, recognised and accepted methods Considers linkages to other programs at the regional, state and national levels Incorporates: location and frequency of sampling measurement parameters method of collection and analysis data analysis and interpretation quality control and quality assurance	Methods and variables, Sampling and Analysis
Reporting information	How often data should be collated and reported Data storage Dissemination Links to management	Reporting
Links to other programs	Other monitoring programs within this monitoring and evaluation guide that are related and may warrant integrated analysis and reporting	
Responsibility	Agencies responsible for the implementation Data custodians	Reporting
Cost	Estimated costs (based on person days and approximations of laboratory costs)	Cost and feasibility
Priority	Priority for implementation (high, medium and low) based on the recommendations of the ECD	

Monitoring programs

This monitoring and evaluation guide is meant as a useable and practical document and as such has been limited to the monitoring recommendations within the ECD that were afforded a medium or high priority. A full and detailed methodology for the monitoring of components and processes that were considered of low priority was considered an inefficient use of available time and resources and these are not considered further. A summary of the programs contained in this monitoring and evaluation guide is contained in Table 3.

Table 3: Monitoring programs detailed within this monitoring and evaluation guide

Monitoring Program	Component / Process	Location	Priority (as cited in ECD)
Water Quality A: Peel-Harvey Estuary	Water Quality (nutrients, salinity, dissolved oxygen, pH, chlorophyll a, turbidity)	Peel Inlet, Harvey Estuary, Goegrup Lake	High
Water Quality B: Yalgorup Lakes	Water Quality (nutrients, salinity, dissolved oxygen, pH, chlorophyll a, turbidity)	Lakes Preston and Clifton	High
Water Quality C: Lakes McLarty and Mealup	Water Quality (nutrients, salinity, dissolved oxygen, pH, chlorophyll a, turbidity)	Lakes Mealup and McLarty	High – Lake Mealup Low / Moderate – Lake McLarty
Hydrology	Water regime (depth and extent of inundation, depth to groundwater)	Yalgorup Lakes, Lakes McLarty and Mealup	High
Phytoplankton	Identification and enumeration	Peel Inlet, Harvey Estuary, Goegrup Lake	Medium
Aquatic Plants	Composition and distribution of benthic plants	Peel Inlet, Harvey Estuary, Lake Preston	High – Peel-Harvey System Medium – Lake Preston
Littoral Vegetation	Extent and condition of saltmarsh and paperbark communities	Peel Inlet, Harvey Estuary, Goegrup and Black Lakes, Lakes McLarty and Mealup	High
Fish	Composition and abundance	Peel-Harvey Estuary	Medium
Waterbirds A	Red-necked Stint counts	All wetlands in the Peel-Yalgorup System	High
Waterbirds B	Cormorant Breeding	Carrabungup Swamp	High
Waterbirds C	Hooded Plover breeding	Yalgorup Lakes	High
Waterbirds D	Collation and storage of existing and future data	All wetlands in the Peel-Yalgorup System	High

The majority of these monitoring programs represent simply more detailed guidance on recommended monitoring contained in the ECD document. However, the proposed program for waterbirds represents a strategic approach developed specifically for this monitoring and evaluation guide. Monitoring of waterbirds to produce statistically defensible results is inherently difficult. There is a large natural variability in waterbird numbers at any wetland at any given time, and they can move between wetlands, using a range of different areas to meet different needs (feeding, breeding and roosting). This, coupled with the size of the Peel-Yalgorup Ramsar site, means that it is unlikely that an adequate program could be undertaken to monitor all waterbirds with the available resources. Therefore, a targeted, strategic approach is proposed that considers three aspects of waterbird usage of The Peel-Yalgorup System that are linked to the reasons for it being listed as a wetland of international importance. These are:

1. Monitoring of Red-necked Stint numbers – This is an easily identifiable bird and one for which the site regularly supports more than 1% of the flyway population. Annual, coordinated counts of this species will provide information on changes in Red-necked Stint numbers and act as a surrogate for other wading species.

2. Monitoring of the Cormorant breeding colony at Carrabungup Swamp - This indicator informs about:

- a key ecosystem service of the Ramsar site (waterbird breeding within the boundaries)
- (indirectly) the condition of Melaleuca wetlands in the site
- (loosely) the availability of fish food resources in the estuary.

3. Monitoring of Hooded Plover at the Yalgorup Lakes - This indicator informs about a key ecosystem service of the Ramsar site (support to at least 1% of the size of a population) and addresses an 'iconic' species that should be reasonably straightforward to count comprehensively.

In addition, there is a large amount of data collected on waterbirds within the Peel-Yalgorup Ramsar site by a number of government agencies, NGOs and community groups. The information collected represents a significant resource, but data is not stored or analysed in a systematic manner. A fourth program that coordinates the collation of this data is proposed.

Linking monitoring to management

By definition, monitoring programs are designed to inform management. In the case of Ramsar sites, monitoring programs are designed to inform management to maintain the ecological character of the site. As described above, the monitoring program for the Peel-Yalgorup Ramsar site has been designed to assess components and processes within the site against LAC.

LAC for the majority of components (particularly those that are abiotic or habitat based) have been designed for use as 'trigger values'. This means that exceedence does not necessarily indicate a change in ecological character, but rather the exceedence should trigger further investigative and possibly management actions. The proposed process for trigger value exceedence is provided in Figure 4 and described below.

The initial steps in the process are designed to ensure that the data indicating a potential exceedence of an LAC are accurate. Therefore, a verification of quality control and quality assurance data from both the laboratory and the field is required. If the results indicating an exceedence of the LAC are found to be inaccurate or not within acceptable quality standards then monitoring should continue. However, if the results are a true reflection of the status of components and process within the Ramsar site, further action is required.

If LAC have been exceeded, it is important to next assess the ecological significance of this exceedence. This will involve expert opinion and analysis of the data and other supporting information to determine if the monitoring results indicate a risk or increased threat to the ecological character of the system. Typical analysis may include:

- the magnitude of the exceedence (e.g. if the LAC is defined as a pH more than 7, and a pH of 7.1 is recorded, this may not be considered a significant threat to the ecological of the system)
- the spatial or temporal extent of the exceedence (e.g. if the monitoring result is limited to an isolated location and a single point in time this may not be considered a significant threat to the ecological character of the system)
- potential contributing factors, or causes of the exceedence (i.e. supporting information should be analysed to determine potential causes for the monitoring results. This may include unusual weather patterns, extreme events, human activities. A decision will then need to be made as to whether this is likely to be a sustained and significant threat to ecological character or a one-off/rare event).

If expert opinion and analysis determines that the exceedence of LAC was not ecologically significant, this should trigger a review of the LAC to determine if they are appropriate. The LAC in many cases were developed based on limited knowledge. Therefore, as more information and data becomes available, they should be refined to better reflect the natural variability within the system.

Finally, if the exceedence of LAC is found to be ecologically significant, then management actions must be implemented to protect and maintain the ecological character of the system. Actions may range from increased frequency or extent of monitoring to increase understanding of the impact on the system, to on-ground actions to address the threatening activities contributing to the impact on ecological character as per Objective 3 of the management plan.

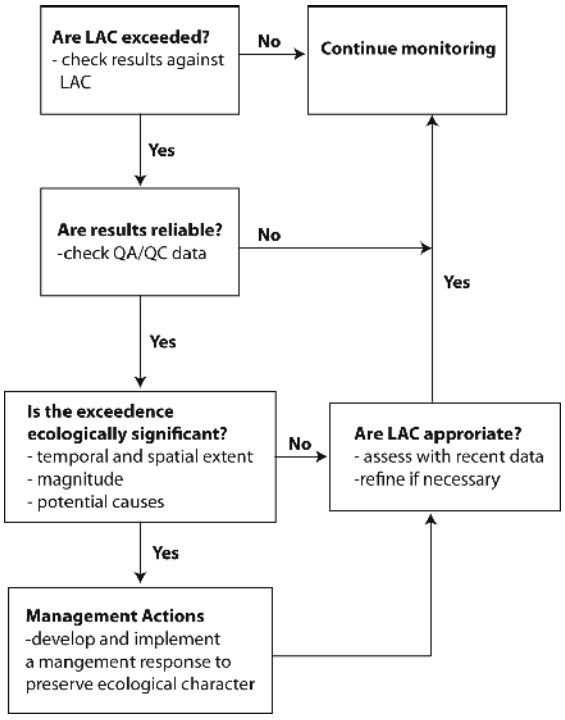

Figure 4. Proposed process for trigger-value exceedence

In order to implement the process described above and illustrated in Figure 4, it is recommended that a *Peel-Yalgorup Technical Advisory Panel* be established. (This, together with the managerial arrangements for the Ramsar site, is further described in the management plans). This panel should comprise scientific experts with knowledge and experience in the Peel-Yalgorup Ramsar site. At a minimum, the panel should include experts in the fields of: waterbird ecology, estuarine fish, saltmarsh and paperbark vegetation communities, seagrass and macro-algae, phytoplankton, thrombolites, water quality and hydrology. The panel should meet at least once a year to discuss the results of the previous year's monitoring, to determine if there have been changes to components and processes that represent a significant threat to the ecological character of the site and to recommend future monitoring and management actions.

Data storage and reporting

There have been a large number of disconnected monitoring and research programs conducted within the Peel-Yalgorup Ramsar site. However, with the exception of water quality, little of this data has been collated and stored in a manner that makes it accessible to the managers of the system. Therefore, as a part of the monitoring program for the Peel-Yalgorup Ramsar site, it is recommended that all information collected be stored in an accessible database. The Department of Environment and Conservation (DEC) has an existing statewide wetlands database (WetlandBase), which is publicly available at www.calm.wa.gov.au It is recommended that this statewide database 'WetlandBase' be adopted as the repository for monitoring data.

The first priority should be to use this database to store information collected under the Peel-Yalgorup monitoring program. However, if additional historical, current and future monitoring conducted at the site could be included in the database, this would increase its value as a management tool.

The management body established for the ongoing management of the Ramsar site should be responsible for coordination and ensuring that all data is forwarded to DEC in the appropriate format for storage in the statewide database. In addition, the monitoring information collected should be reported to the Technical Advisory Group, relevant stakeholders and the general community on an annual basis. More detail about the format of this reporting is provided under each of the monitoring programs as described below.

Review of monitoring

Consistent with the principles of adaptive management adopted for the management of the Peel-Yalgorup Ramsar site, the monitoring programs should be reviewed and, if necessary, refined based on results and outcomes from implementation. Minor reviews should be conducted annually by the Technical Advisory Group, with refinements or modifications to methods documented in their annual report. Every five years, however, a full and formal review of the program should be undertaken during which entire programs could be removed or added, depending on the outcomes of monitoring. The full review procedures are documented within the management plan and should be equally applied to the monitoring of the site.

Rationale

Nutrient concentrations and salinity were considered primary determinants of ecological character for the Peel-Yalgorup System. The Peel-Harvey Estuary has suffered the effects of cultural eutrophication for a number of decades and although the nutrient concentrations in the water column have reduced in the estuary since the opening of the Dawesville Channel, there has been no reduction in nutrient loads entering the system from the catchment.

Nutrient loads from agriculture as well as urban and peri-urban development were identified as a key threat to the Peel-Yalgorup System and the Peel-Harvey Estuary in particular.

Table 4: Limits of acceptable change for the Peel-Harvey Estuary (Hale and Butcher 2007, p129)

Relevant LAC Component	Baseline/Supporting Evidence	Limit of Acceptable Change
Nutrients	Total phosphorus limits have been set by the Water Quality Improvement Plan (EPA 2007). Dissolved inorganic nutrients, which are the form available for uptake. Current baseline suggests peaks in winter, but low concentrations during summer and autumn.	< 30 µg/L (maximum) PO4, NH4, NOx - annual median concentrations < 10 µg/L
Dissolved oxygen	Limits have been set by the Water Quality Improvement Plan (EPA 2007).	70-80 % saturation
pH	Although marine systems have a large buffering capacity, disturbance of acid sulphate pH values. Baseline conditions indicate pH typically 7.3 to 8.5.	pH more than 7 at all times
Salinity	Although the marine influence on the estuary cannot be managed, seasonal salinity fluctuations are important for biota. Fish such as the Long-headed River Goby require salinities of < 30 ppt to trigger spawning. Some waterbirds require fresh drinking water (< 3 ppt).	Winter salinity in the centre of the Peel Inlet and Harvey Estuary < 30 ppt for a minimum of 3 months Water in the Harvey River mouth over winter < 3 ppt
Phytoplankton *a*	Phytoplankton biomass is typically low in the estuary although occasional blooms occur, but persist for only a matter of weeks.	Chlorophyll a - annual median concentrations < 10 µg/L

Objective and Hypotheses

The objective of the water quality program A: Peel-Harvey is:

- To monitor water quality within the Peel Harvey Estuary and Goegrup Lake on a minimum of 12 occasions per calendar year to measure against limits of acceptable change.

Specific hypotheses are:

- Total phosphorus concentrations will not exceed 30 µg/L at any site in the Peel Harvey Estuary during any monitoring event.
- Annual median concentrations of PO4, NH4, NOx and chlorophyll a will be < 10 µg/L at all six water quality monitoring sites within the Peel-Harvey Estuary.
- Dissolved oxygen concentrations will not be less than 70-80% saturation at any site in the Peel Harvey Estuary during any monitoring event.
- pH will not be less than 7 at any site in the Peel Harvey Estuary during any monitoring event.
- Salinity at sites 2 and 58 in the Peel-Harvey Estuary will be < 30ppt for a minimum of three consecutive months between May and November.
- Salinity at site 31 in the Harvey Estuary will not exceed 3 ppt for a minimum of three consecutive months between May and November.
- There will be no significant difference ($p < 0.05$) in measured water quality variables (total phosphorus, orthophosphate, ammonium, nitrate-nitrite, salinity, pH and surface and bottom water dissolved oxygen) between current year monitored and historical (post Dawesville Channel) data.

Current and historical programs

Water quality in the Peel-Harvey Estuary has been monitored since August 1977 at three sites in the Peel Inlet and three in the Harvey Estuary (Kobryn et al. 2002). Frequency has varied between weekly and monthly; however, current sampling occurs approximately 8 times per year. Parameters include: pH, dissolved oxygen, salinity, secchi depth, temperature, salinity, total nitrogen, total phosphorus, nitrate-nitrite, ammonium, phosphate, silicate and chlorophyll a from surface and bottom waters.

Currently water quality under the Water Quality Improvement Plan (WQIP) is also assessed at sites within the Serpentine, Murray and Harvey Rivers, which includes a site within Lake Goegrup (Department of Water 2007).

Monitoring method

Given the extent of historical data sets for water quality in the Peel-Harvey Estuary there are benefits for detecting trends over time in aligning future monitoring with that collected historically. As such, the following program is based on historical monitoring described in Wilson et al. (1999) and that detailed in the WQIP.

Location

There are three sites in the Peel Inlet and three sites in the Harvey Estuary (Figure 5). In addition the site in Lake Goegrup should also be maintained.

Frequency

Results of a power analysis (alpha = 0.05; beta = 0.8) on water quality data collected in 2006 (Department of Water 2007) indicated that between 9 and 12 samples were required to adequately test against LAC. Therefore a minimum of 12 samples is required per year, which should be collected monthly. However if nutrient concentrations begin to trend upwards, a more intensive sampling regime will be required.

Parameters and methods

Field collection:

- Collection and analysis of water quality samples should be undertaken in accordance with relevant Australian Standards – Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000a); Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 200b), and Standard Methods for the Examination of Water and Wastewater (APHA 1999).
- *In-situ* profiles of pH, salinity and dissolved oxygen should be made.
- Samples should be collected for total nitrogen, total phosphorus, orthophosphate, nitrate-nitrite, ammonium and chlorophyll a from surface and bottom waters using a grab sampler (Niskin grab or similar). Dissolved nutrient samples should be filtered through a 0.45µm cellulose acetate membrane filter in the field. Samples should be stored on ice prior to transport to the laboratory.

Laboratory analysis:

- Analysis of all samples should be undertaken by a NATA accredited laboratory according to accredited methods.

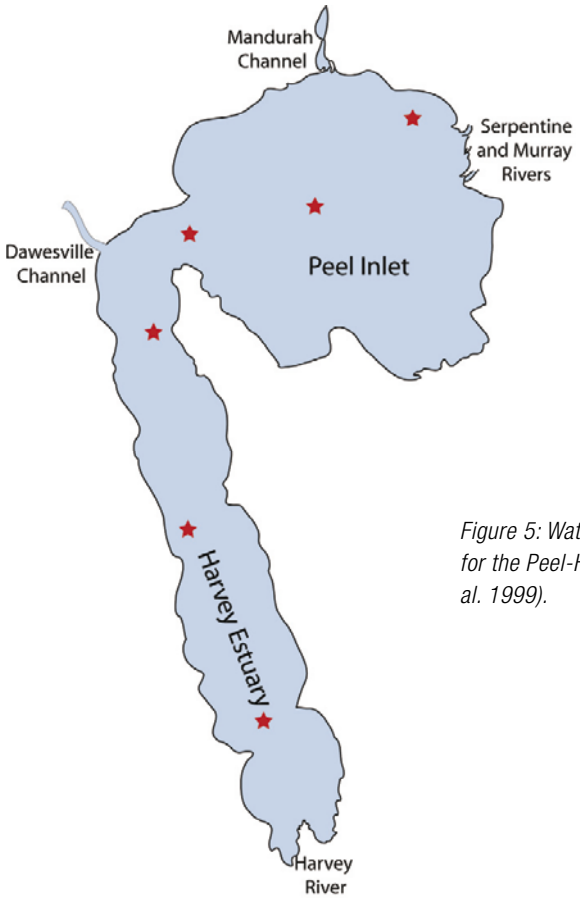

Figure 5: Water Quality monitoring sites for the Peel-Harvey Estuary (Wilson et al. 1999).

Data analysis and interpretation

Results collected for water quality parameters should be assessed against LAC annually.

Trend analysis using appropriate multi-variate statistical analysis should be used to determine whether results from the current sampling year are significantly different from those collected in previous years. This can be simply achieved using tests of differences in means/medians using ANOVA or Kruskall-Wallace tests. However, in the future, consideration could be given to developing and implementing control charting techniques (e.g. Exponentially Weighted Moving Averages - EWMA - to detect changes in water quality over time).

Quality Assurance and Quality Control

Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring, Reporting and relevant NATA accreditation documents should be adhered to. These include:

Field sampling:

- Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring, including:
  - duplicate samples (1 in 10 samples)
  - field blanks (1 in 10 samples)
  - calibration of field instruments (prior to each sampling event).

Laboratory analysis:

- In accordance with NATA accreditation documents:
  - calibration
  - standards
  - duplicates (copies provided with results).

Reporting information

Water quality data should be stored in the WIN Database (with appropriate links placed in WetlandBase). A database for water quality in the Peel-Harvey Estuary exists for water quality monitoring conducted between 1977 and 2001. Priority should be given to updating this database with results collected since this time.

Exceedences of LAC should trigger the management process illustrated in Figure 4, p11 and relevant technical experts on the *Peel-Yalgorup Technical Advisory Panel* consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of this program would also be of use in the interpretation of the following monitoring programs:

- Phytoplankton
- Benthic Plants

Roles and responsibilities

- The Department of Water is currently responsible for undertaking the monitoring of water quality in the Peel-Harvey Estuary and the input of data into the WIN database.
- The Department of Environment and Conservation is responsible for maintaining the WetlandBase database.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for annual reporting and informing the Technical Advisory Panel.

Estimated costs

Field collection:

- 1 person for 0.5 days calibration and field preparation (12 times per year)
- 2 persons for 1 day sampling (12 times per year)
- vehicle and boat.

Laboratory analysis:
approximately $70-100 per suite of parameters = $15,000-18,000 per year.

Interpretation and reporting:
approximately 10 person days per year.

Priority

High

Photo: Amanda Willmott

Rationale

Nutrient concentrations and salinity were considered primary determinants of ecological character for the Peel-Yalgorup System. The Yalgorup Lakes contain Thrombolites and there have been recent concerns over rising salinity and nutrient concentrations.

Table 5: Limits of acceptable change for the Yalgorup Lakes (Hale and Butcher 2007, p130)

Relevant LAC Component	Baseline/Supporting Evidence	Limit of Acceptable Change
Nutrients	Dissolved inorganic nutrients are those that are available for plant uptake and therefore the most indicative of tropic status. Lane and Davies (1993) collected some information from Lake Clifton and this forms the baseline for this limit. It is likely that the limit will need to be refined as more data is collected.	PO_4, NH_4, NOx - median concentrations < 10 µg/L
Salinity	Although many of the lakes are hypersaline, the thrombolite communities are reliant on freshwater.	Lake Clifton salinity < 35 ppt maximum and < 25 ppt during winter and spring
pH	Yalgorup Lakes are within a landscape considered at high risk from acid sulphate soils. Thrombolites rely on alkaline conditions for growth. Natural pH is between 7.2 and 8.5.	pH > 7 at all times
Chlorophyll *a*	Data deficient.	Baseline must be set before limits can be made.

Objectives and Hypotheses

The objectives of the water quality program B: Yalgorup Lakes are:

- To conduct a pilot study to determine variability in water quality (temporally and spatially) in Lakes Clifton and Preston to inform the design of ongoing monitoring.
- To monitor water quality within Lakes Clifton and Preston on a minimum of 12 occasions per calendar year to measure against Limits of Acceptable Change.
- To monitor groundwater quality prior to discharge into lakes to inform on potential sources of salts and nutrients.
- To monitor chlorophyll a concentrations to inform the development of quantitative LAC.

Specific hypotheses are:

- Annual median concentrations of PO_4, NH_4, and NOx will be < 10 µg/L at all water quality monitoring sites within Lakes Preston and Clifton.
- Salinity in Lake Clifton will not exceed 35ppt on any monitoring occasion.
- Salinity in Lake Clifton will be < 25 ppt for a minimum of 5 consecutive months between May and December annually.
- pH will not be less than 7 at any site in Lakes Clifton and Preston during any monitoring event.
- Water quality within Lakes Clifton and Preston is positively correlated with groundwater quality from inflowing aquifers.

Current and historical programs

Although there have been several research projects (e.g. Bourke and Knott 1989, Moore 1987, Shams 1999) there has been no systematic monitoring of water quality at the Yalgorup Lakes. The Department of Water has a number of monitoring bores adjacent to the Yalgorup Lakes and these have been monitored irregularly for parameters such as salinity, temperature and (occasionally) nutrients.

The Department of Environment and Conservation is planning to instigate monitoring at Lake Clifton under the Thrombolite Recovery Program. This will include the instalment of three loggers that will monitor surface water, groundwater and rainfall levels and salinity on a continuous basis close to the Lake Clifton Boardwalk (Forbes and Vogwill 2008).

Monitoring method

With a lack of regular historical monitoring, there are no existing sites (with regular sampling extending for more than a year or so) to inform the monitoring program. Therefore a 12 month pilot study is proposed (and detailed below). The results of this pilot study can then be used to inform the ongoing monitoring program with respect to site number and sampling frequency.

In recognition that there may be limited funds and resources for monitoring in the Peel-Yalgorup Ramsar site, an alternative cheaper (but less scientifically defensible) method is also suggested. This uses the water quality monitoring sites of Moore (1987) in Lakes Clifton and Preston as well as a small number of groundwater bores (from Shams 1999 and/or current DoW monitoring).

The two programs are described under each section marked 'Pilot' and 'Alternative'.

Location

Pilot:
Access to the lakes is likely to be problematic (especially given the annual changes in water level). As such, exact locations of sites will need to be determined following a site inspection. A minimum of five sites on a north south transect across each of lakes Preston and Clifton should be included in the pilot study. In addition, groundwater quality should be monitored at a minimum of six bores to the east of the lakes. These should be the same as those used in the Hydrology program and based on those samples by Shams (1999) and/or current DoW monitoring (Figure 6).

Alternative:
Sampling at two sites in each of Lakes Clifton and Preston as described in Moore (1987) Figure 6. In addition, groundwater monitoring at a single bore location on the eastern shore of each lake (DoW Bore numbers 61319132 and 61319146).

Frequency

Pilot:
Fortnightly samples collected. This may decrease for the full program following the results of the pilot. Consideration should also be given to deploying continuous loggers for salinity within Lake Clifton for at least one year to determine variation and inform ongoing monitoring frequency.

Alternative:
Twelve samples annually, collected monthly.

Parameters and methods

Field collection:

- Collection and analysis of water quality samples should be undertaken in accordance with relevant Australian Standards (Australian Guidelines for Water Quality Monitoring (ANZECC 2000a); Reporting and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 200b), and Standard Methods for the Examination of Water and Wastewater (APHA 1999)).
- *In situ* measurement of pH and salinity should be undertaken.
- Samples should be collected for total nitrogen, total phosphorus, orthophosphate, nitrate-nitrite ammonium and chlorophyll a from mid water column using a grab sampler. Dissolved nutrient samples should be filtered through a 0.45µm cellulose acetate membrane filter in the field. Samples should be stored on ice prior to transport to the laboratory.

Laboratory analysis:
Analysis of all samples should be undertaken by a NATA accredited laboratory according to accredited methods.

