Wilson Inlet Management Strategy

2013 - 2022

A Management Strategy to maintain and where possible, enhance the ecological health of the Wilson Inlet

ACKNOWLEDGEMENTS

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COMMENTS INVITED

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An addendum to this Management Strategy includes the community comment submissions. See contact details to request addendum.

ABBREVIATIONS

Abbreviations used in this document:

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
CENRM	Centre of Excellence in Natural Resource Management
DAFWA	Department of Agriculture and Food WA
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DoF	Department of Fisheries
DoH	Department of Health
DoP	Department of Planning
DoW	Department of Water
DPCWG	Denmark Phytophthora cinnamomi Working Group.
DWAG	Denmark Weed Action Group
LGA	Local Government Authority
NGO	Non Government Organisations
SCNRM	South Coast Natural Resource Management
WICC	Wilson Inlet Catchment Committee
WC	Water Corporation

Figure 1: Wilson Inlet Catchment

COLLABORATIVE SUPPORT

The following groups and agencies endorse this Management Strategy and will continue to work cooperatively to implement its actions as a means of improving the condition of the Wilson Inlet.

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1 EXECUTIVE SUMMARY

The Wilson Inlet is a seasonally closed estuary on the south coast of Western Australia, adjacent to the township of Denmark. The Inlet runs parallel to the coast, 14km long with a maximum width of 4km. On average the depth is less than 2m with the total area $48km^2$. The Wilson Inlet falls within the City of Albany and Shire of Denmark boundaries and is managed by these and a number of State government agencies.

The Inlet, including the surrounding foreshore, is highly valued by both residents and visitors alike. It is valued for its' environmental, recreational, commercial, cultural and heritage significance, performing several important roles. These roles include:

- Assimilating nutrients from urban and rural catchment sources.
- Providing habitat and breeding sites for a variety of aquatic and terrestrial native fauna.
- Providing opportunities for recreational activities.
- Providing opportunities for commercial enterprises including aquaculture, fishing and tourism.
- Containing sites of cultural and heritage value, both Indigenous and non-Indigenous.
- Providing a place of beauty and relaxation.

The ability of the Inlet to function in these roles is dependent on its physical condition and ecological health.

The Inlet and surrounding area are under pressure from a range of factors, primarily human induced which, when combined, impact on the health of the Inlet. These include changing land uses within the catchment (such as forestry and wineries), climate change, development and increased commercial and recreational use associated with an increasing population, nutrient loads both from the catchment and stored in the Inlet, invasive species and diseases and pathogens. With an increasing population in the area these pressures will intensify and require careful management.

The purpose of the Wilson Inlet Management Strategy 2013 – 2022 (the Management Strategy) is to protect, maintain and where possible, enhance the ecological health of the Inlet through a 10-year program of nutrient reduction, balancing water needs for all users of the Inlet and surrounding catchment as well as maintaining and where possible, enhancing habitat for native flora and fauna. Maximising community engagement and improving community knowledge of the Inlet, its processes and management options is key to the success of the Management Strategy.

The Management Strategy follows on from, and builds on the Wilson Inlet Nutrient Reduction Action Plan (WINRAP) 2003, which established a plan to reduce algal coverage in the Wilson Inlet through a 5 year program of nutrient reduction. The 2003 plan was formulated due to concerns by the community that the Inlet's health was deteriorating. Algal blooms and black ooze were seen as symptoms of the Inlet's deteriorating health and, at the time, increasing nutrient levels were identified as the main threat to the Inlet's health. Following a shift in community values (see section 2.2 for values) regarding the Inlet, the Management Strategy scope has broadened, forming a more comprehensive management tool.

It is recommended that there be an opportunity to review the progress of actions in 5 years and include amendments as required, with a complete review of the Management Strategy recommended after 10 years to assess the effectiveness of objectives and actions. This Management Strategy complements sections of existing Management Plans, Local and State Government Policies. These are identified in "Scope of Management Strategy" section 2.3, with the purpose that the complementary documents be used in conjunction with this Management Strategy.

The Wilson Inlet Catchment Committee (WICC) as a key natural resource management group in the catchment and advocate for the community will take a lead role in the implementation of the Management Strategy and its progress. While every effort will be made to undertake this role, as a not-for-profit organization the group's capabilities are dependent on current and future resource capabilities. An action within the Management Strategy will be the formation of a management group to oversee its progress. This group will be made up of a number of key stakeholders and will provide an avenue for continued collaborative support, essential to the success of the Management Strategy.