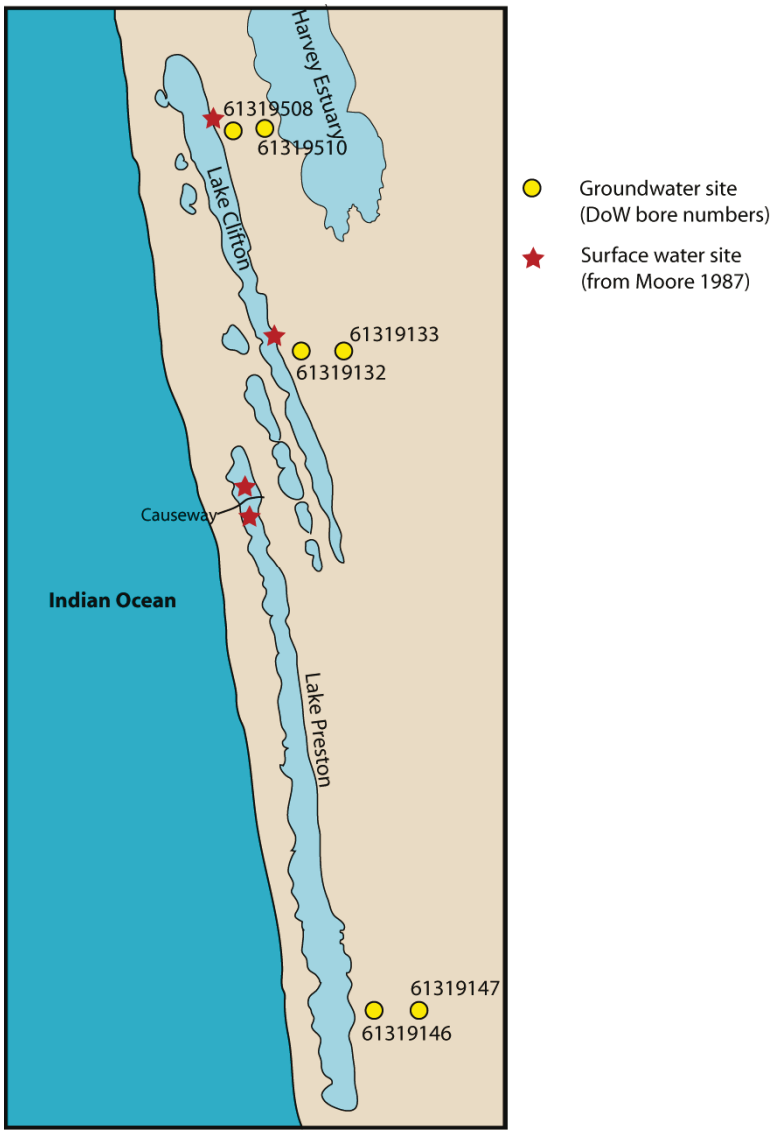

Figure 6: Water quality sampling sites at the Yalgorup Lakes.

Data analysis and interpretation

Results from the pilot study should be assessed through an appropriate statistical analysis (e.g. power analysis) to determine sampling frequency and site locations for ongoing monitoring. In addition, results collected for water quality parameters should be assessed against LAC for each site.

Quality Assurance and Quality Control

Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring; Reporting and relevant NATA accreditation documents should be adhered to. These include:

Field sampling:

- Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring, including:
- duplicate samples (1 in 10 samples)
- field blanks (1 in 10 samples)
- calibration of field instruments (prior to each sampling event).

Laboratory analysis:

- In accordance with NATA accreditation documents:
- calibration
- standards
- duplicates (copies provided with results).

Reporting information

Water quality data should be stored in the DoW WIN database and the DEC WetlandBase.

Exceedences of LAC should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel should be consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of this program would also be of use in the interpretation of the following monitoring programs:

- Hydrology
- Phytoplankton

Roles and responsibilities

- The Department of Water is currently responsible for maintaining the WIN database.
- The Department of Environment and Conservation is responsible for maintaining the WetlandBase database.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as annual reporting and informing the Technical Advisory Panel.

Estimated costs

Pilot:
Field collection:

- 1 person for 0.5 days calibration and field preparation (26 times per year)
- 2 persons for 1 day sampling (26 times per year)
- vehicle.

Laboratory analysis:

- approximately $70-100 per suite of parameters = $29,000-40,000 per year.

Interpretation and reporting:

- approximately 10 person days.

Alternative:
Field collection:

- 1 person for 0.5 days calibration and field preparation (12 times per year)
- 2 persons for 1 day sampling (12 times per year)
- vehicle (possibly).

Laboratory analysis:

- approximately $70-100 per suite of parameters = $3500-4800 per year.

Interpretation and reporting:

- approximately 50 person days per annum.

Priority

High

Photo: Bill Russell

Rationale

Nutrient concentrations and salinity were considered primary determinants of ecological character for the Peel-Yalgorup system. There are concerns over increasing salinity and nutrient concentrations at Lakes McLarty and Mealup and decreasing pH in Lake Mealup.

Table 6: Limits of acceptable change for Lakes McLarty and Mealup (Hale and Butcher 2007, p131)

Relevant LAC Component	Baseline/Supporting Evidence	Limit of Acceptable Change
Nutrients	Dissolved inorganic nutrients are those that are available for plant uptake and therefore the most indicative of tropic status. However this is data deficient at Lakes McLarty and Mealup and likely to be highly seasonal as water levels fluctuate. As a consequence, trigger values for south-west Australian wetlands have been adopted (ANZECC 2000).	PO_4 < 30 µg/L NH_4, < 40 µg/L NOx < 100 µg/L All to be applied only when water levels are > 500mm
Salinity	These represent the only freshwater systems within the Peel-Yalgorup site. However, salinity will fluctuate as water levels rise and fall. Salinity should be based on the tolerances of the water-dependant species and as such should be measured at times when these communities are inundated.	Salinity under rush and sedge communities < 1 ppt Salinity under paperbark communities < 0.5 ppt
pH	Lakes McLarty and Mealup are within a landscape considered at high risk from acid sulphate soils. Natural pH is between 7.2 and 8.5 for Lake McLarty, but has declined to between 3.1 and 4 for Lake Mealup. Hence a limit for Lake Mealup has not been set, but will need to be based on further investigative work.	pH > 7 at all times in Lake McLarty
Chlorophyll *a*	Data deficient.	Baseline must be set before limits can be made.

Objectives and Hypotheses

The objectives of the water quality program C: lakes McLarty and Mealup are:

- To monitor water quality within lakes McLarty and Mealup to measure against limits of acceptable change.
- To monitor chlorophyll a concentrations at lakes McLarty and Mealup to inform the development of quantitative LAC.

Specific hypotheses are:

- Concentrations of PO_4, will be < 30 µg/L within Lakes McLarty and Mealup whenever maximum water depth is > 500mm.
- Concentrations of NH_4 will be < 40 µg/L within Lakes McLarty and Mealup whenever maximum water depth is > 500mm.
- Concentrations of NOx will be < 100 µg/L within Lakes McLarty and Mealup whenever maximum water depth is > 500mm.
- Salinity under sedge communities at Lakes McLarty and Mealup will not exceed 1ppt during any monitoring event.
- Salinity under paperbark communities at Lakes McLarty and Mealup will not exceed 0.5 ppt during any monitoring event.

Current and historical programs

There is little existing data on the water quality at Lake McLarty. However, there is community-collected water quality monitoring undertaken at a central site in Lake Mealup (Lake Mealup Preservation Society unpublished data).

Monitoring method

The variable lake levels at these seasonal wetlands have a significant impact on monitoring and interpreting results. Under natural cycles of wetting and drying, concentration effects can result in high levels of nutrients and salt. This can be difficult to distinguish from human induced impacts resulting in increased salinity and eutrophication. Therefore, the LAC for these wetlands apply only to times when the wetland is inundated to a depth of > 500mm.

Location

As these waterbodies are relatively small, sampling in the past has been at a single central location (Lake Mealup). However, the variability in water quality across these wetlands is not known, and it is suggested that when water levels are sufficient to inundate emergent vegetation (rushes and sedges) and paperbark communities that additional sampling locations are included to measure water quality within these vegetation communities.

Therefore the following locations are suggested:

- Centre wetland sites (Lakes McLarty and Mealup) - when water levels are > 500mm (maximum depth)
- Two sites within emergent reed communities in each wetland (when inundated > 200mm)
- Two sites within paperbark communities in each wetland (when inundated > 200mm).

Frequency

Sampling frequency is likely to be irregular due to the wetting and drying cycles of these wetlands and water quality samples should be taken opportunistically when vegetation communities are inundated. Centre wetland sites should be sampled a minimum of monthly whenever water levels are > 500mm.

Parameters and methods

Field collection:

- Collection and analysis of water quality samples should be undertaken in accordance with relevant Australian Standards (Australian Guidelines for Water Quality Monitoring (ANZECC 2000a); Reporting and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 200b), and Standard Methods for the Examination of Water and Wastewater (APHA 1999)).
- *In situ* profiles of pH and salinity should be made.
- Samples should be collected for total nitrogen, total phosphorus, orthophosphate, nitrate-nitrite, ammonium and chlorophyll a from mid water column using a grab sampler. Dissolved nutrient samples should be filtered through a 0.45µm cellulose acetate membrane filter in the field. Samples should be stored on ice prior to transport to the laboratory.

Laboratory analysis:

- Analysis of all samples should be undertaken by a NATA accredited laboratory according to accredited methods.

Data analysis and interpretation

Results collected for water quality parameters should be assessed against LAC for each site.

Quality Assurance and Quality Control

Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring; Reporting and relevant NATA accreditation documents should be adhered to. This includes:

Field sampling:

- Quality Assurance and Quality Control procedures contained in the Australian Guidelines for Water Quality Monitoring, including:
- duplicate samples (1 in 10 samples or a minimum of one per sampling event)
- field blanks (1 in 10 samples or a minimum of one per sampling event)
- calibration of field instruments (prior to each sampling event).

Laboratory:

- In accordance with NATA accreditation documents:
- calibration
- standards
- duplicates (copies provided with results).

Reporting information

Water quality data should be stored in WetlandBase.

Exceedences of LAC should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of this program would also be of use in the interpretation of the following monitoring programs:

- Hydrology
- Phytoplankton

Roles and responsibilities

- The Department of Environment and Conservation is responsible for maintaining the WetlandBase database.
- The Lake Mealup Preservation Society currently undertakes water quality monitoring on a volunteer basis. This should be supported both in terms of advice and financially.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

Field collection:

- 1 person for 0.5 days calibration and field preparation (8-12 times per year)
- 2 persons for 1 day sampling (8-12 times per year).

Laboratory analysis:

- approximately $70-100 per suite of parameters = $2,500-3,000 per year.

Interpretation and reporting:

- approximately 5 person days per year.

Priority

High – Lake Mealup
Moderate to Low – Lake McLarty

Rationale

Hydrology is considered one of the primary determinants of ecological character for the Peel-Yalgorup System, particularly for those systems that are groundwater-dependant. There are concerns over increasing groundwater extraction and the potential effects of this on lake hydrology, salinity and nutrient concentrations. There was insufficient information available to determine limits of acceptable change for hydrology in the Yalgorup Lakes and Lakes McLarty and Mealup for the ECD.

Objective

The objective of the hydrology program is:

- To monitor groundwater and surface water levels (mAHD) within Lakes Clifton, Preston, McLarty and Mealup to provide baseline information to set limits of acceptable change.

Current and historical programs

There have been isolated research investigations (e.g. Moore 1987, Shams 1999) that have monitored ground and or surface water for short periods (approximately 1 year). However, there has been no consistent monitoring of surface water in the Yalgorup Lakes and Lakes McLarty and Mealup. The Department of Water is responsible for the monitoring of a number of groundwater bores in the vicinity of the Yalgorup Lakes and Lakes McLarty and Mealup. Some of these have data for depth to groundwater collected at various intervals (annually, quarterly and irregular intervals) since 1979. In addition, there has been some water quality monitoring at these locations (including of salinity and nutrient concentrations) although the frequency of sampling and the period of sampling is highly variable (data provided by DoW from the WIN database).

Monitoring method

In order to record surface water levels the most effective mechanism is to put stage height gauges within each lake. In addition, depth to groundwater can be measured at existing bore locations that have been previously (or are currently) monitored by DoW. The most effective means is to augment existing monitoring by ensuring regular sample collection at a small number of bores. This would require negotiation with DoW.

Location

Surface hydrology (as water depth) should be monitored at a single location within each of the following wetlands:

- Lake Clifton
- Lake Preston (possibly needs two – one either side of the causeway)
- Lake McLarty
- Lake Mealup.

Groundwater should be monitored at a number of bores throughout the flowpath of the groundwater sources of the nominated lakes. At Lakes Clifton and Preston these should correspond with bores that are to be monitored for groundwater quality (see Water Quality B above and Figure 6). At Lakes McLarty and Mealup there are a number of existing bores, some of which are monitored for groundwater level by DoW (Figure 7), and these should be considered for inclusion in this program.

Frequency

Surface and groundwater levels should be recorded a minimum of 12 times per year, collected monthly.

Figure 7: Map of existing bore locations adjacent to Lakes Mclarty and Mealup (from DoW)

Photo: Alex Hams

Parameters and methods

Consistent with the National Indicators under the National Land and Water Resources Audit, the groundwater level should be measured in metres, read to the nearest centimetre (0.01m) and recorded in metres below (+ve) or above (-ve) a reference point. The level of accuracy required or allowable error in measuring the water level is plus or minus 5 cm (0.05m).

Surface hydrology should be read from installed water level gauges and recorded to the nearest 0.01m in metres AHD.

Data analysis and interpretation

Hydrographs should be developed for each of the monitoring locations and used to assess trends over time. Consideration should be given to climatic conditions (rainfall, evaporation, etc) when interpreting observed trends. Consistent with the National Land and Water Resources Audit, Indicator program (http://www.nlwra.gov.au), interpretation for each hydrograph should include:

- identification of the baseline trend
- comparisons with rainfall events and long term trends
- prediction of the trend shown in the hydrograph relative to the baseline under different climatic scenarios using simple models such as HAART (Hydrograph Analysis - Rainfall and Time Trend) or Flowtube.

Where possible, results should be assessed against any existing information and a baseline established to set quantitative Limits of Acceptable Change for each of the lakes. Future monitoring can inform against these LAC.

Quality Assurance and Quality Control

Collection of hydrological information should comply with existing national and jurisdictional standards for collection of surface and groundwater hydrological information.

Reporting information

Data collected for trends analysis and development of LAC should be reported annually. Rainfall and climatic data should be used to determine expected surface and groundwater levels and these compared to those actually recorded during the year.
Data collected should be stored in WetlandBase.

Links to other programs

The outputs of this program would also be of use in the interpretation of the following monitoring programs:

- Water Quality
- Phytoplankton

Roles and responsibilities

- The Department of Water is currently responsible for undertaking the monitoring of groundwater and the input of data into the WIN database.
- The Department of Environment and Conservation is responsible for maintaining the WetlandBase database.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

It is anticipated that the field collection for the Hydrology Program could be undertaken in conjunction with the Water Quality Programs B and C. There would therefore be no additional field costs. However, there would be costs associated with establishing water level gauges at the lakes. Additional reporting and analysis costs in the order of 5-10 person days per year would be reasonable.

Priority

High

Rationale

Phytoplankton are primary producers and can respond rapidly to changes in water quality (nutrients, salinity, turbidity). Prior to the opening of the Dawesville Channel, high levels of nutrients resulted in regular phytoplankton blooms in the Peel-Harvey Estuary. In many cases these were of toxic taxa such as Nodularia. In addition the cyanobacteria Lyngbya has been recorded in bloom proportions in Goegrup Lake with concerns for ecosystem health.

The LAC for phytoplankton are centred on biomass (chlorophyll a) and these are addressed under water quality monitoring program A: Peel-Harvey Estuary.

Photo: Bill Russell

Rationale

Seagrass and macroalgae form a significant ecological component of the Peel-Harvey Estuary. Prior to the opening of the Dawesville Channel, excess nutrient loads entering the system resulted in increased growth of macroalgae, particularly in the Peel Inlet. This resulted in both ecological and social impacts, with smothering of seagrass, decomposition of large amounts of macroalgae, noxious odours and deoxygenation of the water column. Since the opening of the Dawesville Channel, data is limited, but there are suggestions that seagrass beds are once more establishing. Seagrass beds provide habitat for fish and invertebrates and a food source for a number of fauna species including some waterbirds.

In addition, there have been reports on the Yalgorup Lakes that macroalgal growth within Lake Clifton may be causing a significant threat to the thrombolites.

There was insufficient available information to determine the limits of acceptable change for macroalgae and seagrass in the Peel-Harvey Estuary or macroalgae in Lake Clifton for the ECD.

Objectives

The objectives of the benthic plant monitoring program are:

- To determine the extent and community composition of macroalgae and seagrass in the Peel-Harvey Estuary to inform development of LAC.
- To determine the extent of macroalgal cover of the thrombolites to determine LAC and the potential threat to Thrombolites within the lake.
- To pilot test a method for ongoing monitoring.

Current and historical programs

Benthic plant biomass and extent was monitored in the Peel-Harvey Estuary from 1977 until 2001 (Wilson et al. 1999). Prior to the opening of the Dawesville Channel in 1994, monitoring was conducted seasonally (four times per year). After this time, sampling frequency was reduced to twice a year (in spring and summer). Quantitative sampling was undertaken at 43 sites across the estuary by divers, using 9 cm cores. Results were analysed with a computer program (SYMAP) which determined density contours for different species (Wilson et al. 1999).

A recent research program conducted by Murdoch University has mapped the benthos of the Peel-Harvey Estuary using remote sensing techniques. However the results only indicate the extent of plant growth, bare sand and rocky substrate and do not provide information on community composition (F. Valesini, pers. comm.).

There has been no routine monitoring of macroalgae at Lake Clifton.

Monitoring method

There have been significant advances in benthic habitat mapping methods since the program was developed for the Peel-Harvey Estuary in 1977. However, many of the remote sensing methods are still in the development phase and may not be applicable in all situations (Holmes et al. 2006). It is therefore recommended that a pilot investigation be undertaken to determine the most appropriate method of benthic plant mapping and monitoring in the Peel-Yalgorup Ramsar site.

A combination of remote sensing using Quickbird/IKONOS multispectral satellite imagery (1 -4 m pixels) with ground truthing and field surveying has proven successful in mapping benthic habitat in other comparable locations in Australia (Phinn et al. 2006). It is recommended that the method described in Phinn et al. (2006) together with that for the field analysis in Roelfsema et al. (2006) be adapted and applied to the Peel-Yalgorup Ramsar site.

Location

Sampling is to be conducted in the Peel-Harvey Estuary and Lake Clifton in the Yalgorup Lakes. Satellite imagery will cover the entire extent of the waterbodies; however, a stratified random sampling design will be required for field validation and ground truthing (see Holmes et al. 2006 for guidance).

Frequency

Sampling is to be conducted annually in spring or summer.

Parameters and methods

The recommended monitoring procedure, adapted from Phinn et al. (2006), is illustrated in Figure 8. Detailed methodology can be found in the source document and will need to be modified to suit the Peel-Yalgorup System. The process involves both the use of remote sensing imagery as well as field collected information to produce a map of the distribution, community composition and density (percentage cover) of benthic plants in the Peel-Harvey Estuary and Lake Clifton.

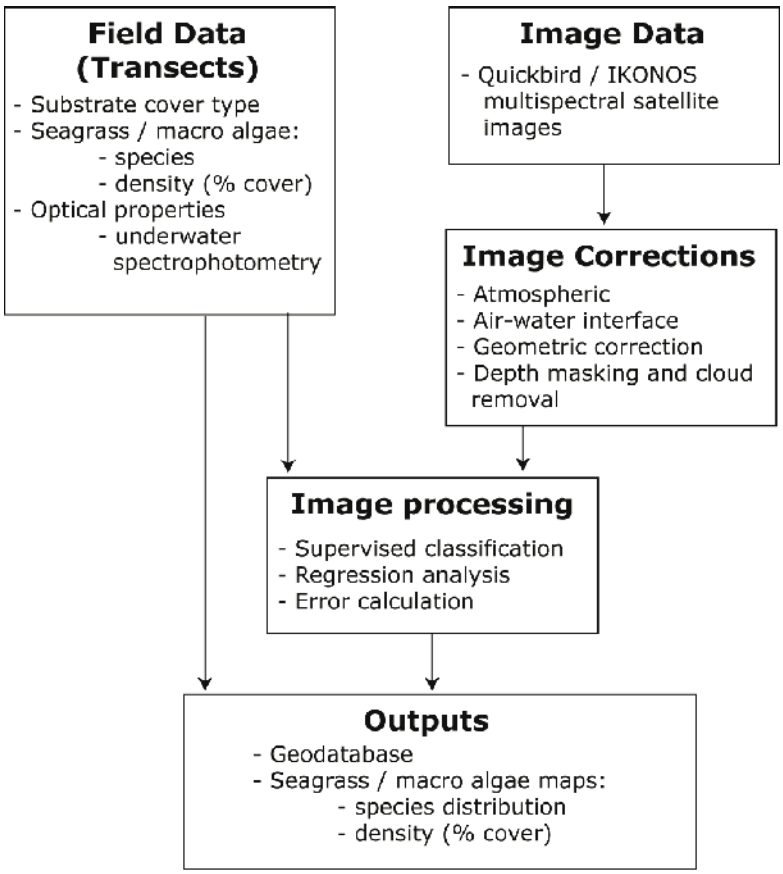

Figure 8: Proposed process for benthic plant monitoring (adapted from Phinn et al. 2006).

Data analysis and interpretation

Data collected is to be used to:

- refine the method and develop a monitoring program that can be consistently implemented annually at the Peel-Yalgorup Ramsar site.
- develop LAC for benthic plant community composition and density.

It is likely that the development of LAC will require data from a number of years to adequately capture natural variation. Therefore, annual comparisons should be made to detect trends in benthic plant distribution, community composition and density. This will be particularly relevant for the macroalgal covering of the thrombolites at Lake Clifton. The Peel-Yalgorup Technical Advisory Panel should be responsible for identifying significant threats and/or impacts and recommending appropriate management actions.

Quality Assurance and Quality Control

Comparisons of field versus remote sensing data and error calculations can be used to determine the likely accuracy of mapping products. Any interpretation of the resulting maps and data should be undertaken with full consideration of these errors and level of uncertainty.

Reporting information

Mapping and geodata data should be stored in WetlandBase.

Once LAC are developed, exceedences should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel should be consulted where necessary.

An annual report describing the results of the monitoring program, trends, LAC development and recommendations of the Peel-Yalgorup Technical Advisory Panel should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of the water quality and hydrology programs could be useful in the interpretation of data collected under this benthic plants monitoring program.

Roles and responsibilities

- The monitoring program will require engagement of a specialist group from a university or consulting firm and the body established for the administration of the management plan should be responsible for coordination and engagement of consultants.
- The Department of Environment and Conservation has access to large spatial datasets and may be able to provide a role in the sourcing and supply of images. They are also responsible for maintaining WetlandBase .
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

The costs of this program are difficult to determine and will include a combination of the cost of image purchase, processing and field collection. Using the estimates contained in Holmes et al. (2006) it is likely that the imagery will cost between $10,000-20,000. Estimates for processing are difficult, and it is likely that the pilot study will be significantly more costly, as methods are developed, than ongoing monitoring. A minimum of 20 person days for image processing would be required. Field expenses are likely to be in the order of 10-20 person days plus boats, vehicles and equipment.

Priority

High

Photo: Kim Wilson

Rationale

Littoral and fringing vegetation of the Peel-Yalgorup Ramsar site is comprised of saltmarsh (samphire), paperbark and emergent reed communities. In addition to its intrinsic value it provides significant habitat for the fauna of the Ramsar site.

Table 7: Limits of acceptable change for littoral and fringing vegetation from Peel-Yalgorup Ramsar site (adapted from Hale and Butcher 2007, p129-131)

Relevant LAC Location/Component	Baseline/Supporting Evidence	Limit of Acceptable Change
Peel-Yalgorup Samphire and Paperbark	The current extent and health of samphire and paperbark communities is unknown.	Baseline must be set before limits can be made.
Lakes McLarty and Mealup Littoral Vegetation	These are dominated by freshwater reeds, but encroachment of Typha is a problem at both wetlands. Sedges are an important habitat component for some waterbirds.	Typha limited to < 20 % of the wetland area Freshwater sedges covering a minimum of 20% of the wetland area
Lakes McLarty and Mealup Paperbark	The fringing freshwater paperbark community is an important habitat for waterbirds. There is no quantitative information.	No decline in paperbark health No net loss of extent of paperbark community
Lakes Goegrup and Black Samphire	There were approximately 83 hectares when mapped in 2006. However, there is no information on the natural variability in this community.	Extent and distribution of samphire within patterns of natural variation
Lakes Goegrup and Black Paperbark	There are fringing areas of both freshwater (47 ha) and saltwater paperbark (145 ha) communities. These perennial woody vegetation complexes have low natural variability in extent.	No change in the condition of paperbark communities No loss of extent of paperbark communities

Objectives

The objectives of the littoral and fringing vegetation monitoring program are:

- To determine the extent and composition of littoral vegetation and paperbark communities at lakes McLarty and Mealup to set a baseline against which change can be assessed.
- To determine the extent and composition of samphire and paperbark communities fringing the Peel-Harvey Estuary to set a baseline against which change can be assessed.
- To monitor the extent and composition of samphire and paperbark communities at lakes Goegrup and Black to assess against LAC.

Current and historical programs

There has been a number of previous programs that assessed the extent and/or condition of littoral and fringing vegetation in the Peel-Yalgorup Ramsar site:

Glasson et al. (1995) - determined the extent of saltmarsh vegetation around the Peel-Harvey Estuary (including Goegrup and Black lakes) from aerial photography. Comparisons were made from five points in time: 1957, 1965, 1977, 1986 and 1994.

Murray et al. (1995) - complemented the work of Glasson et al. (1995) by undertaking field investigations of community composition and biomass of saltmarsh vegetation at 10 locations. Transects were located around the Peel-Harvey Estuary and lakes Goegrup and Black.

Monks and Gibson (2000) – assessed the composition and condition of saltmarsh and paperbark communities around the Peel-Harvey Estuary and Lake Mealup annually from 1994 to 1998.

Ecoscape and R & E O'Connor Pty Ltd. (2006) – The extent and composition of fringing vegetation (saltmarsh and paperbark) was mapped in 2006 as a part of the Goegrup and Black Lake Action Plan. This included aerial photograph interpretation and 37 on-ground sites.

Monitoring method

The recommended procedure is to use remote sensing to map the extent of fringing vegetation communities in broad groups (saltmarsh, paperbark, emergent sedges and reeds) with ground truthing and assessment of community composition from field surveys at permanent transects.

Fringing and littoral vegetation communities often occur in narrow strips (< 50 m wide) around waterbodies. Therefore, accurate mapping by remote sensing requires imagery with a relatively high level of spatial resolution. Glasson et al. (1995) recommended the use of aerial photography which has a pixel size of 0.05 - 1m (Holmes et al. 2006). However, Quickbird/ IKONOS satellite imagery may be sufficient and there could be advantages to using imagery sourced for the benthic plants to also map fringing vegetation.

Location

Map fringing vegetation extent across the Peel-Harvey Estuary, and Lakes McLarty, Mealup, Goegrup and Black.

Conduct field surveys at the 10 permanent transects in the estuary and Lakes Goegrup and Black established by Glasson et al. (1995) plus the Lake Mealup transects of Monks and Gibson (2000) and an additional pair of transects at Lake McLarty (Figure 9).

Frequency

Monks and Gibson (2000) reported the dynamic nature of saltmarsh vegetation in their four year study. However, their investigation was undertaken immediately following the opening of the Dawesville Channel when tides and inundation of fringing vegetation caused dramatic change. Given the high variability in community composition and cover recorded in previous investigations, the ideal frequency for mapping extent and assessing composition would be annually in spring. However the minimum frequency should be once every 3-5 years.

Parameters and methods

The extent of vegetation should be mapped from aerial photography (or high resolution satellite imagery) by supervised classification methods. Resulting maps and statistics should distinguish, at a minimum, the following broad groups:

- saltmarsh
- paperbark
- freshwater reeds
- bare ground
- open water (Lakes McLarty and Mealup).

Field surveys should be undertaken at permanent transects extending from upland (terrestrial vegetation) to the water's edge (in the Peel-Harvey Estuary and Lakes Goegrup and Black) or the extent of vegetation (Lakes McLarty and Mealup). Following the method of Murray et al. (1995) transects should be stratified into zones of similar vegetation (Figure 10). In each zone percentage cover of each species should be recorded in five random quadrants (1 m x 1 m).

In addition, a minimum of 100 random points across the mapped area should be ground-truthed to validate the remote sensing map.

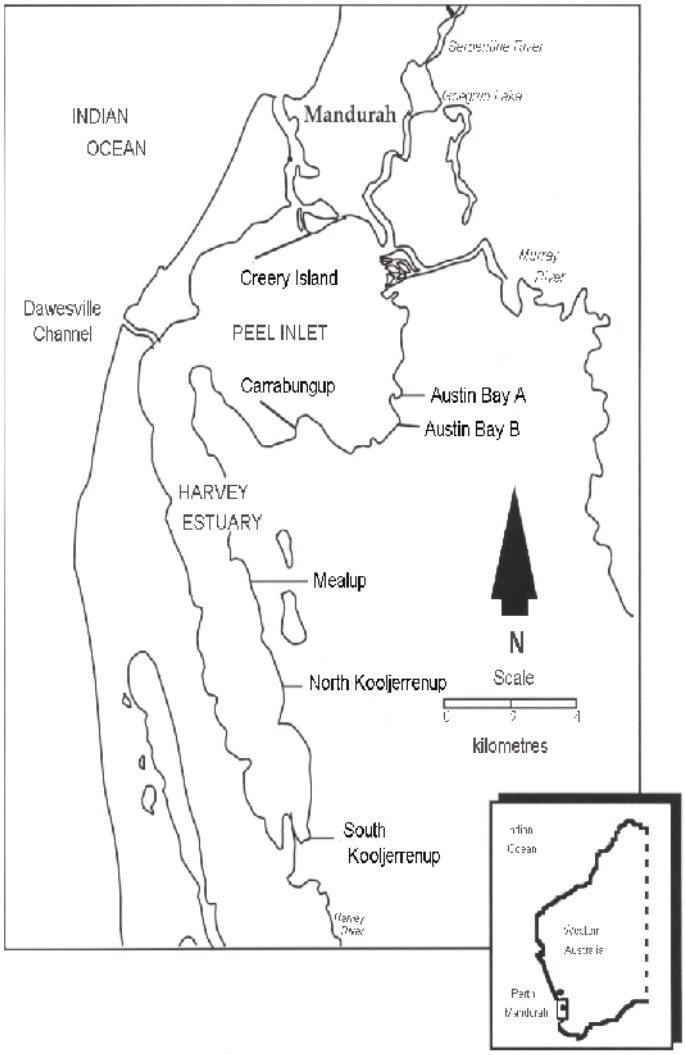

Figure 9: Location of vegetation transects (From Monks and Gibson 2000).

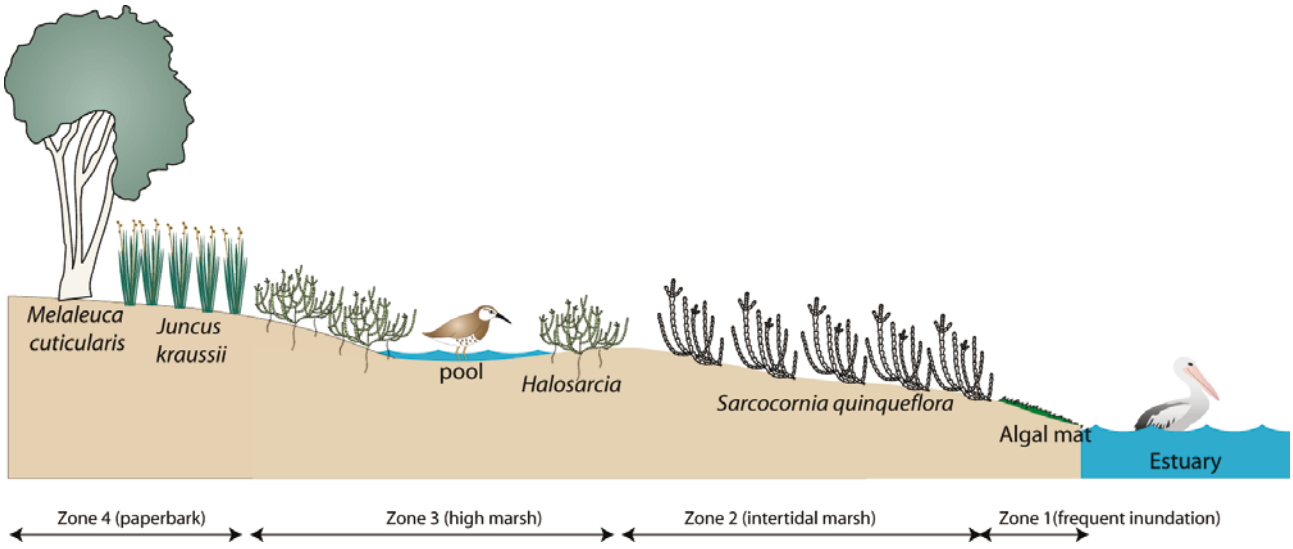

Figure 10: Fringing vegetation zones (adapted from Murray et al. 1995).

Data analysis and interpretation

Mapping of vegetation extent should be compared to the results of Glasson et al. (1995) and Ecoscape and R & E O'Connor Pty Ltd (2006) in terms of change in cover since 1994 and 2006, respectively. The results from the Peel-Harvey Estuary and Lakes McLarty and Mealup should be used to inform quantitative Limits of Acceptable Change.

The results of the field surveying and the remote sensing should be reported as average percentage cover of dominant species in each 'zone' and the linear extent and position of each vegetation zone within a transect.

Quality Assurance and Quality Control

The field ground truthing data should be compared to the remote sensing map to determine the accuracy of the remote sensing techniques.

Field identifications of vegetation species should be checked for accuracy by the Western Australian Herbarium.

Reporting information

Mapping, geodata data and field data should be stored in the WetlandBase .

Once LAC are developed, exceedences should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program, trends, LAC development and recommendations of the *Peel-Yalgorup Technical Advisory Panel* should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of the water quality and hydrology programs may be of use in interpreting the results of the fringing and littoral vegetation monitoring program.

Roles and responsibilities

- The monitoring program will require engagement of a specialist group from a university or consulting firm and the body established for the administration of the management plan should be responsible for coordination and engagement of consultants.
- The Department of Environment and Conservation has access to large spatial datasets and may be able to provide a role in the sourcing and supply of images. They are also responsible for maintaining WetlandBase.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

The costs of this program are difficult to determine and will include a combination of the cost of image purchase, processing and field collection. It is possible that imagery obtained for the benthic plant monitoring could also be used for this program, representing a cost saving. In addition, aerial imagery is available on an annual basis for the entire study area. An inter-agency agreement with the Department of Lands may reduce costs.

Estimates for image processing will be dependant on the skills of the operator and their familiarity with identifying saltmarsh and wetland vegetation. Minimum of 10-15 person days for image processing would be required. Field expenses are likely to be in the order of 10-20 person days plus vehicles and equipment.

Priority

High – Peel-Harvey Estuary and Lakes McLarty and Mealup
Medium – Lakes Goegrup and Black

Rationale

The Peel-Harvey Estuary is an important commercial and recreational fishery. The system also provides an important nursery habitat for some fish species and is a migratory route for the Pouched Lamprey. Fish are also an important food source for waterbirds. In addition, the system provides there is little recent information on the size and composition of the fish of the Estuary. As a consequence, there is no baseline information on which to base LAC.

Objectives

The objectives of the fish monitoring program are:

- To set a baseline in terms of fish community composition and populations to inform the development of LAC.
- To monitor changes in fish community composition and population over time to inform the management of the site.

Current and historical programs

There has been a number of research programs focused on specific fish/crustacean species or questions within the Peel-Harvey Estuary (de Lestang et al. 2003a and 2003b; Lenanton and Potter 1987; Steckis et al. 1980; Young and Potter 2002, 2003a and 2003b). However, there has been little long-term monitoring.

Lonergan et al. (1986) monitored the fish fauna of the Peel-Harvey Estuary twice annually from 1979 to 1981. Fisheries WA (2006) annually monitors commercial catches, including those in the Peel-Harvey Estuary. They report in terms of catch per unit effort and total catch for a number of commercially important species. Murdoch University has a monitoring/research program that includes fish within the Peel-Harvey Estuary but results are yet to be published (F. Valesini pers. comm.).

Monitoring method

The most cost effective method of fish monitoring for the Peel-Harvey Estuary would be to collect data from the Fisheries WA program and use this to set LAC and inform management of the system. However, this does not include information on species that are not of commercial importance.

The alternative is to develop, fund and implement a dedicated fish monitoring program. Suggestions for such a program, based on the methodology of Lonergan et al. (1987) are provided below.

Location

Sampling at the eight locations of Lonergan et al. (1987) located within the Peel-Harvey Estuary and Lake Goegrup (Figure 11).

Frequency

Sampling frequency by Lonergan et al. (1987) was intense – every six weeks from August 1979 to September 1980, then bimonthly for the following year. However, this intensity of sampling is probably not warranted for routine monitoring; and annual sampling in spring or summer should allow for meaningful characterisation of fish populations.

Parameters and methods

Following the methods of Lonergan et al. (1987) sampling should be undertaken using large beach seine nets at each of the eight sites. Total number (and optionally wet weight) of each species should be recorded.

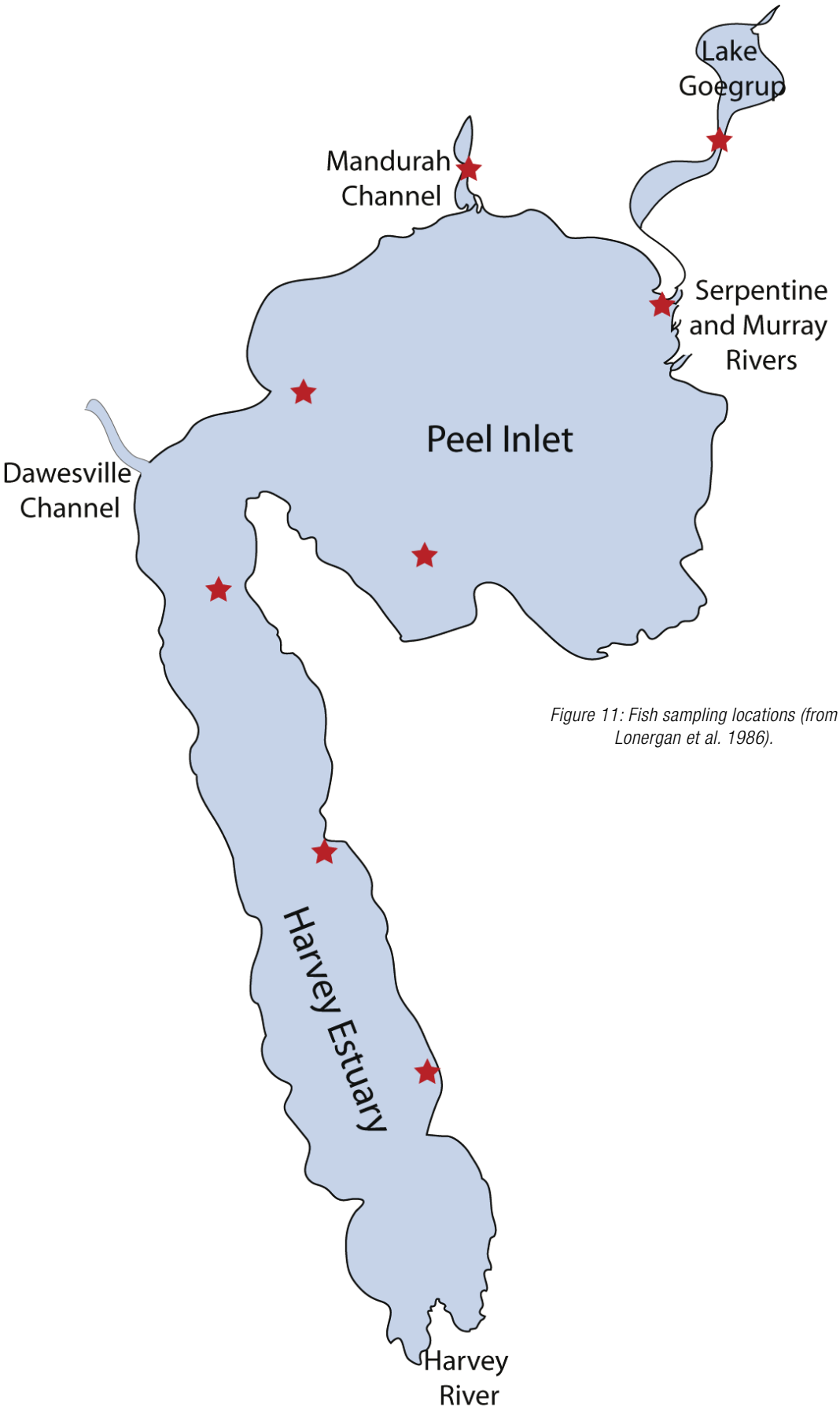

Figure 11: Fish sampling locations (from Lonergan et al. 1986).

Data analysis and interpretation

Data collected is to be used to:

- set LAC in terms of fish community composition and density
- assess against the LAC in subsequent monitoring events.

It is likely that the development of LAC will require data from a number of years to adequately capture natural variation. In the interim data, collected should be statistically analysed to determine any changes in composition or density of fish species over time. In addition, data collected by Fisheries WA on commercially important species should be included in the analysis.

Reporting information

Density and species composition data should be stored in WetlandBase .

Once LAC are developed, exceedences should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program (including that from Fisheries WA), trends, LAC development and recommendations of the Peel-Yalgorup Technical Advisory Panel should be produced and made available to stakeholders and the wider community.

Links to other programs

The outputs of the water quality and hydrology monitoring programs may be of use in interpreting the results of the fish monitoring program.

Roles and responsibilities

- The monitoring program will require engagement of a specialist group from a university or consulting firm and the body established for the administration of the management plan should be responsible for the coordination and engagement of consultants.
- The Department of Environment and Conservation is responsible for maintaining WetlandBase .
- Fisheries WA are currently responsible for commercial fish monitoring and reporting.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

It is estimated that field sampling will take between 15 and 25 person days, plus vehicles and equipment. Data analysis, interpretation and report writing would be in the order of 10-15 person days for a basic summary report.

Priority

Medium

Rationale

One of the reasons that the Peel-Yalgorup Ramsar site has been recognised as a Wetland of International Importance is that it regularly supports more than 1% of the flyway population (Ramsar Criterion 6) of each of 14 species of waterbirds (Hale and Butcher 2008). While it may not be feasible (with available resources) to monitor all of these species intensively, a strategic approach that focuses on two of these species – the Red-necked Stint *(Calidris ruficollis)* and the Sharp-tailed Sandpiper *(Calidris acuminata)* – is recommended. These species have been selected for the following reasons:

- Data from previous surveys (since 1970s) indicate that these species can be expected to be present within the Ramsar site each year, if suitable habitat is present.
- They occur at multiple locations within the Ramsar site and their presence is not dependent on a single area of habitat.
- They are a relatively abundant species, with numbers in the thousands at times and thereby contribute significantly to the site, meeting Ramsar Criterion 5.
- Though presenting some challenges for inexperienced observers, an experienced observer can readily identify them in the field (ignoring several similar small-sized species that occur as vagrants or in very low numbers).
- Being migratory shorebirds, they could be used as an indicator of the site's ongoing (substantial) support of migration by waterbirds (relates to Ramsar Criterion 4).
- The Red-necked Stint is by far the most abundant of the migratory shorebirds at the site and the Sharp-tailed Sandpiper provides different but complementary information.

Two other waterbird species are also recommended for monitoring. (See Waterbirds B and Waterbirds C below.)

The relevant LAC is:

- Supports more than 1% of the population of the following waterbirds in three out of five years:
- Red-necked Stint
- Sharp-tailed Sandpiper.

Objective and Hypothesis

The objective of the Waterbird A monitoring program is:

- To undertake counts of Red-necked Stint and Sharp-tailed Sandpiper annually at strategic locations across the Peel-Yalgorup Ramsar site to assess maintenance of ecological character.

The specific hypothesis of the Waterbird A program is:

- The Peel-Yalgorup Ramsar site will support more than 1% of the flyway population of Red-necked Stints and Sharp-tailed Sandpipers at a minimum of three out of five years.

Current and historical programs

Lane and Pearson (2002) – Monitoring of waterbirds in the Peel-Harvey Estuary from 1975 to 1977. Counts were undertaken over four days every two months involving aerial, boat-based and on-foot methods.

Lane et al. (2002a and 2002b) – Monitoring of waterbirds during October, December and February 1994 to 1999 over four days involving aerial, boat-based and on-foot methods.

Jaensch et al. (1988) – The Royal Australasian Ornithologists Union (RAOU) undertook waterbird counts at a number of wetlands, including the nature reserves in eastern Peel Inlet, and Lakes McLarty and Mealup from 1981 to the late 1980s.

Halse et al. (1990) – CALM undertook annual waterbird counts in wetlands in south-western Australia from 1986 to 1990. This included Lakes Preston, Clifton and McLarty as well as the Peel-Harvey Estuary.

Bamford and Bamford (2003) – Monthly surveys of waterbirds at the Creery Wetlands (Peel-Harvey Estuary) from 2000 to 2003.

Craig et al. (2001 and 2006) – Waterbird and shorebird surveys from Lake McLarty: 33 surveys between 1990 and 1995; regular (monthly and weekly during peak seasons) surveys between 1996 and 2001; irregular (27 total) surveys between 2001 and 2005.

Private individuals – Individuals such as D. Rule and B. Russell have collected a large amount of waterbird count data from the Peel-Yalgorup Ramsar site. Russell has assembled a database of counts from the Yalgorup Lakes from 1995 to 2007.

Monitoring method

Red-necked Stints and Sharp-tailed Sandpipers, as with other waterbirds in the Peel-Yalgorup Ramsar site, are highly mobile and the species can be found at a number of locations within the site at any given time. Consequently, a coordinated monitoring program that involves annual counts simultaneously at these locations should provide a more comprehensive estimate of the total number of birds using the Ramsar site than fragmented counts that are undertaken at different locations at different times.

Location

Red-necked Stints have been previously recorded in significant numbers (at least 10% of their 1% threshold, ie. say more than 300 birds) at: Lake Preston, Yalgorup Lake, Martins Tank and Lake Pollard (B. Russell unpublished data); Peel-Harvey Estuary (Jaensch et al. 1988; Bamford & Bamford 2003; Lane et al. 2002a and 2002b; Lane and Pearson 2002); and Lake McLarty (Craig et al. 2001 and 2006). Therefore it is suggested that the monitoring program target and cover all of these areas. As some of these wetlands are very large (Peel-Harvey Estuary and Lake Preston), it is recommended that the system be divided into 'zones'. In the case of the Peel-Harvey Estuary, the zones described by Lane and Pearson (2002) would provide data that could be compared to that collected historically. Similarly the division of Lake Preston into the northern and middle sections previously monitored by Bill Russell would also provide new data comparable to existing count data.

Frequency

Red-necked Stints are international migrants that breed in Siberia. They are most likely to be in the Peel-Yalgorup Ramsar site between late August and early April. Therefore it is recommended that monitoring takes place each year within this period. Annual population monitoring by the Australasian Wader Studies Group occurs in mid-summer, when southward migration has ceased, so this would be the primary count date (late January or early February).

Parameters and methods

Counts of Red-necked Stints should be undertaken simultaneously at each of the above-mentioned locations/zones. Repetition of the survey on a second (consecutive) day would add robustness to the effort by enabling means and variance to be calculated.

Data analysis and interpretation

Counts each year can be compared with the most recent Waterbird Population Estimates (Wetland International) to ensure that the LAC is met for this species.

Quality Assurance and Quality Control

Application of the recommendations for observer training and monitoring protocols recommended in the Shorebirds 2020 program (Clemens et al. 2007).

Reporting information

Data collated should be stored in a dedicated Peel-Yalgorup Ramsar site Waterbird Database (see Waterbird Program D). In addition, data should be forwarded to Birds Australia for inclusion in the Shorebirds 2020 program and Australian Bird Atlas as well as stored in WetlandBase .

Exceedences of LAC should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

Linking this program with the Birds Australia Shorebirds 2020 would have advantages.

Roles and responsibilities

- Currently waterbird monitoring is undertaken by volunteers coordinated at the state level by Birds Australia WA and at the national level by Birds Australia. Consideration should be given to supporting volunteers in terms of coordination and financial remuneration for expenses incurred.
- The Department of Environment and Conservation is responsible for maintaining WetlandBase.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

The use of volunteers and linking with existing bird monitoring programs (e.g. Shorebirds 2020) would greatly reduce the cost of implementing this program. However, even with the majority of counters volunteering their services, a coordinator will need to be appointed (estimate 10 days annually). In addition, collation, analysis and reporting will require a dedicated person (estimated at 5-10 days per year).

Priority

High

Photo: Tony Kirkby

Rationale

One of the reasons that the Peel-Yalgorup Ramsar site has been recognised as a wetland of international importance is that it supports plant/animal species at critical stages in their lifecycles. This includes over 30 species of waterbirds during breeding (Hale and Butcher 2008). While it may not be feasible (with available resources) to monitor the breeding of all of these species intensively, a strategic approach is recommended that focuses on two species – the Little Black Cormorant *(Phalacrocorax sulcirostris)* and the Little Pied Cormorant *(P. melanoleucos)*. These have significant breeding colonies at Carrabungup (sometimes referred to as Carraburmup) Nature Reserve adjacent to the Peel Inlet and within the Ramsar site. Colonial breeding species typically nest in relatively few locations and so their colonies are inherently vulnerable. Loss of a major colony could have a huge impact on population size and viability. In the 1980s, over one thousand Little Black Cormorants and several hundred Little Pied Cormorants bred, possibly each year, at Carrabungup and these were among the largest known colonies of these species in south-western Australia (Jaensch et al. 1988; Wetlands International unpublished data). Given the high density of nesting and the caution taken to avoid undue disturbance to nesting birds, it is likely that these estimates were somewhat below the actual numbers of nests present at the time. The colonies are arguably the most significant aspect of waterbird breeding in the Ramsar site. Breeding by Hooded Plover is also regionally important (see Waterbirds C).

Objectives

The objectives of the Waterbirds B monitoring program are:

- To assess the breeding status of the Little Black Cormorant and Little Pied Cormorant at Carrabungup Reserve.
- To inform quantitative LAC for breeding for these waterbirds.

Current and historical programs

Jaensch et al. (1988) recorded more than 1,000 breeding pairs of Little Black Cormorant and more than 300 pairs of breeding Little Pied Cormorant in the inundated paperbarks of Carrabungup Reserve in September and October (1981-1985). Movements of birds indicated that the adults fed in nearby parts of the estuary and/or freshwater wetlands. It is not known if the colonies have remained active subsequent to the 1980s. Colonial nesting birds sometimes abandon colony sites for a year or so (during which time trees damaged by nesting may recover) returning to continue nesting in subsequent years. Colonies of cormorants in swamps at the eastern side of Peel Inlet had been known to government wildlife officers and/or ornithologists for some years.

Monitoring method

Confirmation of breeding simply requires an experienced ornithologist to visit the edge of the colony site on one to several occasions during the spring breeding months. (Sometimes cormorants may nest in winter.) A common-sense systematic search of the colony site would enable all or most nests to be viewed, generally at distance, and contents and/or behaviour of adults documented. The number of active nests and stage of activity (building, sitting, feeding young, young recently out of nest) would be recorded for each species. This more complex monitoring of breeding colonies requires trained observers to avoid disturbance of nests as large nestlings are known to leap out of nests if approached too closely. To avoid disturbance and avoid confusion caused by the presence of near-flying young (not readily distinguishable from adults), the optimum time for surveys would be at the early stages of incubation rather than when young are present. However, due to non-synchronous breeding, nests with eggs may occur at the same time as some nests with young.

A map indicating the approximate location of nesting birds in the reserve would be a useful item of additional information. The condition of nesting trees should be noted.

Location

Paperbark wooded swamp at Carrabungup Reserve.

Frequency

Annually in August through to October

Parameters and methods

Visual counts of nests and breeding pairs by trained observers

Data analysis and interpretation

Records of breeding (attempts and success) should be analysed to determine trends over time and inform refinement of LAC.

Quality Assurance and Quality Control

In order to avoid disturbance of nesting birds it is essential that only trained observers are used in this program.

Reporting information

Data collated should be stored in a dedicated Peel-Yalgorup Ramsar site Waterbird Database (see Waterbird Program D). In addition, data should be forwarded to Birds Australia for inclusion in the Australian Bird Atlas as well as stored in WetlandBase.

Exceedences of LAC should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

There is no state or nation-wide program of monitoring breeding colonies of waterbirds, but data should be copied to Wetlands International - Oceania, which has a database of systematic and anecdotal information on breeding colonies in Australia. These data are considered in providing advice to the compilers of updates to the global Waterbird Population Estimates initiative (Wetlands International 2006).