2 ABOUT THE MANAGEMENT STRATEGY

2.1 BACKGROUND AND DEVELOPMENT OF THE MANAGEMENT STRATEGY

The preparation of this Management Strategy is based on identifying, protecting and where possible, enhancing community values of the Inlet, while reducing threats. A steering group (comprised of representatives from the local community, local and state government agencies and key organisations) has utilised current knowledge as well as previous work to guide its preparation. An additional expert panel from key stakeholder groups was brought together during the initial development phase to provide technical advice and information.

Initially community values regarding the Inlet and the overarching vision were identified. From these the key issues that threaten or degrade these values were then determined and strategies and actions developed utilising available information and current knowledge. These strategies and actions, once implemented, are intended to either enhance a value or reduce a threat.

Another important step in developing the Management Strategy was that the key targets, strategic objectives and actions of WINRAP (2003) be reviewed.

Five key targets and 52 measurable outputs were identified in WINRAP (2003) as a measure of the Plan's performance:

Target 1) **Reduction in average nitrogen and phosphorus concentrations from Sunny Glen, Cuppup, and Sleeman to achieve downward trend.** Water quality monitoring of the Inlet over the period of 2003 to 2009 showed that there was no significant change in water quality of the Inlet or in the waterways draining into it. Cuppup Creek is starting to show an emerging trend with Total Phosphorus increasing 0.024mg/L per year from 2007 – 2011 (further samples are required to more accurately determine the trend). See Appendix 9.1: Water quality of the Wilson Inlet from 2005 – 2011 for more detail. Sunny Glen, Cuppup and Sleeman waterways still exceed the ANZECC guideline levels for median total nitrogen levels and median total phosphorus levels hence further work needs to focus on these waterways. With increasing population and associated pressures on these priority waterways it may be expected that, without undertaking mitigation measures in this area, nitrogen and phosphorus concentrations will increase. While having a decrease in concentrations is the aspirational goal no increase in concentrations is an acceptable outcome.

Target 2) **All Water Corporation drains fenced to prevent livestock access.** Since the implementation of WINRAP over 90% of Water Corporation drains have been fenced to date.

Target 3) **30% increase in fencing of Sleeman River and Cuppup Creek.** Achieved. There has been over 30% increase in fencing of the Sleeman River and Cuppup Creek. At the time the Management Strategy was being developed further fencing projects were underway. The Sleeman River in particular has large sections fenced and the process of revegetation has started. Cuppup requires more targeted works to achieve the same results.

Target 4) **All licensed premises to be in compliance with nutrient management conditions.** Partially achieved. Whilst most of the licensed premises are in compliance with nutrient management conditions there have been instances where conditions have not been met i.e. output nutrient levels exceeded target levels.

Target 5) **Inlet floodplain to be incorporated into land use planning guidance.** Achieved. Local Governments have incorporated Inlet floodplain into Local Planning Strategies and Schemes recognising the importance of the Wilson Inlet floodplain. The Shire of Denmark has a general development restriction on land below 2.5m AHD and the City of Albany has restrictions on development of land below 2.88m AHD.

Investment in the reduction of nutrients into the Wilson Inlet through the 52 prioritised actions of WINRAP has achieved significant outcomes since its implementation in 2003. Partnerships between National, State and Local government organisations and the community have worked to deliver projects to reach the key targets. It is important to note however that many initiatives are ongoing. Some of the achievements to date include;

- On-ground works in the catchment;
  - over 430 kilometres of waterway and remnant vegetation fenced,

- over 350 hectares of degraded riparian and remnant vegetation replanted with native seed and seedlings,
- over 4230 hectares of long rooted perennial pastures planted,
- point source nutrient management works occurred on a number of intensive agriculture properties i.e. (dairies)

- Engagement of the community through workshops, school educational days and public forums covering - soil health; updates on the Wilson Inlet and its processes; fauna and flora of the catchment; weed management and various other relevant topics to inform and educate community members. With an average of 40 people attending, these workshops continue to be well received events.
- In conjunction with the soil health workshops 266 subsidised soil testing kits were distributed to landowners in the catchment.
- Evaluation of ecological conditions of waterways through foreshore vegetation surveys and monitoring of best practice wetland sites.
- Changing perceptions on drainage management within the priority Youngs Siding floodplain area by incorporating Best Practice demonstration sites and rehabilitating degraded waterways.
- Support for community based action groups through financial and technical help.
- Assistance with adoption and continuation of policies and planning initiatives aimed at nutrient reduction in local government areas.