Roles and responsibilities

- Currently waterbird monitoring is undertaken by a pool of volunteers coordinated at the state level by Birds Australia WA and at the national level by Birds Australia. This program, however, represents a new waterbird monitoring event and would require establishment and coordination. Consideration should be given to supporting volunteers in terms of coordination and financial remuneration for expenses incurred.
- The Department of Environment and Conservation is responsible for maintaining WetlandBase.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

- The costs of implementing this program are likely to be moderate, approximately 5-10 person days for the counts and an additional 5 days for data interpretation and analysis.

Priority

Medium to High

Rationale

Two of the criteria for wetlands of international importance met by the Peel-Yalgorup Ramsar site are:

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 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

As mentioned above, it is not feasible to adequately monitor all of the waterbirds for which the site meets these criteria. Rather, a strategic approach is proposed in which intensive monitoring of selected species can act as indicators for the wider range of significant waterbird populations. The Yalgorup Lakes regularly support more than 1% (60 birds) of the western population of Hooded Plover *(Thinornis rubricollis)* and are a significant site bioregionally for breeding of these birds (Birds Australia 2006). Additional reasons for selecting the Hooded Plover for monitoring are:

- It occurs regularly at the site and similar, highly suitable lake habitat is scarce if not absent elsewhere on the Swan Coastal Plain (thus reducing the likelihood that the birds may temporarily be using other sites).
- The bird is easily identified and not readily confused with other species.
- Selection of this species ensures inclusion of a waterbird element that focuses solely on the Yalgorup Lakes (which provide habitat differentfrom the other wetland components of the Ramsar site).

Relevant LAC (Hale and Butcher 2008) are:

- Supports more than 1 % of the population of the following birds three out of five years: Hooded Plover (60).
- Successful breeding recorded for Hooded Plover in three out of five years.

Objective and Hypotheses

The objective of the Waterbird C monitoring program is:

- To undertake counts of Hooded Plover quarterly at Lakes Preston and Clifton to assess maintenance of ecological character.

The specific hypotheses of the Waterbird C program are:

- The Peel-Yalgorup Ramsar site will support more than 60 Hooded Plovers in a minimum of three out of any five years.
- The Peel-Yalgorup Ramsar site will support successful breeding of Hooded Plovers in a minimum of 3 out of any 5 years.

Current and historical programs

Birds Australia (2006) has been involved in the monitoring of Hooded Plover at the Yalgorup Lakes since 1994. This has included a banding program, regular summer surveys and breeding observations. Since 2000 the Myalup Bird Observers Group has monitored Hooded Plover behaviour at a number of sites in the Yalgorup Lakes complex. Individual volunteers have been responsible for establishing and collecting information from a suite of sites.

Monitoring method

It is recommended that this monitoring program support the existing monitoring of Hooded Plovers at the Yalgorup Lakes and utilise the results to inform management of the site.

Location

The current program is undertaken at a number of site locations. A review of these to determine if they represent adequate spatial coverage is recommended.

Frequency

Quarterly counts are recommended with observations of breeding behaviour concentrated on the breeding season (December-April).

Parameters and methods

Counts – Total counts of the area of likely occupancy should be attempted wherever possible.

Breeding behaviour – following the methods of the Victorian Hooded Plover Monitoring Program (Birds Australia). Pairs are monitored fortnightly to determine nesting attempts, successful nesting, hatching and fledging (timing and successes). Monitoring protocols are established to minimise disturbance of nesting birds:

- Monitoring is undertaken by trained observers only.
- No observer is to be within 5 m of a nest.
- No nest or pair is to be observed for more than 35 minutes.
- Observations are to be made in the cool of the morning or late afternoon (to avoid overheating of eggs).
- Any behavioural sign of distress from birds (false brooding, distraction display) results in withdrawal of observers.

Data analysis and interpretation

Counts each year can be compared with the most recent Waterbird Population Estimates (Wetland International) to ensure that the LAC are met for this species.

Records of breeding (attempts and success) should be analysed to determine trends over time and inform refinement of LAC.

Quality Assurance and Quality Control

Application of the recommendations for observer training and monitoring protocols recommended in the Shorebirds 2020 program (Clemens et al. 2007).

Reporting information

Data collated should be stored in a dedicated Peel-Yalgorup Ramsar site Waterbird Database (see Waterbird Program D). In addition, data should be forwarded to Birds Australia for inclusion in the Australian Bird Atlas as well as stored in WetlandBase .

Exceedences of LAC should trigger the management process illustrated in Figure 4 above and relevant technical experts on the Peel-Yalgorup Technical Advisory Panel consulted where necessary.

An annual report describing the results of the monitoring program against LAC and describing trends should be produced and made available to stakeholders and the wider community.

Links to other programs

Linking this program with the Birds Australia Shorebirds 2020 would have advantages.

Roles and responsibilities

- Currently waterbird monitoring is undertaken by a pool of volunteers coordinated at the state level by Birds Australia WA and at the national level by Birds Australia. This program, however, represents a new waterbird monitoring event and would require establishment and coordination. Consideration should be given to supporting volunteers in terms of coordination and financial remuneration for expenses incurred.
- The Department of Environment and Conservation is responsible for maintaining WetlandBase.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring as well as for annual reporting and informing the Technical Advisory Panel.

Estimated costs

The use of volunteers and linking with the existing Hooded Plover monitoring would greatly reduce the cost of implementing this program. However, even with the majority of observers volunteering their services, a coordinator will need to be appointed (estimate 5-10 days annually). In addition, collation, analysis and reporting will require a dedicated person (estimated at 5-10 days per year).

Priority

High

Photo: Tony Kirkby

Rationale

A large amount of information is currently being collected on waterbird numbers, breeding and other behaviours in the Peel-Yalgorup Ramsar site. However, little of this information is collated and used to inform management of the site. One of the most cost effective methods of monitoring waterbird populations within the Ramsar site would be to collate and analyse existing information and data currently collected under other programs or by local bird observers groups.

Objectives

The objectives of the Waterbirds D coordination program are:

- To collate existing waterbird usage and monitoring data from the Peel-Yalgorup Ramsar site and store in a dedicated database (Peel-Yalgorup Ramsar Waterbird Database).
- To coordinate the collection of future waterbird monitoring data for input to the database.
- To analyse the waterbird data from the newly developed Peel-Yalgorup Ramsar Waterbird Database to detect trends, refine LAC and inform ongoing management of the site.
- To oversee provision of new monitoring data to external users including Birds Australia and liaise on common tasks (such as reporting) to ensure effective use of resources.

Current and historical programs

Lane and Pearson (2002) – Monitoring of waterbirds in the Peel-Harvey Estuary from 1975-1977. Counts undertaken oveer four days every two months involving plane, boat and foot methods.

Lane et al. (2002a and 2002b) – Monitoring of waterbirds during October, December and February 1994 to 1999 over four days involving aerial, boat-based and on-foot methods.

Jaensch et al. (1988) – The Royal Australasian Ornithologists Union (RAOU) undertook waterbird counts at a number of wetlands including the nature reserves in eastern Peel Inlet, and Lakes McLarty and Mealup from 1981 to the late 1980s.

Halse et al. (1990) – CALM undertook annual waterbird counts in wetlands in south-western Australia from 1986 to 1990. This included Lakes Preston, Clifton and McLarty as well as the Peel-Harvey Estuary.

Bamford and Bamford (2003) – Monthly surveys of waterbirds at the Creery Wetlands (Peel-Harvey Estuary) from 2000 to 2003.

Craig et al. (2001 and 2006) – Waterbird and shorebird surveys from Lake McLarty: 33 surveys between 1990 and 1995; regular (monthly and weekly during peak seasons) surveys between 1996 and 2001; and irregular (27 total) surveys between 2001 and 2005.

Private individuals – Individuals such as D. Rule and B. Russell have collected a large amount of waterbird count data from the Peel-Yalgorup Ramsar site. Russell has assembled a database of counts from the Yalgorup Lakes from 1995 to 2007.

Birds Australia (2006) – Hooded Plover monitoring program for the Yalgorup Lakes. This has included a banding program, regular summer surveys and breeding observations. Since 2000 the Myalup Bird Observers Group has monitored Hooded Plover behaviour at 23 sites in the south-western shore of Lake Preston.

Bamford and Wilcox (2003) – Monitoring of waterbirds (counts ad breeding) at Goegrup and Black Lakes from the mid 1980s until current by the Peel Preservation Group.

Consulting projects – A large number of private development proposals within the Peel-Yalgorup Ramsar site undertake waterbird monitoring to inform environmental impact assessments.

Method

Guidance for the development of a database and analysis of data should be taken from existing programs such as the Australian Waders Studies Group (AWSG), Population Monitoring Program (Gosbell and Clemens 2006). The database developed by AWSG will contain relevant records for the Peel-Yalgorup Management Plan and may be able to be used as a starting point to building a dedicated database for the Ramsar site. In addition, existing compilations of waterbird data from the Peel-Yalgorup Ramsar site are likely to have been collated for other programs (e.g. Shorebirds 2020, comparisons before and after the opening of the Dawesville Channel) and attempts should be made to minimise duplication of effort. There are a number of bird observer groups that are currently involved in monitoring of birds within the Ramsar site. These include:

- Birds Australia WA
- Mandurah Birdwatchers Group
- Myalup Bird Observers Groups
- numerous unaligned individuals.

While some records from these groups and individuals are forwarded to Birds Australia WA or Birds Australia for input into the Australian Bird Atlas, it is up to the individual to submit records and often common species or those that are regularly observed are not submitted (D. Rule, pers. comm.). In addition, the records submitted to the Australian Bird Atlas are not commonly extracted by government agencies to inform wetland management.

The following steps are recommended to address this situation and make the best use of existing information and programs:

- Appointment of a coordinator for waterbird data for the Peel-Yalgorup Ramsar site.
- Development of a suitable database.
- Negotiation with existing holders of data to allow for copies of records to be stored in the Peel-Yalgorup Ramsar Waterbird Database (this may involve establishment of formal data licensing agreements) as well as WetlandBase.
- Input of existing and future data into the database.
- Annual analysis of collected data to determine trends.

The types of analysis suitable for examination of waterbird data will depend on the records available. However, it is possible that it may involve analysis of monthly or annual maximum counts based on key individual species, bird guilds or all species. The analyses could characterise:

- Central tendency (mean, median)
- Variability (standard deviation, percentiles)
- Development of control charting techniques to determine deviation outside expected variability.

Roles and responsibilities

- Currently waterbird monitoring is undertaken by a pool of volunteers coordinated at the state level by Birds Australia WA and at the national level by Birds Australia. This program, however, represents a new waterbird monitoring event and would require establishment and coordination. Consideration should be given to supporting volunteers in terms of coordination and financial remuneration for expenses incurred.
- The Department of Environment and Conservation is responsible for maintaining WetlandBase.
- The body established to administer the management plan for the Peel-Yalgorup Ramsar site should be responsible for the coordination of monitoring and facilitation of communication between the different groups involved.

Estimated costs

Appointment of a coordinator - estimated at 2 days per week during establishment of database and then this could be reduced to 5-10 days per year.
Development of the database may require expert services.
Statistical advice should be sought for appropriate data analysis.

Priority

High

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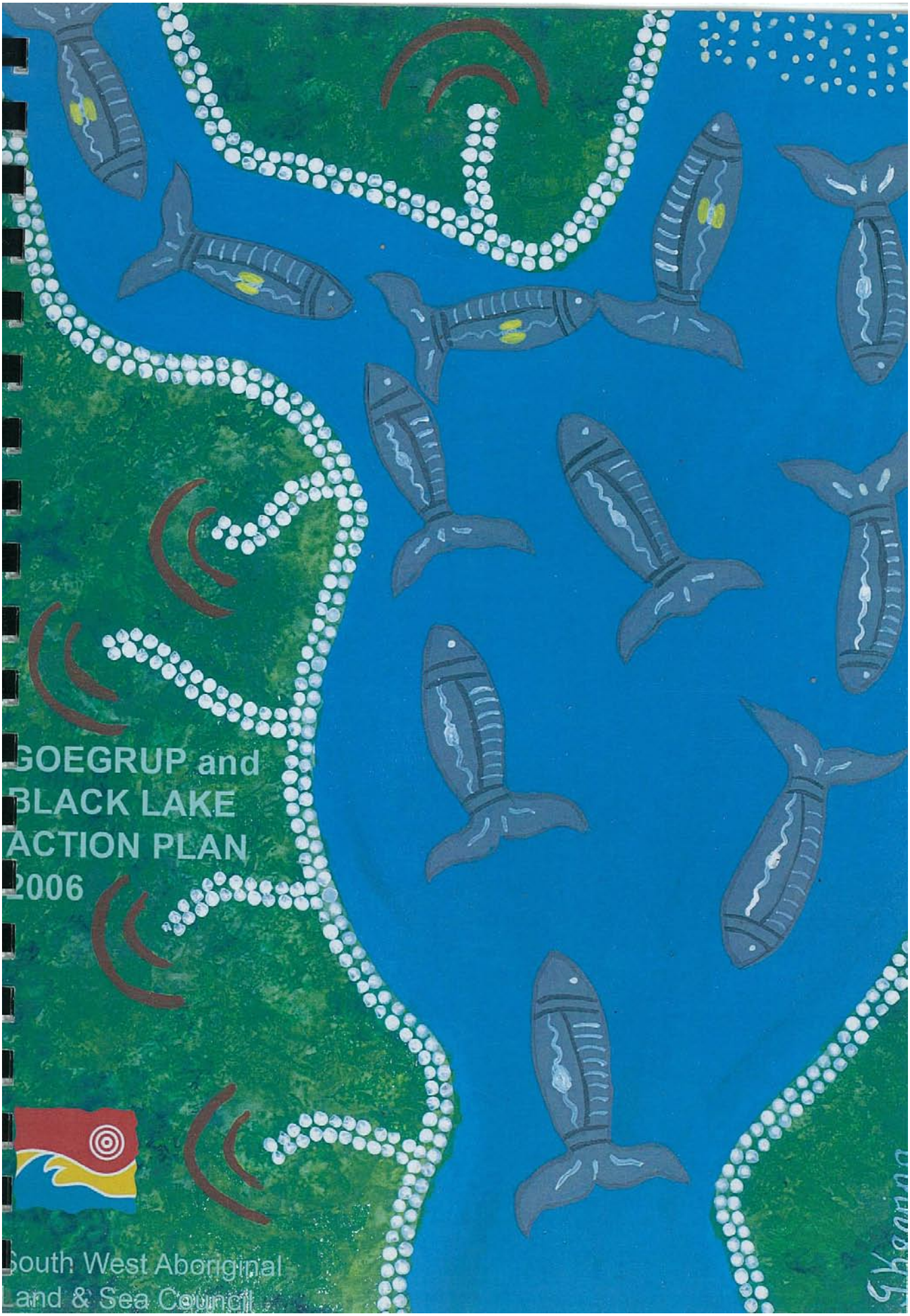
GOEGRUP and
BLACK LAKE
ACTION PLAN
2006
South West Aboriginal
Land & Sea Council

Prepared by:

Ecoscape (Australia) Pty Ltd

&

R. & E. O'Connor Pty. Ltd.

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ecoscape

Direct inquiries to:

Ecoscape (Australia) Pty Ltd
9 Stirling Highway • PO Box 50 North Fremantle WA 6159
Ph: (08) 9430 8955 Fax: (08) 9430 8977
mail@ecoscape.com.au

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		Name	Signature	Name	Signature	Date
final	A. Lo Conte & R. O'Connor	AW		AW		

7.0 Implementation Programme

Goegrup and Black Lake Action Plan

7.1 Identity and Naming

Whilst Goegrup and Black Lakes are officially named, coming up with suitable names for the lakes south of Black Lake is an important step in creating an identity for the lakes and increasing community recognition of the area. The community should be canvassed for suggestions on the naming of the lakes, including consultation with the Aboriginal community on appropriate names. The name should be concise, consisting of one or two words and first consideration should be given to those unofficial names shown in Figure 1 of this report.

There are some policies governing issues on naming features but generally the most important policy is local use and acceptance. Upon receipt of a proposal the Committee will ask all interested parties to comment. No decision will be made without a recommendation from the local government and all appropriate land management agencies.

Once a name for the southern lakes has been determined, signage indicating the name and boundaries of the study area and entry statements should be erected at entrance points to the study area.

7.2 Implementation Responsibilities and Investment Plan

This plan has not been formally adopted by the DEC as a management document. However, through the inclusion of DEC representatives on the steering committee responsible for the review and approval of this plan, it is envisaged that this document will form a working document for the DEC and other stakeholders with interest in the management of the Goegrup and Black Lake.

Table 7.1 below summarises all the recommendations in previously listed in this plan. The priority category definitions are as follows:

High	Recommendation should be initiated within the next year
Medium	Recommendation should be initiated within three years
Low	Recommendation should be initiated within five years depending on budget constraints

The abbreviations are as follows:

DEC – Department of Environment and Conservation
SWALSC – South West Aboriginal Land and Sea Council
NAC – Nannagup Aboriginal Corporation
WAPC – Western Australian Planning Commission
PHCC – Peel-Harvey Catchment Council
PRPC - Peel Regional Park Committee
SoM – Shire of Murray
CoM – City of Mandurah
GBLMC – proposed Goegrup and Black Lakes Management Committee.

Table 7.1 Summary of Recommendations

	RECOMMENDATIONS	PRIORITY	KEY STAKEHOLDERS	PROPERTIES/ ZONES
	RESTORATION			
1	Within Priority Restoration, carry out assisted natural regeneration following the principles of the Bradley method (see Appendix Three) in *Very Good* condition areas, gradually progressing into *Good* areas.	HIGH	NAC, DEC, CoM, SoM, WAPC, private landholders	Zones 1 & 2
2	Within Priority Restoration, carry out reconstruction / revegetation in areas of *Poor* and Very Poor condition bushland (see Map 3) using local provenance genetic material.	Zone 3 – HIGH Zone 4 – HIGH Zone 5 – MED Zone 6 - LOW	NAC, DEC, CoM, SoM, private landholders	Zones 3 to 6
3	Priority Restoration which contains existing restoration needs continued maintenance with additional weed control and infill planting.	HIGH	DEC	Zone 3
4	Document all management practices onsite. This should identify, as a minimum, the type of works, the boundary of works, a planting list and native plants present that require protection, species that are introduced into the study site.	HIGH	NAC, DEC, WAPC, CoM, SoM	All Reserves
5	Monitor restoration works annually and ensure that accurate records are kept of progress.	MEDIUM	NAC, DEC, WAPC, CoM, SoM	All Reserves
	REVEGETATION			
6	Map 2 – Vegetation Communities in association with Table A1.1 in Appendix 1 – Flora list should be used to determine the mix of species to use within areas to be revegetated.	HIGH	All landholders	All properties
7	At all times only species sourced from local propagation stocks (seeds, cuttings, divisions) from the local vegetation communities should be used in restoration programs (in the absence of genetic provenance data that indicates broader genetic provenance boundaries).	HIGH	NAC, DEC, WAPC, CoM, SoM	All Reserves
8	Investigate the feasibility, between the City of Mandurah and the Shire of Murray, of developing a regional seed bank which will aid in acquiring plant propagation material of local provenance for landscape enhancement projects within the region.	MEDIUM	NAC, DEC, PHCC, CoM, SoM	All properties
	WEED CONTROL			
9	Use an integrated approach to weed control including herbicides, manual removal, modifying microclimates (in terms of shade, moisture etc) and biological controls	HIGH	NAC, DEC, WAPC, CoM, SoM, private landholders	All properties
10	Undertake annual surveys for Bullrush (*Typha orientalis),* Watsonia *(Watsonia meriana),* Pampas Grass *(Cortaderia selloana)* and Perennial Veldt Grass *(Ehrharta calycina)* to ensure they do not become established.	HIGH	NAC, DEC, WAPC, CoM, SoM, private landholders	All properties
11	Undertake species-led control within Priority Restoration Zones according to weed priorities in Table 6.3.2 and control methods in Appendix Four, Table A4.1	HIGH	NAC, DEC, CoM, SoM, WAPC, private landholders	Zones 1 and 2
12	Undertake site-led control of weeds within Priority Restoration Zones in conjunction with revegetation works.	Zone 3 – HIGH Zone 4 – HIGH Zone 5 – MED Zone 6 - LOW	NAC, DEC, CoM, SoM, private landholders	Zones 3 – 6

13	Remove Bullrush (*Typha orientalis)* found at site 5, 32 and 33.	HIGH	DEC & private landholders	Lots 3 & 16, Reserve 35283
14	Remove Watsonia (*Watsonia meriana)* at site 23 and 39.	HIGH	NAC & private landholder	Lots 91 & 216
15	Remove Pampas Grass (*Cortaderia selloana)* near site 37.	HIGH	private landholder	Lot 91
16	Prevent the expansion of populations of Perennial Veldt Grass (*Ehrharta calycina).*	HIGH	DEC & private landholders	Reserves 35283 & 26351, and Lots 3, 16, 51, 425 & 442
17	Control Weeds in Restoration Zone 1 as a priority	HIGH	NAC, DEC, CoM, SoM, WAPC, private landholders	Zone 1
18	Ensure that weed control is only undertaken by trained/experienced/licensed personnel who operate in a manner appropriate for bushland & wetlands	HIGH	Landholders	All properties
	DISEASE MANAGEMENT			
19	Establish standard hygiene protocols for management operations within the study site	HIGH	NAC, DEC, WAPC, CoM, SoM	All Reserves
20	Ensure that any soil or plant material used for bushland restoration is disease free.	HIGH	NAC, DEC, WAPC, CoM, SoM	All Reserves
	WATER QUALITY			
21	Continue to monitor water quality regularly on Serpentine River and Nambeelup Brook	HIGH	DEC	Reserves 35283 & 26351
22	Expand water quality monitoring program in both number of sites and measurements (e.g. adding macro invertebrate measurements)	MEDIUM	DEC	Reserves 35283 & 26351
23	Ensure that any adjacent subdivisions comply with Peel-Harvey Coastal Catchment Water Sensitive Urban Design – Technical Guidelines.	HIGH	SoM, DEC	All undeveloped properties
	FIRE MANAGEMENT			
24	Reduce fuel loads through control of weeds such as Perennial Veldt Grass and Bulrush	MEDIUM	DEC, private landolders	Reserves 35283 & 26351, and Lots 3, 16, 51, 425 & 442
25	Fire to be actively managed as a tool for cultural and environmental outcomes.	HIGH	DEC, NAC, WAPC, CoM, SoM, PHCC, FESA	All properties
26	Document fire history with the extent of fires mapped, and dates and causes recorded.	LOW	DEC, NAC, WAPC, CoM, SoM, PHCC	All Reserves
27	Control access into burnt areas as soon as possible after the fire. Access to any burnt areas should be limited to management vehicles only for the first six to twelve months. Seed germination and resprouting of vegetation or regeneration should be monitored for a year following fire.	HIGH	DEC, NAC, WAPC, CoM, SoM, PHCC	All Reserves
28	Revise weed control works after any fires to ensure potential damage by works are minimised and efficiencies are maximised.	HIGH	DEC, NAC, WAPC, CoM, SoM, PHCC	All Reserves
	ACCESS, RECREATION AND INFRASTRUCTURE			
29	Construct signage that can be used to inform visitors that access is restricted to environmentally sensitive areas such as weed control areas, erosion control areas and restoration work.	HIGH	DEC, NAC, WAPC, CoM, SoM, PHCC	All Reserves
30	Replace vandalised signs at Dunkerton Road (near Goegrup and Black Lake crossing) and at the end of Bedingfeld Road.	HIGH	DEC	Reserves 35283 & 26351

31	The boat launching area adjacent to Stakehill Bridge needs to be fenced off from the study site to prevent unauthorised vehicle access.	HIGH	DEC	Reserve 26351
32	Fence off Dunkerton Road Reserve from Goegrup Lake for the areas between Goegrup and Black Lakes following the construction of the bridal crossing.	HIGH	DEC	Reserves 35283 & 26351
33	Fence off Geogrup Lake west of Meares Road to prevent access onto informal bridal trail.	HIGH	DEC	Reserve 35283
34	Place fencing and a gate at the entrance to Lot 216 to prevent unauthorised vehicle access onto Nannup Aboriginal Corporation land and the Reserve.	HIGH	NAC	Lot 216
35	In conjunction with constructing a gate to the entrance of Lot 216, rubbish which has been dumped on the property should be removed.	HIGH	NAC	Lot 216
36	Survey cadastral boundary and place 1500 metres of fencing and a gate at the entrance to Lot 51 to prevent unauthorised vehicle access into Lot 51 and adjacent reserves and properties	HIGH	WAPC	Lot 51
37	Construct fencing along the boundary of Reserve 35283 south of Lot 216 where unauthorised vehicle access is occurring.	HIGH	DEC	Reserve 35283 & Lot 216
38	Replace fences which have been vandalised at each end of Priority Restoration Zones 3	MEDIUM	DEC	Zone 3
39	Undertake a feasibility study and revise the Master Plan for the heritage trail on Lot 51 and Lot 216 in consultation with DEC and the PDC to determine opportunities for funding and generating income for constructing and managing a heritage trail on Lot 216, Lot 51 and Reserve 35283 in consultation with DEC.	HIGH	GBLMC / DEC / PDC	Lots 216 & 51 and Reserve 35283
	COMMUNITY INVOLVEMENT			
40	Promote values identified in Action Plan to general community and local landholders through workshops to communicate the outcomes of this plan and provide support for the formation of a community group to participate in the implementation of this Plan.	HIGH	NAC, DEC, PHCC	All properties
41	Promote adoption of Action Plan by Peel Regional Park Committee	HIGH	NAC, DEC, PHCC, SWALSC, PRPC	All properties
42	The Peel Region Aboriginal groups meet together to appoint a Committee to progress management of the Plan area.	HIGH	Peel Region Aboriginal groups	All properties
43	The DEC be approached by that Committee with a view to instituting a joint management programme for lands in the Plan area currently administered by DEC.	HIGH	GBLMC, DEC	Reserves 35283 & 26351
44	The DEC be approached by that Committee with a view to training one or more local Aboriginal people to act as Rangers for the Plan area. The Ranger's duties could include policing the prevention of noxious run-off into the lakes and controlling inappropriate activities such as unsupervised trail-bike riding through sensitive sandy areas and Aboriginal heritage sites.	MEDIUM	GBLMC, DEC	Reserves 35283 & 26351
45	The DEC be approached by that Committee with a view to creating employment for local Aboriginal people in such activities as weed eradication and feral animal eradication.	MEDIUM	GBLMC, DEC	Reserves 35283 & 26351

46	The City of Mandurah and Shire of Murray be approached by that Committee with a view to establishing a joint tourism venture centred upon Goegrup and adjoining lakes and utilising the Aboriginal land at Lot 216 Dunkerton Road as a base for operations.	MEDIUM	GBLMC, SoM, CoM	Lot 216
47	The study area be proposed as a site for the Annual Great Australian Marsupial Night Stalk	LOW	Perth Zoo	All properties
48	The study area be promoted as a location for regular bird surveys	MEDIUM	Mandurah Birdwatchers, DEC, WAPC, NAC, CoM, SoM, private landholders	All properties
	CULTURAL HERITAGE			
49	Prior to undertaking any restoration works within the study area, refer to the Department of Indigenous Affairs for approval under Section 18 of the *Aboriginal Heritage Act 1972*.	HIGH	DEC, SWALSC	All properties
50	The Peel Region Aboriginal people seek to have *Stored Data* sites reassessed and registered as Aboriginal Sites afforded the protection of the Aboriginal Heritage Act 1972.	HIGH	SWALSC	All properties
51	Approach DIA on behalf of the Peel Region Aboriginal people with a request that a representative of those people should be appointed to the ACMC.	MEDIUM	SWALSC	All properties
52	Seek funding for the production of a management plan for Aboriginal & European heritage in the Peel Region in general and Goegrup and adjoining lakes in particular.	MEDIUM	SWALSC and an appropriate Peel Region Aboriginal group with input from regional elders.	All properties
	INTERPRETATION & EDUCATION			
53	Develop Interpretation Plan for Goegrup and Black Lake, including a signage standard / scheme such that all signs are consistent in materials, dimensions, colours etc..	HIGH	GBLMC, WAPC, DEC	All Reserves & Lots 51 & 216
54	Establish low key Interpretative signs along proposed walk trails	LOW	GBLMC, WAPC, DEC	Lots 51 & 216

GOVERNMENT OF WESTERN AUSTRALIA

SERPENTINE RIVER MANAGEMENT PLAN

STAGE 1 - GOEGRUP LAKE TO BARRAGUP BRIDGE

WATER RESOURCE MANAGEMENT SERIES

WATER AND RIVERS COMMISSION REPORT WRM 12

1998

WATER AND RIVERS COMMISSION

Serpentine River Management Plan

Stage 1 - Goegrup Lake to Barragup Bridge

A report to the Peel Inlet Management Authority
from the Serpentine River Working Group

Water and Rivers Commission
Policy and Planning Division

Water and Rivers Commission
Water Resources Management Series
Report No WRM 12
July 1998

5. Management recommendations

The management recommendations below suggest actions which are aimed at upholding the principles of this plan.

General recommendations relate to issues which cover the entire study area. Site specific recommendations suggest actions related to smaller sub-sections of the study area. The respective locations of the site specific recommendations are shown on the Technical Plan, Map 5.

The agencies responsible for implementation are shown in italics. Recommendations which require an action to be performed only once are referred to as 'one off' recommendations, those that require further implementation or repeat action are referred to as 'ongoing'. The perceived priority level is denoted as high (✪✪✪), medium (✪✪) or low (✪).

5.1 General recommendations

1. Support GLASS rehabilitation initiatives, assist and advise on:
   - flora and fauna identification,
   - rehabilitation and planting techniques,
   - weed identification, removal and disposal techniques,
   - signposting areas subject to rehabilitation to develop interest in the sites.

   PIMA/WRC, AgWA, CALM — *ongoing* ✪✪

2. Provide educational information for residents on:
   - location and general information on nature/bridle trails,
   - the conservation value of riparian vegetation,
   - preventing invasion from garden weeds and exotic plants,
   - encouraging the removal of problem plants from gardens,
   - native alternatives for use in gardens, and
   - minimising fertiliser usage.

   PIMA/WRC — *ongoing* ✪✪

3. Undertake regular reconnaissance to identify and treat weeds in areas of native vegetation. A guide for some major weeds identified in the study area is given below.

April/May	Pampas grass	Remove and destroy flower heads, brush-cut plant to approx 1m, treat with herbicide.
May/August	Rose pelargonium	Hand pull, remove and destroy all plant material.
June/July	Grasses	Spot and blanket spraying is most effective when plants are actively growing. Herbicide selection should be made according to requirements.
Jan/March	Japanese pepper	Fell trees and apply stump-cut herbicide, remove and destroy all cuttings.

LGAs — *ongoing* ✪✪✪

4.	Conduct workshops for local community groups on weed removal and disposal techniques. *PIMA/WRC, AgWA, CALM*	*ongoing*	✪
5.	Survey to identify native fauna in the area. Identify habitat extents and corridors. Report on the potential for improving habitat quality through rehabilitation. *PIMA/WRC, CALM*	*one off*	✪✪
6.	Monitor dieback infection sites identified in the dieback assessment report (Appendix 5). Undertake phosphorus acid treatment on dieback susceptible plant species giving priority to those within 20m of infection sites *CALM, LGAs*	*ongoing*	✪✪
7.	Monitor the environmental impacts of equestrian use, and its continued compatibility with pedestrian use, of the current bridle trail. The trail should be re-routed if impacts are found to be unacceptable. *Shire of Murray, PIMA/WRC*	*ongoing*	✪✪
8.	Undertake regular surveys of embankment profiles and river bank vegetation to monitor erosion processes and identify areas requiring attention. Implement mitigation techniques according to management principles. *PIMA/WRC*	*ongoing*	✪✪
9.	Ensure that stormwater drains are operating effectively and if not that other stormwater management control mechanisms be investigated. *LGAs*	*ongoing*	✪✪
10.	Develop turf maintenance programs for foreshore reserves which minimise fertiliser usage and restrict mowing to well defined sections in areas of high recreational pressure. *PIMA/WRC, LGAs*	*ongoing*	✪✪✪
11.	Establish a comprehensive inventory of mosquito breeding sites to aid in the development of a mosquito control strategy taking into account management principles identified. *Health Dept, MCAC, PIMA/WRC, LGAs*	*one off*	✪✪✪
12.	Investigate potential sites for, and the feasibility of establishing, a designated trailbike riding area in the region to remove illegal, destructive riding from foreshore areas. *LGAs, MFP.*	*one off*	✪✪
13.	Implement a trial placement of 'dog latrines' at strategic locations. Signpost conservation area access points to advise that dogs to be kept on a leash. *LGAs*	*one off*	✪
14.	Undertake annual inspections of bushland areas, fire breaks, access and adjoining properties to assess fire risks and management options taking into account the management principles identified. *LGAs, Landowners, Bush Fires Board*	*ongoing*	✪✪

15. Support Fisheries Western Australia's Volunteer Inspector Scheme and provide information and contact details.

Fisheries Dept, PIMA/WRC — *ongoing* — ✪

16. Encourage Department of Transport policing of river traffic. Advise DOT on any perceived replacement/new sign requirements. Ensure licensed s tructures meet required standards, remove unlicensed jetties and revegetate these sites.

PIMA/WRC, DOT — *ongoing* — ✪

17. Continue regular river inspections which include identifying illegal activities such as boats on foreshore reserves, moorings, bait digging, unsound structures etc. Implement control measures or notify relevant agencies to take action.

PIMA/WRC — *ongoing* — ✪✪

5.2 Greenfields foreshore : Site specific recommendations

5.2.1 Pinjarra Road to Serpentine Cove

18. Ensure that the high conservation area adjacent to Serpentine Cove is protected by a development foreshore management plan. If development is not proceeding for some time foreshore measures may need to be initiated by City of Mandurah and WRC.

Some aspects to be considered are:

- ensure the protection of existing native vegetation and fauna habitats,
- undertake rehabilitation schemes to improve, or maintain the integrity of, the existing foreshore habitat,
- pathways to be designed and located to prevent damage to vegetation and river banks
- fencing to prevent unrestricted access to foreshore
- no vehicle access to foreshore except emergency or maintenance vehicles.

City of Mandurah, WRC, CALM, PIMA — *ongoing* — ✪✪✪

19. Monitor the ongoing activities of the Western Rosella Bird Park and aquire a wider foreshore reserve from this area as a condition of any further subdivision.

PIMA/WRC, MFP, City of Mandurah — *ongoing* — ✪✪

5.2.2 Serpentine Cove to Riverside Gardens Reserve

20. Cease mowing of open areas at base of access paths, initiate a weeding program and replant with native vegetation to exclude weeds and re-establish fringing vegetation.

City of Mandurah, PIMA/WRC — *one off* — ✪✪✪

21. Survey for weed invasion, particularly along paths, and initiate a weeding program (see Vegetation Assessment for suggested methods).

City of Mandurah, PIMA/WRC — *ongoing* — ✪✪

22. Undertake rehabilitation of informal pathways or block with barrier plantings.
City of Mandurah, PIMA/WRC — *one off* — ✪✪✪

23. Define a single informal pathway leading from the dual use pathway(DUP) near Tuart Road to an access node on the river bank downstream from the backwater. This section of path may later require modification to link with Serpentine Cove development foreshore plan which should include a DUP from Redcliffe Road to the Bird Park which links existing DUPs.
City of Mandurah, PIMA/WRC — *one off* — ✪✪✪

24. Undertake rehabilitation of stabilising and emergent vegetation.
City of Mandurah, PIMA/WRC, MFP — *ongoing* — ✪✪

5.2.3 Riverside Gardens Reserve

25. Erect an information board showing path maps, information on flora and fauna, Nyungah and local history.
City of Mandurah, PIMA/WRC — *one off* — ✪✪

26. Construct a dual use pathway along the landward edge of the reserve to link the existing Redcliffe Road dual use pathway with the proposed dual use pathway along Koolyanga Road.
City of Mandurah. — *one off* — ✪✪

27. Clearly define existing parking areas with bollards or other barriers utilising suitable, natural, materials and native garden beds around outer borders to prevent vehicle incursions into the grassed recreation area.
City of Mandurah. — *one off* — ✪✪✪

28. Create areas of shrubs between picnic tables and reinforce the number of shade trees by planting seedlings in appropriate locations.
City of Mandurah — *one off* — ✪✪✪

29. Clearly define the limits of the grassed area to be mowed and implement a turf management program (as per recommendation 10). An informal pathway along the river bank should separate emergent vegetation and prevent lawn grasses from extending to the water's edge.
City of Mandurah — *one off* — ✪✪✪

30. Install a crosswalk and traffic calming devices on Wanda Road connecting Eacott Park and Riverside Gardens Reserve.
City of Mandurah — *one off* — ✪

5.2.4 Riverside Gardens Reserve to Bulara Road

31. Restrict access to the high conservation area adjacent to Goegrup Lake by erecting fencing from just north of the Wanda Road boat ramp, along Koolyanga Road to Bulara Road.
    City of Mandurah, CALM, PIMA/WRC — *one off* — ✪✪✪

32. Construct DUP between the road and the above fence from Bulara Road and the existing DUP at Teranca/Bedingfeld Road to link with the proposed extension of the Redcliffe Road dual use pathway.
    City of Mandurah — *one off* — ✪✪

33. Provide visual access to saltmarsh via a raised boardwalk, intersections to be off-set. Suggested access points are at Bulara Road, Bedingfeld Road and opposite Koolyanga Reserve.
    City of Mandurah, PIMA/WRC — *one off* — ✪✪✪

34. Erect signs at access points stating the high conservation value and request that people stay on the walkway and keep dogs on a leash. Place flora and fauna information plaques at appropriate points along the walkway.
    City of Mandurah, PIMA/WRC — *one off* — ✪✪

35. Undertake weed eradication and control strategies in the high conservation area near Goegrup Lake.
    City of Mandurah, PIMA/WRC — *ongoing* — ✪✪✪

36. Initiate a rehabilitation scheme along the degraded outer edge of the high conservation area.
    City of Mandurah, PIMA/WRC — *ongoing* — ✪✪✪

37. Survey stands of Casuarina obesa for natural regeneration and initiate planting schemes where necessary.
    PIMA/WRC — *one off* — ✪✪

5.3 Barragup foreshore : Site specific recommendations

5.3.1 Barragup Bridge to chicken farm

38. Identify major weed grasses and extent of main infestation. Create a barrier / buffer around the area and initiate a weed control and rehabilitation program.
    Shire of Murray, PIMA/WRC — *one off* — ✪✪✪

39. Initiate manual weed control with spot spraying in less infested areas to prevent greater infestation with grass weeds.
    Shire of Murray, PIMA/WRC — *ongoing* — ✪✪✪

40. Consult with landscape architects in the design of a formalised access node at the severely degraded riverside site near the chicken farm, lot 100 and lot 101. Consultation should include an investigation into the suitability of providing vehicle access, information signs, parking and picnic facilities. The creation of any formalised recreation area must comply with the principles of this plan.

Shire of Murray, PIMA/WRC — *one off* — ✪✪

5.3.2 Chicken farm to Noorumba Road

41. Remove rose pelargonium, Victorian tea trees and pine trees from reserve area in front of houses (see Vegetation Assessment for suggested methods).

Shire of Murray, AgWA — *ongoing* — ✪✪✪

42. Rehabilitate and/or place barriers around grassed clearings in front of houses to prevent the gradual expansion of these areas.

PIMA/WRC, Shire of Murray — *ongoing* — ✪✪

43. Maintain existing fence line from rivers edge to foreshore boundary near lot 2 Pinjarra Road and place low bollards, or other suitable barriers, across the path at this point to prevent 4WD and trailbike access while still allowing for pedestrian and equestrian access.

Shire of Murray, CALM — *one off* — ✪✪

5.3.3 Noorumba Road to Hougham Road

44. Place low bollards, or other suitable barriers, across the Noorumba Road path to prevent trailbike access while still allowing for pedestrian and equestrian access.

Shire of Murray, CALM. — *one off* — ✪✪

45. Investigate the best method of stabilising the river bank and provide a fishing access node near Noorumba Road path.

PIMA/WRC, Shire of Murray — *one off* — ✪

46. Rehabilitate vegetation at the following locations:
    - fire degraded sites near lot 112 Caponi Road,
    - side path toward house on lot 12 Caponi Road,
    - right hand (less used) branch of Noorumba Road path,
    - south branching pathways into small saltmarsh area near Noorumba Road path.

PIMA/WRC, Shire of Murray — *one off* — ✪✪

5.3.4 Hougham Road to Goegrup Lake

47. Block and revegetate informal pathways in reserve 44436 and leading toward and across the small saltmarsh nearby.
    PIMA/WRC, Shire of Murray
    one off ✪✪✪

48. Investigate the suitability of providing a stabilised fishing access node opposite the Wanda Road boat ramp. The site should be located to minimise disturbance of existing Nankeen Night Heron rookery.
    PIMA/WRC, Shire of Murray, CALM
    one off ✪✪

49. Place low bollard, or other suitable barrier, across the bridle path, near the power poles where the fire break thins to a pathway to prevent trailbike and 4WD access while still allowing for pedestrian and equestrian access.
    Shire of Murray
    one off ✪✪

50. Erect an information board showing nature/bridle trail maps, vehicle restrictions, information on flora and fauna, Nyungah and local history at Caponi Road access points.
    WRC, Shire of Murray
    one off ✪✪

51. Block and revegetate informal pathway from Hougham road reserve fire break to Goegrup Lake.
    PIMA/WRC, Shire of Murray
    one off ✪✪✪

5.3.4 Hougham Road to Goegrup Lake

47. Block and revegetate informal pathways in reserve 44436 and leading toward and across the small saltmarsh nearby.
    PIMA/WRC, Shire of Murray
    one off ✪✪✪

48. Investigate the suitability of providing a stabilised fishing access node opposite the Wanda Road boat ramp. The site should be located to minimise disturbance of existing Nankeen Night Heron rookery.
    PIMA/WRC, Shire of Murray, CALM
    one off ✪✪

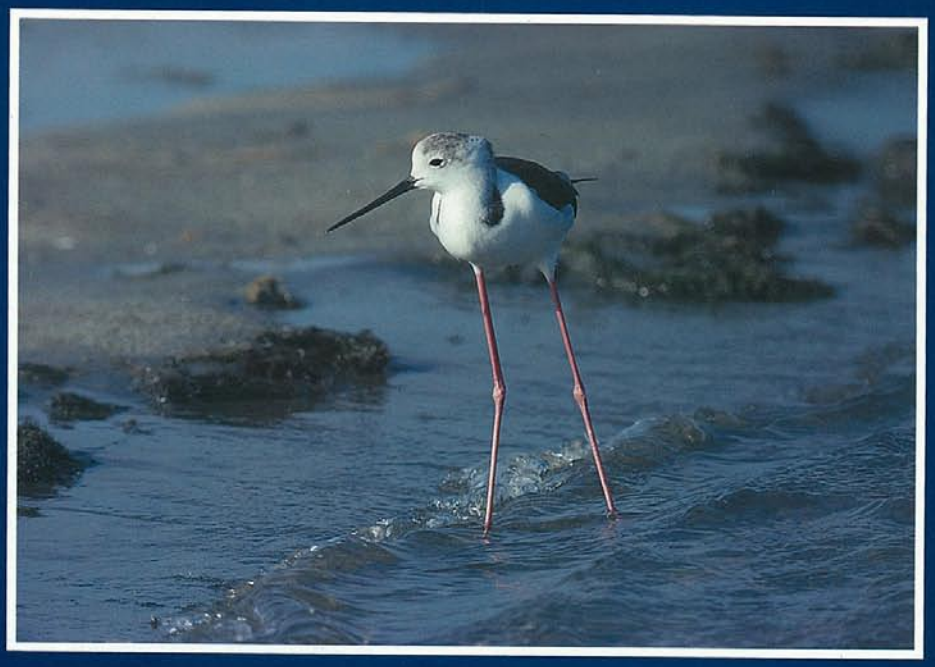
49. Place low bollard, or other suitable barrier, across the bridle path, near the power poles where the fire break thins to a pathway to prevent trailbike and 4WD access while still allowing for pedestrian and equestrian access.
    Shire of Murray
    one off ✪✪

50. Erect an information board showing nature/bridle trail maps, vehicle restrictions, information on flora and fauna, Nyungah and local history at Caponi Road access points.
    WRC, Shire of Murray
    one off ✪✪

51. Block and revegetate informal pathway from Hougham road reserve fire break to Goegrup Lake.
    PIMA/WRC, Shire of Murray
    one off ✪✪✪

Yalgorup National Park

Management Plan 1995-2005



MANAGEMENT PLAN No. 29

Department of Conservation and Land Management

National Parks and Nature Conservation Authority

YALGORUP NATIONAL PARK

MANAGEMENT PLAN

1995-2005

Planning Team

Chris Portlock (coordinator)
Aminya Koch
Scott Wood
Peter Hanly
Steve Dutton

Department of Conservation and Land Management
for
The National Parks and Nature Conservation Authority

PART I. PLAN IMPLEMENTATION

40. PRIORITIES

The objective is to manage the Park according to assigned priorities for implementation.

The conservation value in the Park that is most under threat is Lake Clifton and its stromatolites and thrombolites. Actions to protect conservation values of Lake Clifton are the highest priority to carry out and are listed in Group 1. Those which would immediately protect the Park's other conservation values are also high priority and are listed in Group 2. Group 3 includes high priority management, research or information dissemination actions that need to proceed along with actions that more directly protect and restore conservation values. Often the development of increased recreational opportunities and associated facilities can direct, control and minimise impact from recreational activities, particularly when educational and interpretive programs are part of the opportunity offered. Recreational actions are also included in the third group for this reason.

TABLE 8. MANAGEMENT PRIORITIES

(by Section and Action)

HIGH PRIORITY - GROUP 1
4. Land Tenure and Boundaries 4. Negotiate with the relevant State or local government authorities about adding to the Park the following reserves: 40372, 33285, 28796, 32261, 33843, 34745, 27458 and 25912 (Table 2).
7. Geology, Landforms and Soils 2. Minimise development along the edge of the lakes and disturbance to the vegetation and foreshores of the Vasse Lagoonal System (See Map 4).
8. Vegetation and Flora 4. Protect and restore the Vasse Lagoonal Complex and the Quindalup Dune Complex and the fringing vegetation around the Lakes.
10. The Lake System 1. Liaise with local government to ensure that management of lakeside reserves is consistent with Park management objectives 2. Survey poorly identified tenure boundaries. 3. Reposition or establish new fences on foreshores to stop stock entering the lakes or consider an incentive program for private property owners so they will take this initiative.

HIGH PRIORITY - GROUP 1 (Cont)

5. Liaise with local government, relevant State Government agencies, CSIRO and the DEP to provide advice to landholders on land-use practices that are appropriate within the Park catchment area (see State Government section).
6. Restrict recreational activities on the lakes to waterskiing and canoeing in the lower section of Lake Preston.
8. Seek greater legislative protection of the Lake Clifton stromatolites and thrombolites.

24. Nature Observation and Nature Trails

6. Provide a nature observation facility at the end of Mount John Road for viewing waterbirds and stromatolites and thrombolites in Lake Clifton.

27. Water Based Activities

2. Continue to prohibit any water-based activities on all of the Yalgorup Lakes, except for the lower third of Lake Preston

29. Information and Interpretation

4. Prepare and make available publications such as a brochure to inform schools, the public, and local landholders of the intrinsic value of the Park's lakes and constraints on activities permitted within the Yalgorup catchment.

34. Private Property

1. Encourage private property owners to manage their properties to reduce nutrient input into the lakes.
2. Encourage private property owners to protect fringing vegetation between private property and the lakes by excluding stock, weeds, fire and any use of the area that may degrade the soil or vegetation.
3. Encourage private property owners to rehabilitate areas of fringing vegetation with indigenous species, provide plants and trees when possible and inform property owners of preferred species to plant.
5. Actively encourage private land owners to fence their properties and control stock, the spread of disease, weeds, feral animals and fire particularly in any areas near the lakes.

HIGH PRIORITY - GROUP 2

4. Land Tenure and Boundaries

5. Acquire for the Park or seek sympathetic management, from current vesting bodies, of Melros Reserve 33139 and Tims Thicket Reserve 24198.

7. Geology, Landforms and Soils

4. Minimise management activities in, and public access to, the coastal dunes areas.

8. Vegetation and Flora

1. Locate threatened and priority flora species and store information on biology, location, and herbarium specimens at the District Office, the State Herbarium and at CALM's Como Office. Consult records and take appropriate action before undertaking development or management activities.
2. Extend the detailed vegetation and flora survey undertaken in the Park's northern section to cover the entire Park and important adjacent areas. Locate populations of important vegetation groups and priority and fire sensitive species, and develop management recommendations for their conservation particularly preceding any new recreational site development or burning operation.
3. Protect areas that are in good condition and protect and consider enhancing areas with threatened and priority flora, particularly those vegetation communities and species susceptible to disturbance, plant disease or weed invasion.

9. Fauna

1. Protect fauna habitats from the spread of weeds, disease, wildfires, and human disturbance.
4. Instigate more intensive fauna surveys and investigate reintroducing former known threatened fauna inhabitants in conjunction with a fox baiting program (See Section 17 Feral Animals).

HIGH PRIORITY - GROUP 2 (Cont)

13. Visual Landscape

3. Classify Park landscapes according to the Departmental Landscape Management System.
4. Any visual alterations to the natural landscape should be subtle, and remain subordinate to natural elements by borrowing extensively from form, line, colour, texture and scale found commonly in the surrounding landscape.

14. Erosion, Mining and Rehabilitation

2. Monitor the movement of dune blowouts. If a blowout is expanding and is likely to destroy management infrastructure or important vegetation or habitats, implement control measures.
8. Ensure that within any scenic areas, degraded landscapes (such as quarries) are rehabilitated after use or progressively in stages.

15. Disease

1. Conduct plant disease surveys and implement appropriate hygiene measures prior to commencing any operation that requires soil or plant material movement.
2. Educate Park users about plant disease, through printed information emphasising preference for summer activity use in the Park and the need to stay on well formed roads or tracks.
3. Provide educational signs and printed information for horse riders on disease management strategies.
4. Train Park staff to recognise plant diseases, and in sampling and management techniques.

16. Introduced Plants and Noxious Weeds

1. Liaise with the Agriculture Protection Board, landholders and local authorities regarding weed control on Park boundaries and adjacent properties.
2. Continue to maintain a register of all known occurrences and severity of introduced weeds.
3. Prepare and implement an introduced plants and weeds control program.
4. Monitor any effects of control programs on non-target species and make changes to procedures if required.
5. Avoid any unnecessary disturbance to soil while carrying out management activities, particularly in areas adjacent to sources of weeds.
6. Clean machinery, vehicles and trucks before moving from areas with weeds into areas without weeds.

17. Feral Animals

4. Implement comprehensive feral animal control programs in conjunction with native fauna release programs.

18. Fire

1. Implement prescribed burns in accordance with the master burning plan. Implement a range of fire regimes, including variation in season, intensity and size, particularly between different blocks according to the fire management plan (Map 6).
2. Burning will be conducted in accordance with written prescriptions approved by CALM's District Manager (available for viewing on request). The frequency of prescribed burns will depend on the succession of litter accumulation and protection, regeneration and conservation requirements.
3. Strategically placed fuel reduced areas will be maintained, rather than narrow buffers, along private property boundaries. Where possible successive burns in each block will be programmed in different seasons.
4. Roads required for fire control and essential management activities will be defined and maintained to suitable standards. Firebreak construction will be kept to a minimum. Those roads considered unsuitable for public use will remain closed to the public (See Section 22).
5. Continue to liaise with local government and the local Bush Fire Brigades to ensure an effective fire fighting force is in place. Establish agreements with adjacent landholder agencies, where necessary, regarding a cooperative approach to carry out fuel reduction requirements. If conditions or land responsibilities change, review agreements or establish new agreements to ensure ongoing protection.

HIGH PRIORITY - GROUP 2 (Cont)

6. Contain all fires in or threatening the Park considering values at risk, disease risk, fire behaviour, resources, presence of low fuel areas and ecological values. Suppression actions may include direct attack, backburning from established roads or buffers, or by allowing the fire to burn out to low fuel buffers.
7. Actively promote public education and awareness of fire risk, safety and survival through pamphlets, information boards and personal contact by Park staff.

19. Tuart

1. Initiate research to study the effects of land-use and fire management on the population dynamics of Tuart to determine whether or not Peppermint is replacing Tuart in some stands.
2. Select recruitment methods that do not adversely effect other Park conservation values such as habitat requirements for the Ring-tailed Possum.
3. Seek NPNCA approval of recruitment methods before they proceed, if research shows that intervention is necessary.