Building on the achievements of WINRAP (2003) and through identification of gaps and areas requiring improvement, the Management Strategy forms a management tool relevant to the threats and issues facing the ecological health of the Wilson Inlet today.

Over the past nine years knowledge and baseline information on the Wilson Inlet and its catchment has expanded. A significant amount of technical information, strategies, plans and studies that complement the Management Strategy have been developed. A number of these have been used as a source of information for the Management Strategy. Recommendations and actions from relevant Management Plans including; the Wilson Inlet Foreshore Reserves Management Plan (2008) and the draft Wilson Inlet Drainage Review (2009) are to be used in conjunction with this Management Strategy and are referenced in later sections.

2.2 COMMUNITY INVOLVEMENT

A steering group consisting of a number of key stakeholders and community members was formed to guide the preparation of the Management Strategy. Additionally, community values and concerns were conveyed throughout its development with;

- one on one contact,
- 2011 community survey,
- further calls for community input.

An addendum to this Management Strategy includes community comment submissions. See contact details to request addendum.

Values and concerns regarding the condition of the Inlet were similar to those identified in 2003. However, there was more emphasis placed on the Wilson Inlet as an important habitat for native fauna and flora, as a breeding site for native fauna and an understanding that the upper catchment is linked to the Inlet.

Through the consultation process of identifying community values a common long term vision for the Inlet and surrounding catchment was derived.

VISION

To maintain and where possible enhance the Wilson Inlet's ecological condition in order to provide habitat for abundant and diverse native flora and fauna species whilst protecting social, heritage and cultural values and maintaining water quality.

COMMUNITY VALUES

The following values of the Wilson Inlet and surrounding catchment were identified;

- Natural beauty of the Inlet and foreshore
- Healthy and abundant native flora and fauna
- Recreational uses of the Inlet and foreshore including walking, fishing, boating and bird watching
- Commercial uses of the Inlet including fishing, aquaculture and tourism
- Balance of agriculture, healthy bushland and waterways in the surrounding landscape
- Protection of culture and heritage values; indigenous and non-indigenous

2.3 SCOPE OF THE MANAGEMENT STRATEGY

COMMUNITY VALUES	POTENTIAL THREATS	RELEVANT MANAGEMENT DOCUMENTS
Natural beauty of the Inlet and foreshore	Increasing nutrients and algal growth/ decay.	Wilson Inlet Management Strategy
	Destruction of fringing vegetation.	Wilson Inlet Management Strategy Foreshore Management Plans
	Inappropriate design/siting of development on foreshore.	Town Planning Schemes Foreshore Management Plans
	Reduced water recharge from catchment.	Wilson Inlet Management Strategy Shire of Denmark Dam Policy
	Inappropriate discharge of storm water.	Wilson Inlet Management Strategy Denmark Town Planning Scheme
Recreational use – Boating, swimming, bird-watching, walking, fishing.	Obstruction on boating access due to algal growth.	Wilson Inlet Management Strategy
	Smell of rotting algae.	Wilson Inlet Management Strategy
	Uncontrolled recreational use.	Foreshore Management Plans
	Inadequate recreational facilities.	Foreshore Management Plans
	Inappropriate development restricting access/enjoyment.	Town Planning Schemes
	Over fishing.	Department of Fisheries Recreational Fishing Guide - bag limits.
Commercial use - fishing, aquaculture	Over-fishing.	South Coast Estuarine Fishery Policy
	Anoxic water conditions or toxic algal blooms	Wilson Inlet Management Strategy
	Excessive algae restricting hauling of nets/boat access.	Wilson Inlet Management Strategy
	Ecosystem failure due to increasing nutrients.	Wilson Inlet Management Strategy
	Non-bar opening; Lack of recruitment of marine fishes.	Wilson Inlet Drainage Review Bar Opening protocol
Healthy and abundant native flora and fauna	Climatic changes; reduced water recharge from catchment and increasing temperature trends.	Wilson Inlet Management Strategy
	Anoxic water conditions or toxic algal blooms.	Wilson Inlet Management Strategy
	Invasive species including; environmental weeds and feral animals.	Wilson Inlet Management Strategy Foreshore Management Plans
	Diseases and pathogens.	Wilson Inlet Management Strategy Foreshore Management Plans
	Inappropriate development	Town Planning Schemes Foreshore Management Plans
	Uncontrolled water storage development in catchment.	Wilson Inlet Management Strategy Shire of Denmark Dam Policy
	Wildfires and inappropriate fire management	Denmark Fire Prevention Plans Foreshore Management Plans
	Gaps in community knowledge and skills.	Wilson Inlet Management Strategy
Balance of agriculture, healthy bushland and waterways in the surrounding landscape	Changing land uses creating opportunity for erosion and further nutrient loss.	Wilson Inlet Management Strategy
	Inappropriate clearing of native vegetation	Wilson Inlet Management Strategy Town Planning Schemes Land Clearing legislation
	Inappropriate development in surrounding floodplain area	Wilson Inlet Management Strategy
Protection of culture and heritage values; indigenous and non-indigenous	Inappropriate development and uncontrolled recreational use	Foreshore Management Plans Wilson Inlet Cultural Heritage Plan