21. Attractions and Existing Use

3. Monitor the impacts of all activities in the Park and make any necessary changes to management practices if unacceptable impacts are found to be occurring.

22. Access

1. Confine public vehicle access to existing developed roads and tracks where possible.
6. Monitor, in association with user groups and local government, all four wheel drive tracks, access to four wheel drive beaches, the use of dune buggies and motorbikes and instigate management action as necessary.
8. Maintain management tracks to a level suitable for visitor convenience and management requirements.
12. Restrict vehicles to using any vegetated beach areas between the low and high water marks and discourage access into vegetated foredunes with signs and road closures.

25. Day Use

4. Tims Thicket Road (High Priority)
   - Designate a day-use area south of Tims Thicket Road if the site is added to the Park.
   - Provide further day-use facilities south of Tims Thicket Road in a suitable location near the beach with a walk track to the beach if the site is added to the Park.
   - Rehabilitate all unnecessary vehicle tracks and disturbed areas.
   - Investigate the possibility of using old quarries for recreation after further rehabilitation, including earth shaping and revegetation.

26. Camping

10. Tims Thicket Road (High Priority)
    - Designate a camping area south of Tims Thicket Road if the site is added to the Park.
    - Rehabilitate all unnecessary vehicle tracks and disturbed areas.

33. Leases

5. Assess the environmental impact on Lake Preston of waterskiing and the foreshore facilities provided, and report the results to the NPNCA.

38. Nature Conservation Research

3. Carry out more detailed surveys to record the distribution, abundance and other details of flora and fauna.
4. Carry out detailed surveys of the Park's flora and vegetation to complement work recently done in the northern section.
14. Assess the effects of water-based recreation and disallow or modify management of the activity if environmental impacts are unacceptable.

HIGH PRIORITY - GROUP 3

5. Zoning

1. Introduce a zoning scheme to manage the Park (Map 3).
4. Inform the public of the zoning system, including where access is allowed, and the reasons for the zones.

7. Geology, Landforms and Soils

3. Locate and design recreation sites to prevent or minimise their impact on fragile geological features and landforms.
5. Locate access roads and recreation sites according to specialist advice on prevailing wind direction, stabilisation of slopes, disease-risk, and land capability.

10. The Lake System

4. Inform landholders of the importance of minimizing nutrient input into the lakes.

13. Visual Landscape

1. Manage all Park landscapes according to CALM's Landscape Management Policy Statement No. 34 and seek specialist advice when implementing the management plan.
2. Plan and implement all activities in the Park to complement rather than detract from the inherent visual qualities of the Park and surrounding landscapes.
9. Encourage local authorities, other government agencies and private landholders to use landscape management skills when siting facilities and signs, selecting site-compatible materials and colours, and planning for utilities, roads and building envelopes.

14. Erosion, Mining and Rehabilitation

1. Ensure that, as far as possible, any mining or excavation operations within or adjacent to the Park has minimum impact on the Park, particularly with regard to landscape values, spread of disease and decrease in water quality.
3. Prepare a detailed rehabilitation program that prioritises the works to be implemented and includes dune stabilization techniques.
6. Ensure native plant species that occur in the Park are used in rehabilitation for brushing, planting and seeding.
7. Train Park staff in all aspects of disease identification and rehabilitation work. Seek specialist advice as required.

15. Disease

5. Determine how susceptible the Park's plant species are to disease, starting with all threatened and priority species.

17. Feral Animals

1. Continue to liaise with the Agriculture Protection Board, local government authorities and surrounding land holders to control feral animals and to educate landholders of the impact of feral animals including foxes, cats and dogs on native wildlife.
2. Expand the Rabbit control program to include areas under rehabilitation and ensure chemicals used do not affect native fauna.
3. Monitor feral animal populations and regularly assess the effectiveness of control programs and their threat to native flora and fauna.

22. Access

2. Ensure access is in place to evacuate the Park in an emergency.
3. Close and rehabilitate all unnecessary access tracks.
4. Provide two wheel drive access within walking distance of the beach by continuing North Preston Beach Road closer to the beach, and investigate the possibility of allowing four wheel drive access to the beach (Map 8 Prop. new access).
13. Provide information to Park users on appropriate for wheel drive techniques for coastal areas.

HIGH PRIORITY - GROUP 3 (Cont)

23. Horse Riding

1. Establish a code of ethics for horse riding elaborating on horse care and control to minimise any impact within the Park.
2. Further assess the land's capability and suitability for horse riding and determine the exact location of the trail.
3. Permit horse riding in the Park (including the possibility of commercial horse or camel rides) on a designated trail on the outside boundary of the Park (Map 7). No specific additional horse riding facilities will be provided.
4. Ensure that the designated horse trail Park entrance locations are well designed and signposted to ensure compliance through information on dieback disease hygiene principals, weed invasion impact and the effects of horse activity on water quality.
6. Close tracks when maintenance work or rehabilitation is required.
7. Monitor the impacts of horse riding and modify or further restrict use if the activity appears environmentally unacceptable.

25. Day Use

3. Martins Tank (High Priority)
   - Develop a day-use area at Martins Tank Lake for picnicking with a walk to Lake Pollard and further north
5. White Hill Road (High Priority)
   - Develop a day-use area at the end of White Hill Road with a lookout, picnic facilities, two wheel drive access close to the beach and four wheel drive beach access.
8. Information Bay (High Priority)
   - Maintain information facilities at this site on Preston Beach Road, and consider including a toilet when the walk track to Lake Preston and the lookout has been developed.
9. Mount John Road (High Priority)
   - Design a day-use site at the end of Mount John Road with the main activity being to interpret the stromatolites and thrombolites in Lake Clifton.

26. Camping

8. Design camping sites and facilities to ensure that potential risks to visitors and the impact on Park values are minimised.
9. Martins Tank (High Priority)
   - Continue site development at Martins Tank Camp Ground in accordance with the Recreation Development Plan.

27. Water Based Activities

1. Retain the waterskiing zone, access by the Bunbury Waterski Club and access by the public boat launching facility on Lake Preston subject to monitoring environmental impacts.
3. Provide information on the conservation values of Lake Clifton, Hayward and Pollard to explain to visitors why water-based activities are not permitted on these lakes.
4. Monitor the effects of water-based recreation activities on the environment and modify the activities if necessary.
6. Consider introducing some form of conditional canoeing in Martins Tank Lake, and extending zoning for canoeing to include the entire lower third of Lake Preston, after an assessment has been made to determine the environmental impact canoeing will have on each of these lakes.

29. Information and Interpretation

1. Develop and implement a community education and interpretation strategy for the Park.
3. Build small information/interpretation facilities at Mount John Road, Lake Hayward, Martins Tank, White Hill Road and at the Lime Kilns as funds become available.

30. Education

4. Liaise with program coordinators to modify any educational activities that may be having a detrimental impact on the Park's environment.

HIGH PRIORITY - GROUP 3 (Cont)

32. Tourism

2. Ensure that commercial tour operators maintain appropriate standards with respect to information, quality of service provided and minimal environmental impact operations.
4. Identify the sustainable level of tourist operator use where concessionaires wish to operate, monitor the impacts of these activities and regulate them as required.
5. Call for expressions of interest for concessionaires and limit the number of operators to a sustainable level.

34. Private Property

4. Seek to inform present and prospective landowners of compatible land-use practices and environmental constraints on land-use in the Lake Clifton and Lake Preston catchments.
6. Inform Park neighbours about Park management practices and encourage them to manage their lands in sympathy with Park objectives.

35. Local Government

1. Negotiate with local government authorities to manage land near the Park in a way that is consistent with Park management objectives.
2. Encourage local government to prepare management plans where property and conservation values of the Park, or in adjacent reserves, may be at risk.
3. Liaise with local government planning staff and councillors to ensure that any proposal on private land is adequately assessed for potential impacts on Park values.
4. Negotiate with local government to refer any land development proposal to CALM if it may potentially affect Park values.
5. Assist local Shires and others, where possible, to conserve natural areas, particularly areas adjacent to the Park.

36. State Government

1. Arrange for all land owners who seek approval from local government to construct a bore in the Clifton/Preston catchment to be advised that they are required to consult with the Water Authority and the South West Coastal Groundwater Advisory Committee.
2. Encourage the Department of Environmental Protection to prepare an Environmental Protection Policy which provides for the protection of Lake Clifton and Lake Preston and in particular the associated vegetation and water quality.
3. Encourage the Department of Planning and Urban Development to:
   i) complement the Environmental Protection Policy with a statement of planning.
   ii) ensure consistency between their Peel Region Plan, the Bunbury Wellington Region Plan and CALM's planning and policy documents regarding directions to local government on development control.
4. Support the Department of Agriculture and the Community Catchment Support Group (Peel Harvey Community Catchment Centre in Pinjarra) in advising, educating and involving the Clifton/Preston catchment community to manage their properties to minimise nutrient loading and pollution in the catchment.
6. Use a coordinated approach between the relevant authorities, departments and landowners to ensure land uses or sub-divisions of enclaves or adjoining private land do not adversely affect Park values.
7. Liaise with relevant authorities and departments to ensure that land use on adjoining land does not adversely affect Park values.

38. Nature Conservation Research

6. Continue research to increase knowledge and understanding of patterns and processes in the Park's ecosystem and, particularly, within Lake Clifton and the Park catchment.
7. Actively encourage research into the hydrology of the Park and its surrounds, and monitor the impacts of catchment land-use practices on ground and surface waters to enable better scientifically-based land-use management decisions.
8. Monitor the effectiveness and impacts of fire management measures and make any necessary changes to procedures in the light of research and experience.
9. Monitor the status of all plant diseases in the Park and carry out any necessary management actions in the event that new disease threats become apparent.
12. Investigate the habitat requirements and ecology of vulnerable species in relation to the impact of feral predators, fire regimes and plant disease occurrence.
13. Assess the Park's flora and fauna to determine appropriate release sites for the Ring-tailed Possum and any other native fauna. Implement a fox control program in association with landholders, and integrate and coordinate research efforts in the area.

HIGH PRIORITY - GROUP 3 (Cont)

15. Monitor the impacts of horse riding and disallow or modify management of the activity if environmental impacts are found to be unacceptable.

39. Social Research

2. Monitor the need for additional facilities resulting from changes in visitor use, and consider their provision subject to an assessment of their likely impact.

40. Priorities

3. Seek resources to implement this plan, as detailed in Staff and Funding (Section 41).

41. Staff and Funding

1. Seek sufficient staff or staffing arrangements at Yalgorup National Park to enable recreational site developments to proceed, particularly in the northern section of the Park.
2. Actively seek sufficient funds to implement this plan and to enable administrative and maintenance infrastructure to expand to cover the Park and additions to it.
3. Install a self registration camping fee collection station at Martins Tank. Use the funds collected to increase, improve and maintain Park facilities and services.
4. Seek revenue from external sources such as special grants, sponsorship and other alternative funding, which could be managed by a trust fund established to implement the Plan.
5. Continue to seek budget allocations for Yalgorup National Park sufficient to ensure the recommendations in this Plan are implemented.

MEDIUM PRIORITY

4. Land Tenure and Boundaries

1. Continue negotiations to cancel unnecessary road reserves within the Park boundaries including Quail Road Reserve which runs east west, the northern section of road reserve 228 and 13736, and add these to Yalgorup National Park (Map 2).
2. Extend the Park boundary along the coast to the low water mark.

5. Zoning

2. Develop appropriate access and recreational facilities in each zone according to environmental sensitivity and ease of management.
3. Control access to separate incompatible activities and provide for equitable use.

7. Geology, Landforms and Soils

1. Identify specific areas of the Park that are vulnerable to damage due to the nature of the geology, soils and landforms.
6. Provide interpretive information on the Park's geology, its relationship with landforms, soils and vegetation and their vulnerability to damage.

8. Vegetation and Flora

5. Minimise or prevent the removal of or damage to vegetation from constructing and maintaining roads and tracks, and developing and maintaining facilities for visitor use.
7. Retain representative areas of each vegetation community in locations that have been unburnt for extended periods of time (Section 18).

9. Fauna

2. Ensure mosquito and midge research and control programs are approved by CALM's Director of Nature Conservation by virtue of the power delegated to him by the NPNCA (NPNCA, 1993).
3. Increase knowledge of the Park's fauna by recording the incidences of death or injury to fauna resulting from motor vehicles and other causes.

INTERIM RECOVERY PLAN NO. 153

THROMBOLITE (STROMATOLITE-LIKE MICROBIALITE) COMMUNITY OF A COASTAL BRACKISH LAKE (Lake Clifton)

INTERIM RECOVERY PLAN

2004-2009

Robyn Luu[1], David Mitchell[2] and John Blyth[3]

[1] Project Officer, WA Threatened Species and Communities Unit, CALM, PO Box 51 Wanneroo, 6946.
[2] Regional Leader Nature Conservation, CALM's Swan Region, PO Box 1167, Bentley Delivery Centre, 6983.
[3] Acting Manager, WA Threatened Species and Communities Unit, CALM, PO Box 51 Wanneroo, 6946.

Photograph: Val English

June 2004

Department of Conservation and Land Management
Western Australian Threatened Species and Communities Unit (WATSCU)
PO Box 51, Wanneroo, WA 6946

Natural Heritage Trust
Helping Communities Helping Australia

Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

3. RECOVERY ACTIONS

The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for 'lower' priorities and other opportunities arise.

3.1 Coordinate recovery actions

The Lake Clifton Recovery Team has been established and consists of representatives from CALM's Swan Region (Chair) and Swan Coastal District, Science Division, City of Mandurah, University of Western Australia, Water and Rivers Commission, CSIRO, Lake Clifton Landcare Group, Agriculture WA, and CALM's WA Threatened Species Unit. The Recovery Team will continue to coordinate recovery actions for the Lake Clifton thrombolite community. Input and involvement will also be sought from any indigenous groups that have an active interest in Lake Clifton. The Recovery Team will include information on progress in their annual reports to CALM's Corporate Executive and funding bodies.

Responsibility: Recovery Team; CALM (Swan Coastal District)
Cost: $2,000 per year (to run team)
Completion date: Ongoing

3.2. Map critical habitat

It is a requirement of the EPBC Act that spatial data relating to critical habitat be determined. Although critical habitat is described in Section 1, the areas as described have not yet been mapped and that will be done under this action. If any additional occurrences are located, then critical habitat will also be determined and mapped for these locations.

Responsibility: Recovery Team; CALM (Swan Coastal District)
Cost: $2,000 in the first year
Completion date: Year 1

3.3 Clarify the extent and condition of the community

Funds will be sought to develop and implement a strategy to determine, through detailed survey, the extent (including number of individual structures if possible), size and condition of the thrombolite structures at Lake Clifton, to provide baseline data for future comparison.

Visual inspection of the structures for the presence of constructive filamentous cyanobacteria and macroalgae (indicative of algal blooms) will be done on a bi-annual basis.

Responsibility: Recovery Team; CALM (Swan Coastal District)
Cost: $5,000 in Year 1
Completion date: Initial studies completed, monitoring ongoing

3.4 Seek creation and protection of a suitable native vegetation buffer for the lake

A 200m wide vegetated buffer measured from the high water mark will be sought to help provide effective protection for the thrombolite community. General disturbance should be minimised within this zone and the area should not be utilised for other purposes such as retention basins or filtering ponds.

Responsibility: Recovery Team; DEP, Western Australian Planning Commission (WAPC), City of Mandurah, Shire of Waroona; CALM (Swan Coastal District); adjacent developers in response to Ministerial Conditions
Cost: Costs of all liaison $2,000 per year

Completion date: Ongoing

3.5 Conduct biological research to clarify threats to the thrombolites and help design recovery actions

The 'health' or viability of the thrombolites has been established through a biological/petrographic study of the structures and this indicated that they were healthy at December 2000 and that the organisms that formed them are still dominant. The health of the thrombolites will be monitored through compositional and structure studies. The impact of introduced fauna, such as bream and snails, will also be examined. Studies will also include identification of where macro-algae occurs in the lake.

Responsibility: Recovery Team; CALM (Swan Coastal District); Water and Rivers Commission (WRC)
Cost: $3,000 for Year 1 (microscope), $2,000 per year for monitoring
Completion date: Ongoing

3.6 Manage access to site

Ensure scientific and public access and research on the thrombolite community is undertaken in a coordinated and organised way with minimal disturbance and physical damage.

Responsibility: Recovery Team, CALM (Swan Coastal District)
Cost: $1,000 in Year 1 to develop protocol, $500 per year to manage system
Completion date: Ongoing

3.7 Ensure areas containing the microbial community are protected from physical damage

Actions will include the upgrading of the boardwalk at the site and the placement of signs at the site informing visitors not to step on the thrombolites. Liaison will also occur with the local landowners to ensure that their fencing is maintained as to prevent their stock entering the lake and crushing the thrombolites.

Responsibility: Recovery Team, CALM (Swan Coastal District)
Cost: $15,000 for Year 1
Completion date: Ongoing

3.8 Manage physical impacts to thrombolites through provision of information

Continue to develop an education program through the use of information boards, brochures etc, that explain the importance of the site and features.

Responsibility: Recovery Team; CALM (Swan Coastal District)
Cost: $2,000 per year
Completion date: Ongoing

3.9 Undertake ongoing monitoring of physical condition and microbial assemblage of thrombolites

Using methods for monitoring condition, size and extent established under Recommendation 3.5, undertake ongoing monitoring. Such monitoring should include continuing assessment of the composition of the microbial community. The possibility of monitoring numbers of intact thrombolites along a transect to determine gross changes, and the use of photographic monitoring to measure the extent of physical crushing will be investigated. As the area of the thrombolite reef is quite large sub areas, and/or areas identified as being at high risk can be sampled.

Responsibility: Recovery Team; CALM (Swan Coastal District); WRC
Cost: $6,700 in year one, $1,700 per year thereafter
Completion date: Ongoing

3.10 Monitor water quality and hydrology

Undertake ongoing monitoring of the limnological status of the lakewaters and groundwaters. Data should include ionic composition, nutrient levels, nutrient input and collection of water level and water quality information from the lake middle and edges adjacent to thrombolites and from monitoring bores in adjacent areas of interest. Methods used to monitor salinity should be consistent with previous sampling regimes so that the data are comparable.

Responsibility: Water Corporation; Water and Rivers Commission (WRC); Recovery Team
Cost: To be determined following analysis of baseline monitoring data (between $12,000-$33,000 per year)
Completion date: Ongoing

3.11 Determine the range of normal fluctuations for hydrological regimes and attempt to maintain them within that range

The adequacy and appropriateness of current water level measurements needs to be assessed. Groundwater levels should also be measured, and specific actions may need to be initiated if levels decline below a certain point. Criteria that can trigger fuller investigation will be established during the term of this IRP and, if required, incorporated into the full Recovery Plan.

Baseline monitoring data on water level is already available for the lake from 1985 to 2000 (Lane, J. unpublished data). The period of inundation of the thrombolites will continue to be monitored.

Responsibility: CALM (Swan Coastal District), Recovery Team, Water Corporation; WRC
Cost: $1,000 per year
Completion date: Ongoing

3.12 Manage water quality

Liaise with land and water managers to respond to results of water monitoring as appropriate, for example limiting groundwater abstraction rates if saltwater intrusion occurs.

Responsibility: Recovery Team; CALM (Swan Coastal District); Water Corporation; WRC
Cost: To be determined as a result of monitoring actions prescribed in this IRP.
Completion date: Ongoing

3.13 Provide information to surrounding landholders to ensure actions on their lands do not impact the thrombolites

Such information should aim to minimise fertiliser use, avoid use of chemicals that may be toxic to the community and ensure other threatening processes are mitigated. A pamphlet that includes this information will be provided to people who purchase land adjacent to the lake.

Responsibility: Recovery Team; CALM (Swan Coastal District); liaison with surrounding landholders, the City of Mandurah and Shire of Waroona
Cost: $2,000 per year
Completion date: Ongoing

3.14 Cooperate with appropriate agencies to manage land uses to ensure appropriate water quality within the lake

CALM will cooperate with agencies, such as the City of Mandurah, Shire of Waroona, Department of the Environment, Water and Rivers Commission, and the Department of Agriculture, to achieve the implementation of recommendations made in EPA Bulletin 864 in relation to the management of land likely to influence Lake Clifton.

Responsibility: Recovery Team; CALM (Swan Coastal District); liaison with other agencies
Cost: $1,000 per year
Completion date: Ongoing

3.15 Liaise with the EPA to encourage the updating of Bulletin 864 and the formulation of an Environmental Protections Policy

The phosphorus levels found in the Yalgorup Lakes study (Shams 1999) were found to be above recommended guideline levels. EPA Bulletin 864 states that 'Where the Yalgorup Lakes study points to the need for greater controls on new land uses, then the EPA criteria will be updated accordingly. Further if the study reveals that existing land uses are causing significant environmental problems, an Environmental Protection Policy (EPP) may be formulated'. CALM will liaise with the EPA to seek the implementation of those commitments.

Responsibility: Recovery Team; CALM (Swan Coastal District); liaison with EPA
Cost: $1,000 in year 2
Completion date: Year 2

3.16 Collect relevant baseline information and ongoing monitoring data for the vegetation that provides a buffer for the thrombolite community

The vegetation buffer is important in controlling sheet flow and inhibiting the movement of sediment into the lake. A survey on the density, root mass, and the width of the vegetation buffer in the length of the 14km buffer adjacent to the thrombolites as well as the lake boundary will be undertaken. Weeds may contribute to sediment movement and susceptibility to fire and should therefore be controlled in the vegetation adjacent to the lake (see 3.17).

Responsibility: Recovery Team; CALM (Swan Coastal District)
Cost: $10,000 for initial vegetation survey; $1,000 every year thereafter for flora monitoring
Completion date: Ongoing

3.17 Control weeds and rehabilitate plant communities on eastern side of lake

Design and implement a strategy to rehabilitate degraded areas of the sedgeland and other plant communities on the eastern side of the lake that provide a buffer for the wetland containing the thrombolites. This will include carefully designed and monitored weed control - taking extreme care not to impact the thrombolites, and replanting as necessary (eg. where the plant communities have been impacted). Liaison with adjacent land owners on the eastern side of the lake is required to ensure that fences adjacent to the thrombolites are maintained.

Responsibility: CALM (Swan Coastal District), Recovery Team
Cost: $100,000 for Year 1, $30,000 per year thereafter
Completion date: Ongoing

3.18 Design and implement a Fire Management Strategy to sustain the vegetation buffer

3.18.1 Develop and implement an approved fire management strategy

The strategy will allow for the natural development of the sedgeland and adjacent plant communities that provide a buffer for the thrombolites. It should include an annual fire monitoring and reporting schedule.

There is a need for research into the effect of fire on the vegetation buffer and the implications for management. A fire history map of the area, which is updated annually, is also required.

These issues are considered in a general sense in the Management Plan for the Yalgorup National Park.

Responsibility: CALM (Swan Coastal District); Recovery Team; adjacent landowners; City of Mandurah; Shire of Waroona; Fire and Rescue service.
Cost: $850 to develop fire management strategy in Year 1
Completion date: Year 2

3.18.2 Ensure maintenance of strategic firebreaks on occurrences or construction of new strategic fire breaks on surrounding lands to help prevent fire spreading to community.

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to degrade the community. Where firebreaks are not deemed strategically necessary, they will be closed and allowed to rehabilitate.

Local CALM staff should be responsible for planning fire break construction and maintenance.

Responsibility: CALM (Swan Coastal District); Recovery Team; in liaison with surrounding landholders
Cost: Cost of firebreaks $2,500 per year; costs of liaison included in 3.18.3
Completion date: Ongoing

3.18.3 Liaise with adjacent landholders and Fire and Rescue service to ensure fire suppression strategy in adjacent areas does not impact community; eg avoidance of the use of chemicals that adversely impact the thrombolites and avoidance of construction of new tracks in the vegetation area adjacent to the lake for use in fire suppression.

The strategy for fire suppression procedures should be to minimise physical and chemical impacts on the thrombolites.

Responsibility: CALM (Swan Coastal District); Recovery Team; City of Mandurah; Shire of Waroona; liaison with adjacent landholders
Cost: Costs of all liaison included in Action 3.18.1
Completion date: Ongoing

3.19 Report on success of management strategies for the thrombolite community

Reporting on the success of overall strategies to maintain or improve condition of the thrombolite community will be done in annual reports prepared by the Recovery Team for CALM's Corporate Executive. A final report will be prepared at the end of five years, perhaps as part of the preparation of a full recovery plan (see 3.20 below).

Responsibility: CALM (Swan Coastal District); Recovery Team
Cost: $2,000 per year
Completion date: End of Year 5

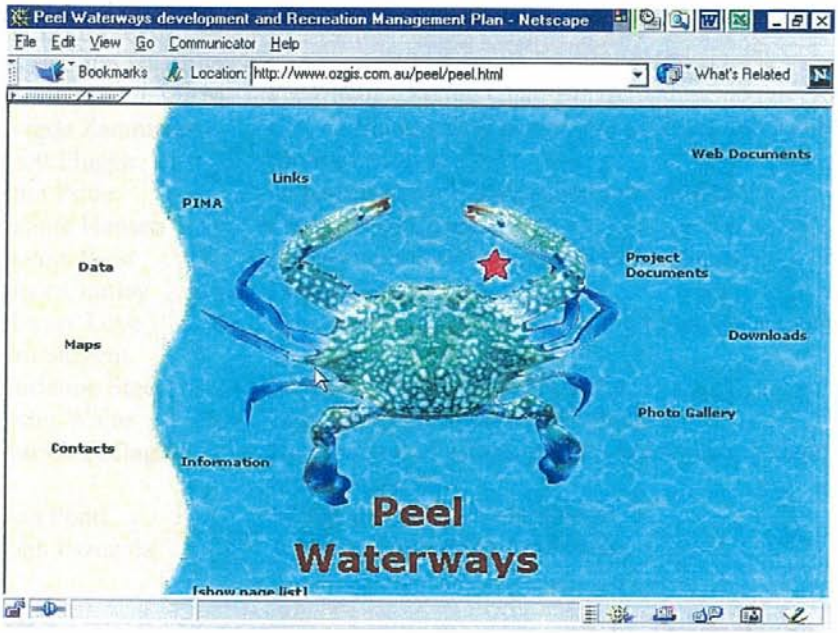
3.20 Review the need for a full Recovery Plan

At the end of the fourth year of its five-year term this Interim Recovery Plan will be reviewed and the need for further recovery actions will be assessed. If the community is still ranked as Critically Endangered at that time a full Recovery Plan may be required.