2.4 OBJECTIVES OF THE MANAGEMENT STRATEGY

- Protect and conserve habitat for healthy native flora and fauna species.
- Protect social, cultural and heritage values.
- Maintain good water quality.
- Manage nutrient levels.
- Reduce levels of algae.
- Provide a place of relaxation and aesthetic beauty.
- Promote a sustainable balance of farming and native vegetation in the catchment.

The key objectives of the Management Strategy are listed above in no particular order. The Management Strategy takes a pragmatic approach to achieving these objectives, focusing on works that have the greatest level of community support and likelihood of implementation. Collaboration between landholders, community groups, local, state and national government agencies is essential for achieving these objectives and realising the long term vision for the Wilson Inlet.

2.5 IMPLEMENTING THE MANAGEMENT STRATEGY

Implementing the recommendations of the Management Strategy will take place over the next ten years. In some instances, actions are already underway. It is proposed to take a cooperative approach to implementing the Management Strategy with Local and State Government, industry, community and interest groups responsible for working together to ensure that recommendations are completed. Obtaining funding for the actions and a Project Officer to facilitate those actions are essential for the success of the Management Strategy.

3 BACKGROUND THE WILSON INLET AND SURROUNDING LANDSCAPE

3.1 LOCATION, TENURE AND PHYSICAL CHARACTERISTICS

The Wilson Inlet is an estuary on the south coast of Western Australia, adjacent to the township of Denmark. The Inlet runs parallel to the coast, and is approximately14km long with a maximum width of 4km. The total area of the Inlet is 48km².

Fed by five major river systems the Wilson Inlet catchment covers 2379km² and extends northwards for 48km with the town of Mount Barker on the north-eastern catchment boundary (see Figure 1).

A sandbar forms seasonally at the mouth of the Inlet. The increased river flow from winter rains raises the water level in the Inlet and the sandbar is artificially breached. Timing of the opening is largely dependent on the water level in Wilson Inlet, which is determined by rainfall and discharge from rivers. The channel that is formed remains open for several months during which time there is water exchange between the Inlet and the ocean. With decreased river flow in summer the channel eventually closes.

There has been a great deal of debate about the sandbar opening. In most cases the main objective has been to increase the flow of marine waters in and estuarine waters out through the channel during the bar opening period. The bar opening protocols revised in 2009 take into account a range of factors including marine exchange, requirements for fisheries and other aquatic fauna, fringing foreshore vegetation, recreational and commercial users of the Inlet as well as infrastructure and farming communities in surrounding low lying areas. The bar opening decision tool can be found in Appendix 9.2.

Wilson Inlet is located within two local government areas, the Shire of Denmark to the west of Hay River and the City of Albany to the east. Land tenure around the Inlet varies, with foreshore reserves managed by local government, Department of Environment and Conservation (DEC) and sections of unallocated crown land. The Wilson Inlet Catchment area extends northward from the Shire of Denmark and the City of Albany into the Shire of Plantagenet (Mitchell, M. (2008)). Within the catchment are the regional towns of Denmark and Mount Barker along with several smaller communities, including Narrikup, Youngs Siding and Redmond with a combined population of over 10,000.