Responsibility: CALM (Swan Coastal District and WATSCU) through the Recovery Team
Cost: $17,500 in Year 5 (if full Recovery Plan required)
Completion date: Year 5

Economic Development and Recreation Management Plan

For the
Peel Waterways



Prepared for
the Water and Rivers Commission

August 2002

Department of Employment, Workplace Relations and Small Business
City of MANDURAH
SHIRE OF MURRAY
WATER AND RIVERS COMMISSION
PEEL INLET MANAGEMENT AUTHORITY
THE PEEL REGION
PEEL DEVELOPMENT COMMISSION
GOVERNMENT OF WESTERN AUSTRALIA
Department for Planning and Infrastructure
Coastal Facilities Marine Safety

Economic Development and Recreation Management Plan

For the Peel Waterways

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Members of the Peel Waterways Development and Recreation Management Planning Group and Steering Committees:

Professor John Hamblin	Chairman PIMA (until July 2001)
Mr Bruce Tatham OAM	Chairman - Acting Chair PIMA
Mrs Verda Zammataro	City of Mandurah (Department of Sport and Recreation)
Mr Brett Flugge	Shire of Murray
Mr John Pride	Department for Planning and Infrastructure
Ms Leonie Hansen	Chamber of Commerce
Ms Donna West	Department for Planning and Infrastructure
Mr Mike Cranley	Department of Fisheries
Mr Murray Love	Department of Conservation and Land Management
Mr Jim Sargent	WA Tourism Commission
Ms Christine Steer	Peel Development Commission
Mr Craig Waite	Department of Sport and Recreation
Mr Patrick Gallagher	Department of Employment, Workplace Relations and Small Business
Mr Bob Pond	Water and Rivers Commission
Mr John Pszczola	Water and Rivers Commission

9 IMPLEMENTATION

9.1 Implementation Program

Conventional practice in management plans is to list the key strategies, assign priorities and time frames to them, identify which agency should be responsible for each initiative and propose a budget spread over the period of the plan. Whether or not the plan is implemented or gathers dust is largely dependant on the size of the budget proposed and its acceptability to Government; and the degree of complexity or controversy in the plan. For example, one submission to the study stated that there was a perfectly good management plan produced in 1993 which appears not to have been implemented.

This plan takes a different approach. It is about driving economic development; and ways in which the public and the business community can work with management agencies to achieve positive outcomes in complex situations. This approach says that *if you drive it, it will happen*. The first step to implement the plan will be for the Water and Rivers Commission, through the Peel Waterways Development and Recreation Management Steering Committee, to decide its priorities and establish working groups to plan further activity.

Only seven key initiatives are listed here as the implementation strategy. Initially, they require no specific funding. These are:

Issue	Implementation
Environmental infrastructure funding for sustainable urban development.	Management, planning and service agencies need to advise their respective Councils, Administrations and Ministers, of the deteriorating state of the Peel Waterways environment and the urgent need for major infrastructure funding for environmental remediation as part of preparations for urban growth.
Use, development and management of waterways and adjacent land	Use, development and management of the Peel waterways and adjacent land should be guided and regulated in accordance with the recommendations set out for the respective policy areas. This will involve: • inclusion of appropriate provisions in local government planning strategies and town planning schemes; • consideration of the policy recommendations in statutory decision-making by authorities such as WRC, local government, the Western Australian Planning Commission and Environmental Protection Authority.
Large scale revegetation and reafforestation within the catchment and along rivers.	WRC and the Peel Harvey Catchment Council should invite industry, business, landowners and expert personnel support and participate in joint programs for reafforestation within the catchment, including seeking grants and development of a local carbon credit or nutrient credit scheme.
Rehabilitation of the habitats and environs of the Murray	WRC and the Shire of Murray should invite business, landowners and expert personnel to help plan and

Issue	Implementation
River.	implement strategies for rehabilitation of the river environment.
Development of nature based tourism and eco-tourism enterprises and facilities.	The WA Tourism Commission, Local Tourism interests and the Chamber of Commerce should identify prospective providers and assist them to develop plans for specific eco-tourism initiatives in consultation with WRC, CALM and the community.
Initiate a Peel Waterways Institute as a tourist discovery centre, based on an education, training and R&D facility.	WRC, the Peel Development Commission and the Councils should invite business, community members, training authorities and expert personnel to help plan, devise a management structure and implement the Peel Waterways Institute.
Plan and implement a 30 year program of fish stock enhancement.	WRC and Department of Fisheries should work with fishing and environmental groups, tourism interests and the community to plan and implement a program of fish habitat enhancement to improve fishing opportunities.

At the local level, each of the agencies with management roles related to the Peel Waterways is more or less fully committed to the task of maintaining their services, and that is their area of greatest expertise. They are nevertheless the prime areas of expertise and advice on many of the issues raised in the plan and should make special provision in their programs to participate in the community driven projects that will ensue.

As a general recommendation, they should each consider the strategies of relevance in the plan in the light of their current programs and decide how they can best work with the community to advance at least one new initiative, perhaps on the basis of achieving the best result for the least input.

9.2 Funding of Management and Development

9.2.1 Resources for Environmental Repair

There was a consistently strong view expressed by those consulted that the Waterways environment underpins the Peel Region's economy and lifestyles, but that too few resources are committed to environmental management, maintenance and repair. The need for adequate resourcing was mentioned at the launch of the public consultation phase of the project when Professor John Hamblin, then Chairman of PIMA, observed that:

> *"Greater pressure on the environment means that the region may become less desirable as a place to live in and visit. A wealthy community has a greater ability to provide solutions to environmental problems. Poor people and poor regions cannot afford the luxury of conserving resources. Therefore the way forward for the Peel Region is to identify and manage those components of the local environment that are vital to the social and economic aspirations and well-being of its people. Of being a place where people want to live and visit. At the same time ensuring that there is an expanding economic base, providing opportunities for families and individuals to meet their own personal goals and needs."*

There are critical interrelationships between the economy, society and the environment which provide a context to the management plan as a whole. A more detailed discussion of those

relationships, and the best practice management of change is in Part 3 of the draft report. However for now it is probably sufficient to say that responses to environmental degradation such as the example provided by the Dawesville Channel are, at best, playing 'catch up'. More fundamental and pro-active approaches are required that anticipate the scale of current and future environmental issues.

Ultimately this is a question of broad resource allocation. In dealing with urban growth, planners have regard for the cost of infrastructure well ahead of development and the necessary funding is provided in the State budget process. It is doubted whether the real infrastructure cost of restoring and maintaining the waterways to cope with growth has been taken into account, yet the financial consequences of not doing so may be enormous in terms of environmental loss and future restoration costs.

It is essential that the planning and servicing agencies make provision for the infrastructure cost of preparing the waterways environment for urban growth and the additional costs of providing for new recreation facilities.

9.2.2 Funding for Management

All of the Government agencies with responsibilities in and around the waterways indicated a shortage of resources to fulfil their present functions. The Department of Conservation and Land Management advised that it will need extra financial resources if it is to have a significant role in the management of the proposed Peel Regional Park.

Government has an expectation that all agency expenditures are properly coordinated and meeting objectives. Their performance will in part be judged on the extent to which their policies, objectives and programs accord with adopted plans. This leads to much more liaison between agencies and the public, and more effective and focussed programs. .

Strategies

- Planning and service agencies should make clear to the Government, the levels of funding which will be necessary to enable urban and recreational growth of the scale currently proposed;
- Management authorities should regularly review programs and consider the diversion of recurrent expenditure to facility improvement and lower maintenance solutions;
- WRC, through the Peel Waterways Development and Recreation Management Steering Committee, should decide its priorities and establish working groups to implement the plan.

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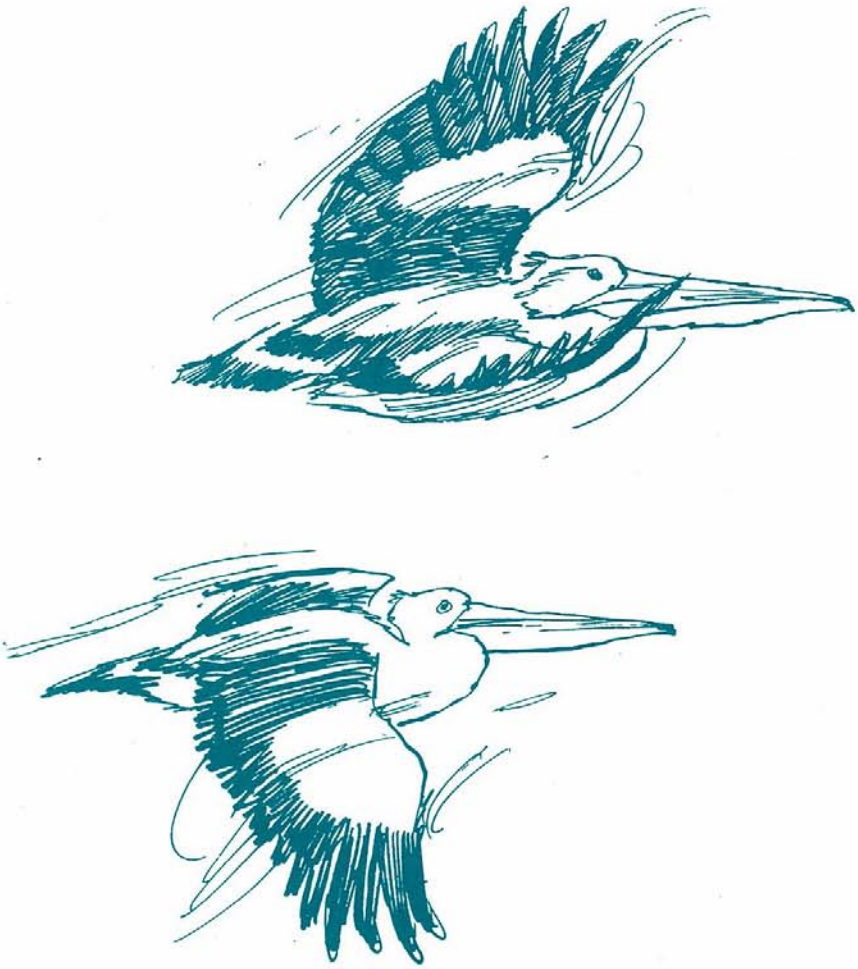
PEEL INLET

MANAGEMENT PROGRAMME

1992



WATERWAYS COMMISSION

REPORT No. 27

January 1992

PEEL INLET

MANAGEMENT PROGRAMME

1992

Prepared for the Peel Inlet
Management Authority
by the Waterways Commission

WATERWAYS COMMISSION
REPORT NO 27
1992

RECOMMENDATIONS

All General Recommendations are listed below in numerical order (1-106). The rationale behind these recommendations is discussed in Chapter 5. Chapter 6 lists the Area Recommendations (A.1-A.200) in relation to their geographical locations. These have not been duplicated in this section because of the large number of recommendations presented and the need to consider them in conjunction with the relevant map. The agencies responsible for implementation of the recommendation are provided in abbreviated form following each recommendation. The lead agency is underlined. These abbreviations are expanded in full on a fold-out sheet at the back of the document.

GENERAL RECOMMENDATIONS

AGENCY CO-OPERATION AND PUBLIC PARTICIPATION

State, Local Government and Community Representation

1. Continue the practice of appointing representatives from the City of Mandurah and the Shires of Murray and Waroona, to PIMA (WWC).

2. Continue the practice of appointing representatives from relevant State government authorities to PIMA (WWC).

3. Continue the practice of appointing interested members of the public to PIMA (WWC).

Administrative Referrals

4. Seek advice from all relevant authorities before reviewing management programmes (PIMA).

5. Refer all management programme reviews and draft policies to the relevant authorities for comment (PIMA).

6. Refer PIMA meeting minutes to local authorities for their information (PIMA).

7. Refer all major development proposals to be undertaken by PIMA to the relevant authorities for comment (PIMA).

8. Comment on all proposed amendments to town planning schemes which affect the management area (PIMA).

9. Seek referral of all development applications affecting the management area or waterway which are being considered by town planning authorities, to enable input from PIMA concerning waterway issues (PIMA, DPUD, LGAs).

10. Seek referral of proposals to change the vesting, boundaries, purpose or use of reserves within the management area (PIMA, DOLA, LGAs).

Public Education and Participation

11. Seek advice from interested people and groups about the structure and content of management programmes (PIMA).

12. Advertise in local newspapers for public comment on management programmes reviews (PIMA).

13. Prepare a comprehensive programme of public education relating to the waterway and its management (PIMA, WWC), including:

    a) Information packages for members of management authorities and committees, LGA councillors and staff, and other authorities.

    b) Information packages for members of the public.

    c) Educational packages for schools, with assistance by PIMA staff in their interpretation and use.

    d) Information for neighbours, including farmers, canal estate and river bank residents and commercial property owners and tenants.

    e) Waterways information leaflets similar to Leaflet No 1 "The Blue Manna Crab". Other topics of immediate relevance include "Birdlife of the South-West Estuaries" and "The Samphire Marsh".

    f) Displays on the role and functions of PIMA for use in libraries and other public venues.

    g) Advertising to get information to specific audiences (for example, boat owners, anglers and yacht owners).

    h) An information video about the waterway and its management.

    i) Disseminate WWC guidelines on the control of pollution by anti-fouling paints to all slipyards and boating operators.

    j) Prepare a pamphlet on the possible impacts of climatic change on the waterway.

CONSERVATION AND ENVIRONMENTAL PROTECTION

Water Quality Management

14. Support and assist the implementation of the ERMP Stage 2 which will assist in the improvement of water quality of the waterways, and report to the community concerning changes in water quality (PIMA, WWC).

15. Support the creation of a central committee to co-ordinate all planning decisions which affect the catchment of the waterways, to enable full consultation between authorities. The committee should include representatives of local government (PIMA).

16. Develop a policy with respect to living on vessels within the management area to ensure they do not have an impact on water quality (PIMA, CM, SM, SW).

17. Protect fringing vegetation around the estuary which reduces the nutrient level of ground water (PIMA, LGA, CALM, DPUD).

Weed Harvesting

18. Upgrade weed harvesting operations to make more effective use of existing resources in accordance with Option A outlined in "Review of Weed Removal Operations - Peel Inlet and Harvey Estuary", prepared by the Waterways Commission 1989. The funding of this work is recommended in the EPA Assessment Report relating to the ERMP Stage 2 (PIMA, WWC).

Proposed Peel-Harvey Regional Park

19. Establish the Peel-Harvey Regional Park and an effective management framework based on existing authorities (DPUD, PHCDC, CALM, EPA, PIMA, LGAs).

20. Determine appropriate vestings and reserve purposes for foreshore land in accordance with the Area Recommendations as outlined in Chapter 6 (PHCDC, DPUD, DOLA, LGAs).

21. Establish a body to co-ordinate Regional Park management (DPUD, CALM, PHCDC).

Conservation Reserves

22. Support the implementation of the System 6 Recommendations C50 and C51 and provide technical advice concerning these areas if appropriate (Appendix 1). Investigate wildlife habitats within the study area and seek their protection (PIMA, PHCDC).

Conservation of Waterway Margins

23. Establish a Waterways Protection Precinct in areas where protection of waterways and adjacent foreshore margins is of high priority. To protect the waterway in this precinct PIMA will:

- Seek the acquisition and reservation of any privately owned waterway areas and recommend appropriate vesting.
- Provide advice about the development of private land which enables its use without unacceptable change to the waterways environment.
- Investigate closely the rezoning of land in the precinct if it will enable more intensive development, and provide appropriate advice to decision making authorities.
- Identify areas of fringing vegetation and determine their current ownership and management.
- Prepare detailed recommendations about the future vesting of Vacant Crown Land and reserves which contain fringing vegetation.
- Undertake work to protect and rehabilitate areas of vegetation within this precinct in co-operation with land owners and relevant authorities and in accordance with the WWC Foreshore Management Policy.

- Undertake research to determine effective techniques for rehabilitating degraded fringing vegetation.
- Support the long term use of the State Government's moratorium on clearing and drainage, and the Environmental Protection Authority's Wetland Policy.
- Identify and monitor all existing drainage outlets into the waterway and encourage the use of biological filters on all proposed drainage systems.
- Support the implementation of the Department of Agriculture's Soil Conservation Act which prohibits the clearing of more than 1 hectare of land without a permit.
- Encourage local land owners to form local management groups to address waterway management issues.
- Identify areas of remnant vegetation and seek their protection.

Erosion Control

24. Identify and monitor areas of the waterway at risk from erosion and implement a long term erosion control programme (PIMA, LGA, DMH). Control measures should include:
    - Foreshore stabilisation with native vegetation.
    - Tree planting adjacent to rivers.
    - Improving public access to stable areas of the waterway and discouraging access to erosion prone areas.
    - Adoption of agreements with landholders to prevent livestock from damaging the river banks and vegetation.
    - Beach renourishment, walling, groynes, flow redirection, use of baffle boards to dissipate wave action.
    - Modification to recreational activities in serious erosion areas.
25. Provide information to private land owners to encourage appropriate methods of erosion control (PIMA, LGAs).
26. Establish a Bank Revegetation Precinct in areas where revegetation of the river banks is of high priority. To prevent further loss of vegetation PIMA will encourage property owners, local government authorities and community groups to undertake revegetation programmes under PIMA's guidance (PIMA).
27. Develop techniques for propagating rushes for use in bank stabilisation programmes (PIMA, CALM).

Mosquito Control

28. Undertake the recommended works and monitoring programmes defined in the Interim Strategy for Mosquito Control in the Peel Inlet and Leschenault Estuary Regions (PIMA, HD, LGA).

Aboriginal Sites

29. Encourage management bodies and developers to consult with the Department of Aboriginal Sites, WAM, concerning development plans at an early stage to ensure that Aboriginal sites are not inadvertently disturbed (DPUD, PIMA, LGA).

European Historic Sites

30. Identify and protect sites of cultural and/or historic significance by proclamation of Western Australian Heritage Legislation (WAHC).

31. Develop appropriate historic sites as tourist attractions (WATC, LGAs, WAHC).

LAND USE AND WATERWAY PLANNING

Peel Regional Planning Study

32. Provide advice to DPUD concerning waterway conservation needs during preparation of the Peel Regional Planning Study (PIMA, WWC).

Foreshore Reserves

33. Treat all foreshore reserves and the waterway as a single Regional Park for the purposes of planning and management (DPUD, LGAs, CALM, DOLA, PIMA).

34. Implement the recommendations which relate to the rationalisation of foreshore land outlined in the Area Recommendations (PIMA, DPUD, LGAs, DOLA, CALM).

35. Establish a fund to enable the purchase of privately owned foreshore land which cannot be acquired by other existing mechanisms (WWC, TREASURY).

36. Establish a priority order for the acquisition and vesting of foreshore land (DPUD, PIMA, LGAs).

37. Designate areas suitable for declaration of waterway recreation nodes, conservation areas and linear parks (DPUD, PIMA, LGAs, DOLA).

38. Develop foreshore reserves designated for recreational use in the Area Recommendations to facilitate water oriented activities or enhance the use of the waterway. Where the adjoining waterway is not suitable for recreational use other activities should be considered (LGA, PIMA, MSR, DPUD, DMH).

39. Determine the width of foreshore reserves taking into account the following criteria (DPUD, LGAs, PIMA, DOLA):

- future land use
- conservation of natural ecosystems
- educational value
- recreational links between linear parks
- the flood plain
- heritage values

- landscape conservation
- management access
- public access
- erosion and accretion processes
- wildlife corridors
- the need to protect water quality
- possible future changes in sea level
- the advice of the RAOU

40. Identify management agencies for all foreshore reserves and Vacant Crown Land (DPUD, LGAs, CALM, PIMA).

41. Plan service corridors to provide for the combined needs of utilities so that all services cross the waterway at a limited number of common locations where their impact can be minimised (DPUD, LGAs, and other relevant authorities).

42. Liaise with Treasury, DOLA, DPUD and LGAs to develop a properly structured mechanism for funding foreshore reserve management. Consider the use of Trust Funds as a management mechanism (PIMA).

Landscape Protection

43. Determine suitable means of land use control which enable the character of rural areas to be maintained while avoiding the necessity for land acquisition, including the use of strengthened provisions in LGA town planning schemes (DPUD, LGAs, DA).

44. Incorporate special zones into LGA town planning schemes to give protection to valued landscapes, particularly in built up areas (LGAs).

45. Prepare an overall landscape plan in order to co-ordinate landscape enhancement proposals (LGAs).

46. Develop site design criteria and development guidelines for recreational nodes (PIMA, DPUD, LGAs). Specific issues to be considered include:

    - recreational nodes, which should be complementary to each other. Site design should provide a range of offshore and onshore activities;
    - interpretative and educational facilities;
    - toilet facilities; and
    - a variety of modes of access, e.g. foot, vehicle and bicycle.

47. Control advertising signs within the management area in accordance with set guidelines (LGAs, PIMA).

48. Provide low key dinghy/yacht storage areas and liaise with boat owners concerning their use (PIMA).

49. If necessary, invoke the provisions of the Soil Conservation Act to prevent the clearing of large areas near the waterway (DA, PIMA).

Australian Heritage Listing

50. Support the ongoing protection of the waterway with reference to its place on the Register of the National Estate (PIMA, WWC).

Public Access

51. Establish a Public Access Precinct in areas where the provision and management of public access is of high priority. To secure, promote and encourage public access within these areas, PIMA will:

- Support DPUD's practice of reserving and retaining (where possible) river foreshore land to provide public access, and provide advice to DPUD where necessary.
- Seek the acquisition of freehold land in accordance with the WWC Foreshore Management Policy.
- Encourage the incorporation of Vacant Crown Land and unvested reserves into existing reserves for recreation or waterways management purposes and recommend appropriate vesting.
- Promote the preparation and implementation of management plans which improve public access.
- Investigate the feasibility of entering into agreements with private land owners to gain the right of public access, while protecting the right of property owners.
- Support the planning, construction and extension of dual use paths by LGAs in accordance with the Dual Use Path Guidelines.
- Seek to ensure that the boundaries between reserves and private properties are clearly defined by road, dual use path or substantial fencing.
- Identify areas where private development of foreshore reserves has occurred and liaise with property owners and relevant authorities to remove illegal developments.
- In conjunction with WAHC, LGAs and CALM, promote and develop the concept of heritage trails in the scenic or historic areas of the waterway to assist in the development of public awareness of the estuarine environment.
- Support the provision of unobtrusive sign-posting on public reserves, by the relevant authorities in accordance with recognised standards.
- Support the provision of foreshore facilities by LGAs to provide access for the disabled.
- Ensure ongoing public consultation on matters relating to public access.
- Consider the possibility of providing equestrian access through bridle trails.

Urban Development

52. Approving agencies to seek early consultations with PIMA when considering the subdivision or development of land within the management area to determine waterway management requirements (DPUD, LGAs).

53. Ensure that any subdivision or development in newly developed or undeveloped waterway locations has regard for (DPUD, Dev):

- the nature of nearby foreshore reserves, whether conservation or recreation based;
- the capacity of the foreshore to sustain heavier use;
- the degree of protection provided for foreshore areas; and
- the inclusion in town planning schemes of landscape protection areas identifying vegetation and landforms which must be protected to maintain landscape values.

54. Ensure that residential developments near the waterway include adequate foreshore reserves which are developed and managed in accordance with WWC Foreshore Management Policy (WWC, PIMA).

Commercial Developments

55. Ensure that commercial developments do not occur in areas reserved for conservation or waterway management purposes (DPUD, LGAs, DOLA, PIMA).

56. Have an input to ensure that commercial developments only occur in suitable locations which are chosen after careful consideration of social, environmental and physical planning criteria (DPUD, LGAs, PIMA), including:

- availability of the essential services required by the development including water, sewerage, electricity and telephone;
- likelihood of the development having an adverse impact on neighbouring residential areas because of noise, traffic and parking;
- intent of the LGA town planning scheme as it relates to adjacent areas;
- impact of the development on the amenity of the existing landscape and natural environment;
- effect the development may have on the hydrology of the floodway and flood plain, and risk of flooding to the development;
- every proposal for commercial development should be considered on its individual merits. It should also be considered in context to take into account cumulative impacts; and
- impact of the development on public access to the foreshore.

57. Refer proposals which involve over-water structures or developmental dredging, or those which abut areas which are subject to System 6 Recommendations, to the EPA for environmental impact assessment (DPUD, LGA, PIMA).

Dredging

58. Implement the dredging guidelines prepared by the EPA as an environmental protection policy under the Environmental Protection Act 1986 (EPA, PIMA).

Canal Developments

59. Monitor the environment of all existing canal developments to increase overall knowledge of these artificial waterways (PIMA, Dev, EPA).

60. Establish a mechanism to ensure funds are available to undertake maintenance work on canal developments when required (LGAs, DMH).

61. Assess future developments on land zoned for canals with reference to increasing knowledge of the impact of existing canal estates and the implications of the proposed Dawesville Channel (EPA, DPUD, PIMA, LGAs).

Flood Plain Management

62. Investigate the need for legislative changes in conjunction with the consolidation of the Water Authority Acts and amendments to other planning Acts, to ensure that suitable co-ordination exists between planning authorities and the Water Authority for sound flood plain management (WAWA).

63. Prepare guidelines to assist agencies involved in the planning and management of flood prone land (WAWA, DPUD).

64. Undertake studies to prepare and update flood prone land maps and include all designated flood lands required for the proposed guidelines (WAWA).

65. Prepare flood plain management plans for the river system. These should consider factors such as flood behaviour, including risk and effects of future development, conservation of the natural environment, and planning issues (WAWA, DPUD, LGA, PIMA).

Water Transport

66. Improve facilities for boats and ferries (LGA, PIMA, DMH) by supporting the

- raising of the old traffic bridge which limits boat access; and
- provision of car parking, public toilets, and sewage pump out facilities.

Where appropriate developers of waterside facilities should contribute to the cost of providing these facilities.

67. Provide suitable sites for hire and drive operators at appropriate locations around the estuary (LGA, PIMA, DMH).

68. Ensure that proposals to develop new commercial boating facilities undergo proper investigations to avoid environmental problems and user conflicts (PIMA, EPA, DMH, LGA).

Living on Boats

69. Ensure that all boats which contain living facilities include effluent holding tanks, bilge tanks and pump out fittings (DMH, PIMA).

70. Ensure that effluent pump out facilities are included in the design of nominated marina facilities around the inlet (LGA, PIMA).

71. Seek Cabinet approval to gazette a regulation limiting the residential use of boats (HD, WWC, PIMA).

Planning for Climatic Change

72. Seek wider and more elevated areas of foreshore reserve to limit losses in the event of sea level rises (DPUD, LGA, PIMA).

73. Discourage the development of buildings and other permanent structures below 1.5 m AHD (WAWA, PIMA).

74. Ensure that all advice provided by PIMA relating to development proposals near the waterway contains a statement warning developers of the predictions of climatic change and sea level rises (PIMA).

TOURISM

Provision for Tourist Facilities and Activities

75. Limit foreshore tourist facilities to those providing direct services to tourists. Facilities providing support services to the tourist industry, e.g. administrative buildings, should be located away from the foreshore (DPUD, LGA).

76. Identify areas where tourist developments may occur without loss of the waterway environment (PIMA).

77. Prepare an information booklet and map detailing attractions of the waterway for tourist and day visitors and advising of the need to protect the waterway environment (PIMA).

78. Encourage developers of tourist facilities to seek advice about waterways management issues before preparing development proposals (PIMA).

79. Require tourist operations proposing to conduct tours near conservation areas to seek approval from the relevant authority. Any tourist operator working in conservation reserves must be licensed by the Department of Conservation and Land Management (PIMA).

FISHING

80. Reduce the number of professional fishing units using the mechanisms outlined in the "Need for Action", to a number which can operate viably on the waterway (DF).

81. Consider the waterway's capacity to sustain both professional and amateur fisheries when determining the "ideal" number of professional fishing units (DF).

82. Develop an education programme which emphasises the need for regulation and maintenance of habitats and breeding areas (PIMA, DF).

83. Continue research on (DF, PIMA):

- species taken by commercial and amateur fisherpeople;
- the impact of commercial and amateur fishing activities on fish stocks in the estuary; and
- the effects of changes to the waterway environment on fish and shellfish and their habitats.

RECREATION

84. Identify areas where recreation reserves can be created or increased in area and upgraded to provide for existing and future demands (PIMA, MSR, DPUD, LGA).

85. Improve water quality to encourage swimming and if appropriate create areas of deeper water suitable for swimming (PIMA, MSR, EPA, WWC, DPUD).

86. Improve picnic area design to create better areas for relaxing and social interaction within small groups (LGAs, PIMA, MSR).

87. Identify sites suitable for the development of recreation club activities (LGAs, PIMA, MSR).

88. Monitor trends in recreational use and participation through surveys, observation and public consultation to determine requirements for future recreation (MSR, PIMA, LGA, WWC).

89. Prepare a brochure which identifies recreational areas and facilities, and encourage the public to use those areas most suitable for particular activities (MSR, LGA, PIMA).

90. Integrate hire and drive operations with other foreshore activities and provide facilities (toilets, parking, picnic facilities, seating and shade) to serve all foreshore users (LGAS PIMA, Dev, MSR).

91. Identify areas which are suitable for hire and drive operations in foreshore management plans (PIMA, LGA, MSR).

92. Identify areas which may be used by horse riders and prepare guidelines for their use (PIMA, LGA, MSR).

NAVIGATION AND BOATING SAFETY

93. Prepare a strategy for the systematic upgrading of existing boat ramps to enable their most efficient use (PIMA, LGA, DMH).

94. Undertake engineering and environmental investigations to identify the location of additional boat ramps which will reduce congestion at existing facilities. Where appropriate developers of waterside land should contribute to the cost of providing boat ramps and associated facilities (DMH, PIMA, LGA).

95. Support the enforcement of WA Marine Regulations relating to boating safety (PIMA, DMH).

96. Consider the establishment of special use areas having regard for: (DMH, PIMA, DPUD)

- Boating safety.
- Recreational use.
- Impact on the foreshore including vegetation bank stability.
- Compatibility with the overall river plan for the area.

97. Extend the existing mechanism so that navigable waters may be closed for conservation and maintenance objectives as well as for safety reasons (DMH, PIMA, CALM).

98. Encourage and expand the recently introduced voluntary training programmes for boating operators (DMH).

99. Ensure installation of fire fighting equipment at all major jetties (DMH).

MANAGEMENT

Co-ordination

100. Prepare and implement procedures for referral and consideration of development proposals so that the interests of all relevant agencies are considered (DPUD, PIMA, all relevant authorities).

101. Prepare and implement procedures for the referral and consideration of all land use management plans and town planning schemes so that they may be considered by relevant authorities before adoption (DPUD, PIMA, all relevant authorities).

Emergency Procedures

102. Amend the CPDOSPHA so that its format is similar to DEPM (PIMA, WWC).

103. Acquire the equipment recommended in the DEPM and store in an appropriate manner (PIMA, WWC, Treasury).

104. Ensure that all PIMA staff are familiar with emergency procedures and are trained in the use of the equipment (PIMA).

105. Amend CPDOSPHA to reflect the requirement to react to emergencies throughout the entire catchment (PIMA, WWC).

106. Ensure that all Waterways Commission staff are familiar with DOSHWA procedures for handling dangerous materials (WWC, PIMA, DOSHWA).

Lake McLarty Nature Reserve

2008
Management Plan No 60

ACT NOW FOR THE FUTURE

Department of Environment and Conservation
Our environment, our future

Conservation Commission
WESTERN AUSTRALIA

MANAGEMENT SUMMARY TABLE

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
PART B. MANAGEMENT DIRECTIONS AND PURPOSE				
9. LAND TENURE • The planning area comprises two 'class A' nature reserves that should be amalgamated into a single reserve of 219 ha and officially named Lake McLarty Nature Reserve. • A gazetted road reserve marks the eastern boundary of the nature reserve. This should be added to the nature reserve. • There is a significant amount of vegetation on the private property adjacent to the eastern side of the nature reserve which effectively doubles the width of the vegetated buffer. Subject to reaching agreement with the owners, consideration should be given to acquiring these areas by direct purchase, or as an environmental contribution if the current agricultural land is subdivided in future. • The Conservation Commission and the Department will recommend that any future subdivisions adjoining the reserve will be subject to the principle of net conservation benefit, and that environmental conditions to minimise environmental impacts should be duly placed on proponents.	**OBJECTIVE** To protect the values of the reserve by securing areas of greatest value into the conservation estate. **THIS WILL BE ACHIEVED BY:** 1. securing additions to the reserve wherever possible, including the road reserve on the eastern side of the lake; 2. amalgamating Reserve 44978 into Lake McLarty Nature Reserve (Reserve number 39404), resulting in a consolidated reserve of 219 hectares; 3. officially naming the two reserves that comprise the nature reserve "Lake McLarty Nature Reserve"; 4. seeking to enter into voluntary agreements with reserve neighbours to protect remnant vegetation via future purchase of land for addition to the reserve; and 5. negotiating environmental contributions with developers should further subdivisions be approved.			
PART C. MANAGING THE NATURAL ENVIRONMENT				
12. WETLAND AND CATCHMENT PROTECTION **Managing Water Levels** • Lake McLarty is a surface expression of groundwater that has formed where the water table intersects with the ground surface. Therefore, the lake's water levels are directly affected by management of the regional groundwater system. • The surface water levels of the lake have been monitored monthly on the western side of the lake by the Peel Preservation Group since 1996. **Managing Water Levels (continued)** • The pattern of water level changes within the lake is dictated by local rains. The lake is marginally ephemeral and dries, on average, for 1–4 months of the year. • The timing of inundation and drying of Lake McLarty is important for bird species and bird numbers. • Groundwater, and subsequently, wetland water levels may be under threat as a result of a combination of dry climate and groundwater abstractions in surrounding areas. • Management of the groundwater resource within the Peel-Harvey Catchment is the responsibility of the Department of Water.	**OBJECTIVE** To maintain a water level regime that supports the lake's water-dependent ecosystems and meets the needs of the range of waterbirds that use the lake. **THIS WILL BE ACHIEVED BY:** 1. negotiating a Memorandum of Understanding with State and local government agencies and other land managers to ensure integrated planning and management of Lake McLarty, to enable the Department to achieve the objectives of this plan; 2. liaising with the Department of Water regarding the monitoring and maintenance of water levels; **THIS WILL BE ACHIEVED BY: (continued)** 3. working cooperatively with the Department of Water to ensure that the management of the lake's water levels considers waterbird and other fauna habitats; and 4. liaising with the Department of Water to establish at least two more water monitoring bores in the area surrounding the lake.	Changes in groundwater levels.	No significant change to the current hydrology of the lake (including seasonal patterns).	Every two–three years

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
• Groundwater levels at Lake McLarty are currently monitored twice annually by the Department of Water from four bores located within a three kilometer radius of the lake. The establishment of further monitoring bores within the subdivision and to the east of the lake is required to determine the impact of continued residential development on groundwater levels within the catchment.				
12. WETLAND AND CATCHMENT PROTECTION **Managing Water Quality** • Factors such as nutrient runoff from surrounding residential and rural land influence the water quality of Lake McLarty. • The Department is responsible for monitoring the water quality in the lake. They are assisted by the Peel Preservation Group.	**OBJECTIVE** To maintain a healthy aquatic ecosystem, thereby ensuring the provision of a feeding ground and refuge for waterbirds and protection of the reserve's ecological values.	Changes in abundance, species diversity and structure of naturally occurring aquatic macro-invertebrate populations.	No decline in the abundance or diversity of naturally occurring aquatic macro-invertebrate populations based on 2000 levels.	Every two–three years
Managing Water Quality (continued) • Establishing new and maintaining existing buffer vegetation is vital in assisting to maintain and improve water quality. A buffer will act as a filter and storage for nutrients, as well as providing a physical barrier to problem insects such as midges between the lake and surrounding development. • An integrated, whole of catchment approach is required for managing groundwater quality and levels throughout the Peel Harvey Catchment. • The EPA, together with the Peel Harvey Catchment Council, is developing a Water Quality Improvement Plan for the catchment, which contains key recommendations to achieve reductions in phosphorous.	**THIS WILL BE ACHIEVED BY:** 1. supporting the Peel Preservation Group in continuing to monitor the water quality (including dissolved oxygen, pH, salinity, total nitrogen and phosphorus, and macro-invertebrates) of the lake every six months; 2. ensuring that the management of water quality considers waterbird and other fauna habitats; 3. continuing to re-establish buffer vegetation surrounding the lake; 4. working cooperatively with state and local government authorities regarding the management of surface and subsurface drainage; 5. maintaining the Department's role on the Peel-Harvey Catchment Council; and 6. supporting the recommendations of the EPA's Water Quality Improvement Plan for the Peel Harvey catchment, particularly when commenting on development proposals on land adjoining Lake McLarty.	Changes in salinity and total nitrogen and phosphorus levels of the lake.	No significant increase in the salinity or changes in levels of total nitrogen and phosphorus in the lake.	Every two–three years
13. NATIVE ANIMALS AND HABITATS • Lake McLarty, as part of the Peel-Yalgorup System, was designated to the List of Wetlands of International Importance under the Convention on Wetlands (Ramsar, Iran, 1971) in 1990. It is also listed in the Directory of Important Wetlands in Australia (as part of the McLarty System). • Cattle grazing has occurred within the reserve since the 1880s, although (at the time of writing) not within the past few years. Grazing at Lake McLarty has contributed to the creation of valuable habitat for waterbirds. • The planning area is an important breeding ground for local birds, and supports 31 and 36 species protected under the JAMBA and CAMBA, respectively, and is a summer refuge for 29 migratory wader species. • A total of 160 bird species have been recorded in the reserve, including 81 species of waterbirds, and supports four specially protected species and one priority fauna species.	**OBJECTIVES** 1. To conserve indigenous fauna, with an emphasis on threatened and priority species and those protected by international agreements. 2. To conserve and enhance the reserve for waterbirds as per the management requirements for Ramsar-listed wetlands. **THIS WILL BE ACHIEVED BY:** 1. maintaining shorebird habitat by controlling the type and structure of shoreline vegetation by: – allowing cattle grazing to continue under a formal lease/licence, with cattle restricted to (i) specified areas in the southern and south-eastern part of the reserve and (ii) seasonal use, until the impact of this activity on the wetland system can be established; and – assessing and trialling alternative management options to cattle grazing for maintaining mudflat habitats for shorebirds; 2. protecting native fauna from introduced and problem animals through appropriate control regimes where necessary (see *Introduced and other Problem Animals*);	Number of migratory waterbirds utilising the lake as a summer refuge and feeding ground. Changes in species diversity and species composition of migratory waders.	Subject to natural variations, no decline in the number of migratory waterbirds visiting lake. Subject to natural variations, maintain or increase the species diversity and species composition of migratory birds from 2007 levels.	Every three years. Every three years.

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
• There are no known records of rare or priority flora in the Lake McLarty Nature Reserve. • The main threats to the vegetation are water levels and quality, environmental weeds, human disturbance (including pets), cattle grazing and fire. • The western side of the lake has been highly degraded as a result of historical land use, with almost all of the original vegetation removed.	2. maintaining vegetation biodiversity by reducing threatening processes; 3. maintaining the variety of habitats that are available at the lake to support the diversity of bird species, including encouraging some areas of emergent native vegetation to re-establish to provide habitat for targeted bird species (e.g. Australian reed warbler); 4. rehabilitating degraded areas around the lake to restore a vegetation buffer; and 5. maintaining fences within the reserve to ensure that cattle grazing occurs only in designated areas.	Changes in range of habitats available.	Maintain or increase the variety of habitats available at the lake from 2007 levels.	Every five years.
15. ENVIRONMENTAL WEEDS • Thirteen weed species have been identified within the reserve. As rated in the *Environmental Weed Strategy for Western Australia* two species are rated as High and seven as Moderate according to their impact on biodiversity.	**OBJECTIVE** To prevent species loss and community decline from weed invasion. **THIS WILL BE ACHIEVED BY:** 1. controlling environmental weeds rated as high or moderate in the *Environmental Weed Strategy for Western Australia*, and declared weeds, including cottonbush; 2. mapping and annually monitoring the distribution of *T. orientalis* and immediately controlling new satellite clumps; and	Changes in abundance and distribution of priority environmental weeds as identified in the *Environmental Weed Strategy for Western Australia*.	No increase in the abundance and distribution of high and moderate rated environmental weeds from 2007 levels.	Every three years.
• There are no known records of rare or priority flora in the Lake McLarty Nature Reserve. • The main threats to the vegetation are water levels and quality, environmental weeds, human disturbance (including pets), cattle grazing and fire. • The western side of the lake has been highly degraded as a result of historical land use, with almost all of the original vegetation removed.	2. maintaining vegetation biodiversity by reducing threatening processes; 3. maintaining the variety of habitats that are available at the lake to support the diversity of bird species, including encouraging some areas of emergent native vegetation to re-establish to provide habitat for targeted bird species (e.g. Australian reed warbler); 4. rehabilitating degraded areas around the lake to restore a vegetation buffer; and 5. maintaining fences within the reserve to ensure that cattle grazing occurs only in designated areas.	Changes in range of habitats available.	Maintain or increase the variety of habitats available at the lake from 2007 levels.	Every five years.
15. ENVIRONMENTAL WEEDS • Thirteen weed species have been identified within the reserve. As rated in the *Environmental Weed Strategy for Western Australia* two species are rated as High and seven as Moderate according to their impact on biodiversity.	**OBJECTIVE** To prevent species loss and community decline from weed invasion. **THIS WILL BE ACHIEVED BY:** 1. controlling environmental weeds rated as high or moderate in the *Environmental Weed Strategy for Western Australia*, and declared weeds, including cottonbush; 2. mapping and annually monitoring the distribution of *T. orientalis* and immediately controlling new satellite clumps; and	Changes in abundance and distribution of priority environmental weeds as identified in the *Environmental Weed Strategy for Western Australia*.	No increase in the abundance and distribution of high and moderate rated environmental weeds from 2007 levels.	Every three years.
• *Typha orientalis* has the potential to further reduce the area of open water at Lake McLarty. Although its current distribution is limited, *Typha* has been widespread on the lakebed previously and may again become a management issue. • Other weed species threatening reserve values include cottonbush (a declared weed), brome grass (high priority weed species) and goosefoot.	3. trialling different cost effective methods to control *T. orientalis* to determine the most effective method for Lake McLarty.			
16. INTRODUCED AND OTHER PROBLEM ANIMALS • Problem animals associated with the reserve include foxes, cats (feral and domestic), dogs and rabbits.	**OBJECTIVE** To prevent, and where possible, negate the impacts of problem animals on the reserve's values.	Changes in the numbers of mosquitoes trapped within the reserve.	No significant increase in the mosquito populations present at the lake.	Every five years.

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
• Foxes and cats may pose a threat to native fauna, and it is thought that foxes may have been a major cause of decline in the local population of oblong turtles. • A fox baiting program commenced in the nature reserve at the end of 2006, which is planned to continue on a monthly basis at least until the end of 2011. • Mosquito and midge breeding within the lake is a potential problem for future residents. The Shire of Murray monitors mosquito larvae numbers adjacent to Lake McLarty.	**THIS WILL BE ACHIEVED BY:** 1. preparing a control program for problem animals based on the following criteria: a. existing and potential impact of the species; b. the efficiency and effectiveness of control measures; c. availability of resources; and d. the capacity for long-term monitoring of the population; 2. establishing a formal lease/licence to allow closely monitored cattle grazing to continue in the reserve (see *Native Animals and Habitats*); 3. reinforcing the vegetation buffer around the lake to negate potential problems with midges and mosquitoes; 4. referring proposals to spray for midge and mosquito control to the Conservation Commission; and 5. increasing community awareness of the need to keep domestic animals out of the reserve, and increasing the effectiveness of the dog-resistant fence on the western side of the lake if necessary.			
17. DISEASE • Lake McLarty Nature Reserve is 'uninterpretable' for the presence of *Phytophthora cinnamomi*. However sections of the adjacent McLarty Nature Reserve are 'interpretable' and susceptible to this pathogen. • *Phytophthora cinnamomi* could have an impact on revegetation programs in the reserve if the species planted are vulnerable to it. • *P. cinnamomi* can be spread by humans, vehicles and animals moving infested soil and plant material.	**OBJECTIVE:** To prevent the introduction and spread, of *Phytophthora cinnamomi*. **THIS WILL BE ACHIEVED BY:** 1. surveying the adjoining McLarty Nature Reserve for *P. cinnamomi* infection and quarantining affected areas; 2. reducing the risk of introducing and spreading the disease to uninfected areas by limiting access to affected areas, and ensuring appropriate hygiene standards for machinery and vehicles when undertaking works within the reserve; 3. ensuring soils and other materials brought into the reserve are free of *P. cinnamomi*; and 4. raising community awareness of the impacts and management issues associated with dieback (see *Involving the Community*).			
18. FIRE • Wildfire is a significant threat to the natural values of the reserve, and to adjoining properties. • The Department has the lead role in fire suppression within the reserve and, in the event of fire, would be assisted by the Shire of Murray • Fire management at Lake McLarty is guided by the Bush Fires Act 1954 and the Department's Fire Management Policy. • Fires in small reserves surrounded by agricultural land usually promote weed invasion. • Large infestations of introduced bulrush are a fire hazard.	**OBJECTIVE:** To protect the biodiversity of the reserve, as well as people and property, by minimising the impact of wildfire. **THIS WILL BE ACHIEVED BY:** 1. minimising the area of *Typha* infestations to prevent the build up of fuel; 2. maintaining the concrete tank and bore on the western side of the lake for fire fighting purposes; 3. ensuring that access for fire protection purposes is considered and provided when any subdivisions are proposed; and 4. considering selective prescribed burning only for the protection of specially protected, threatened or priority species.			
19. REHABILITATION • Degradation and loss of natural vegetation, particularly on the western side of the lake, has occurred historically as a result of farming practices and cattle grazing.	**OBJECTIVE** To restore degraded areas of the reserve to a condition resembling the natural environment.	Change in the area of land rehabilitated within the reserve.	Land in the southern and western parts of the reserve satisfactorily rehabilitated.	Every five years.

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
19. REHABILITATION (continued) • Rehabilitation of the western side of the lake was undertaken in 2004 using native species grown from seed collected from the reserve.	**THIS WILL BE ACHIEVED BY:** 1. rehabilitating with plants that have been propagated from seeds and cuttings collected either from within the reserve or from provenance from the Swan Coastal Plain; 2. coordinating rehabilitation works with weed control, fire protection and cattle exclusion; 3. encouraging members of the local community, community groups and schools to participate in rehabilitation works, and to seek external funding for such works; 4. ensuring mulch and soil used in rehabilitation works does not contain unwanted seeds or plant diseases; 5. encouraging natural regeneration as much as possible by managing grazing pressure from cattle and rabbits; and 6. undertaking rehabilitation works on the southern and south-eastern sides of the reserve, and continuing rehabilitation on the western side.			
PART D. MANAGING CULTURAL HERITAGE				
20. INDIGENOUS AND **21. NON-INDIGENOUS HERITAGE** • There are no known Aboriginal sites in the reserve, although registered sites exist within the Peel Inlet/Harvey Estuary area.	**OBJECTIVE** To protect the reserve's cultural heritage. **THIS WILL BE ACHIEVED BY:** 1. notifying relevant Native Title Claimants and authorities when proposing to undertake public works in registered heritage sites; 2. ensuring management activities do not impact upon cultural heritage values; and 3. collating information on cultural heritage sites and adding them to the register on the Department's Recreation and Tourism Information System (RATIS) database.			
PART E. MANAGING VISITOR USE				
23. VISITOR ACCESS • Visitor access to the reserve is limited to gates located on the western and southern sides of the lake, although the southern access is for management vehicles only. Walkers also use management and fire access tracks. **23. VISITOR ACCESS (continued)** • Canoeing on the lake is only permitted for management and scientific research purposes.	**OBJECTIVE** To provide safe and convenient access within the reserve, for visitors and management, that is consistent with reserve values. **THIS WILL BE ACHIEVED BY:** 1. maintaining designated access points to the reserve to facilitate walking and bird watching activities; 2. installing an information sign at each of the access points; 3. continuing to permit pedestrian access on management and fire access tracks unless otherwise signposted; 4. pending future subdivisions, considering upgrading vehicle access to the south of the lake off Mills Road to allow off-road parking; 5. pending a future increase in visitor numbers, consider developing defined walking trails if required; and 6. prohibiting the use of recreational watercraft (including model boats) in the lake, and allowing the use of canoes only for education, research and management purposes by approved users.			
24. VISITOR USE • The most popular visitor uses at the reserve are bird watching and nature appreciation. • Visitor use at Lake McLarty is expected to increase over the life of the management plan as residential development on adjoining land progresses and the area becomes more accessible with the completion of the Peel Deviation Freeway. • Facilities are limited to an information board on the western side of the lake.	**OBJECTIVE:** To provide for passive, low-impact visitor uses in a manner that is consistent with the reserve's purpose and values, and which minimises conflict between visitors. **THIS WILL BE ACHIEVED BY:** 1. promoting visitor use that is consistent with the protection and promotion of the reserve's values; 2. ensuring that visitor uses do not impact on the values of Lake McLarty; and 3. constructing a viewing platform on the western side of the lake .			

KEY POINTS	OBJECTIVES AND STRATEGIES	KEY PERFORMANCE INDICATORS*		
		Performance Measure	Target	Reporting Requirements
PART F. INVOLVING THE COMMUNITY				
25. INFORMATION, EDUCATION AND INTERPRETATION • Information, education and interpretation provide targeted communication with the public. • It is important for the effective implementation of the management plan that community understanding and support is fostered **INFORMATION, EDUCATION AND INTERPRETATION (continued)** • There is limited community awareness of Lake McLarty's importance as a nationally and internationally significant wetland.	**OBJECTIVES** 1. To increase community awareness, appreciation and understanding of the reserve's values, and to gain support for management practices. 2. To increase community awareness, appreciation and understanding of Lake McLarty's national and international importance for waterbirds. **THIS WILL BE ACHIEVED BY:** 1. providing information to visitors on reserve values and issues such as its importance for migratory waterbirds, visitor safety, permitted activities and regulations; and 2. installing signs and information for the purpose of public education and interpretation to assist in achieving conservation objectives.			
26. WORKING WITH THE COMMUNITY • Community involvement is an integral component of the Department's operations. • Community groups and individuals are encouraged to be involved in the management of Lake McLarty. • Community support is essential for the successful implementation of this management plan.	**OBJECTIVE** To facilitate effective community involvement in the management of the reserve. **THIS WILL BE ACHIEVED BY:** 1. continuing to encourage, promote and support volunteers and community groups with essential resources to help them carry out their activities; and 2. involving the community in the implementation of this management plan.	Change in the numbers of volunteers hours contributed to reserve management.	20 percent increase in the numbers of volunteer hours contributed to the management of the reserve from 2006 levels.	Every five years.
27. SCIENTIFIC AND RESEARCH USE • Data collected at the reserve includes water quality indicators, water levels, bird counts and mosquito larvae counts. Opportunities exist for further studies to complement proposals in this management plan, particularly in relation to impacts and/or benefits of cattle grazing and alternatives for habitat maintenance. • All research should be co-ordinated by the Department.	**OBJECTIVE** To increase knowledge and understanding of key values to provide for improved management of the planning area and to monitor the possible impacts associated with implementing the management plan. **THIS WILL BE ACHIEVED BY:** 1. conducting research and monitoring, as resources permit and according to priority, that focuses on issues and values required to report on this management plan, and the establishment of baseline information; 2. encouraging and supporting, wherever possible, external agencies, organisations, volunteer groups and individuals to undertake research and monitoring projects where they contribute to biodiversity conservation and reflect visitor's use of the area; and 3. supporting, and where possible, seeking grant applications to encourage scientific research and monitoring within the planning area, particularly in relation to impacts and/or benefits of cattle grazing and alternatives for habitat maintenance.	Research within the reserve is conducted according to Departmental priorities and Government initiatives, and to assist with the performance assessment for this management plan.	Research undertaken is that which has been deemed a high priority.	Every five years.

*Note: the response to target shortfall for each of the key performance indicators is for the Department to investigate the cause and report to the Conservation Commission for action.