3.2 CLIMATE

The catchment has a temperate climate with mild wet winters and hot dry summers (BOM, 2008). Seasonal and annual variation in climate results from the migration of the subtropical anti cyclone belt. A steep gradient exists between the coastline and the upper areas of the catchment for most climatic factors, including rainfall. The mean annual rainfall increases from Mount Barker (600mm) in the north to Denmark (1100mm) in the south. About 10% of the rain that falls on the catchment reaches the Inlet (Department of Water, 2002).

January is the hottest month and July and August are the coolest months inland and on the coast, respectively. Mean maximum and minimum temperatures are influenced by proximity to the coast. Inland areas have a greater range in mean temperatures than the coastal areas. The average summer temperatures are about 19°C on the coast and 20°C inland, while average winter temperatures are about 12°C and 10°C respectively (Department of Water 2010b).

3.3 HYDROLOGY

Five major waterways drain into the Inlet; the Denmark, Hay, Sleeman and Little Rivers and Cuppup Creek together with other minor sources. Over 70% of the catchments of the Hay, Cuppup and Sleeman have been cleared for agriculture, while much of the Denmark River catchment remains forested. Water also enters the Inlet through drains from adjoining properties, stormwater and groundwater.

The Hay and Denmark river systems drain 89% of the catchment. Like many other river systems in high rainfall areas of the south-west of Western Australia, the waters can be fresh or nearly so in winter, with a salinity gradient developing along their length when flow slackens in summer months.

The Denmark River was first dammed in 1960–1961, when a 0.42 GL concrete pipe head dam was constructed 5 km north of Denmark for the town water supply (Ruprecht et al. 1985; 1961). Since the decline in water quality, due to significant land clearing, the Quickup Dam has provided water for Denmark (Quickup is a tributary of the Denmark River).

East of the Inlet the waterways have been highly altered to become the Cuppup Creek – Lake Saide drainage system. The waterways have been straightened to drain water more effectively. Additional drains have been constructed to drain the low lying flat areas in these catchments. This has been detrimental to the waterway's ability to function as an ecosystem and has exacerbated nutrient export and caused erosion and downstream sedimentation issues.

3.4 GEOLOGY, LANDFORMS AND SOILS

The greater part of the Inlet catchment lies in the Albany/Frazer geological province with its Precambrian granite overlain by Quaternary sands and laterite (Mitchell 2008). Soils around the Wilson Inlet and its catchment consist of a variety of silts, sand, clays and gravel. The primary soil types being yellowish brown sandy and gravelly duplex soils (South Coast NRM, 2011).

The catchment is characterised by undulating lateritic plains and poorly drained flats, hilly terrain with rock outcrops and deeply incised valleys where the waterways have exposed the weathered profile and underlying bedrock (Collins & Fowlie 1981; Kern 1992; Bari et al. 2004).The Inlet is situated on a narrow coastal plain about 10km wide, with coastal dunes to the south and an undulating, hilly plain to the north leading up to the plateau of the upper catchment. West of the Inlet there are moderate hills while, to the east, the land is characterised by low lying flats and plains.

Several landform units reflect the major soils and vegetation types and include:

- lateritic sandplain – scrub Jarrah and sandplain heaths
- sandy/swampy flats and drainage lines – paperbark, dense scrub and scattered trees
- lateritic plateau and uplands – Jarrah forest
- rolling, dissected lateritic country – Jarrah, Wandoo and swamp Yates
- moderately and deeply incised valleys – Jarrah–Marri forest giving way to Karri forest in the south. (Ward, et. al, 2011).

3.5 FLORA AND FAUNA

The Wilson Inlet and surrounding foreshore supports numerous flora and fauna, both terrestrial and aquatic. Some 65 species of fish; 37 species of aquatic fauna; 109 land, water and marine bird species; 20 species of mammals; 12 reptile species; 12 frog species;16 types of large algae and 21 forms of microscopic algae have been recorded (WIMA, 1997; Green Skills, 2008; Mitchell, 2008).

It should be noted that, in estuarine environments, like the Wilson Inlet, there is not naturally a very diverse assembly of invertebrates and fish due to the need for them to be tolerant of a wide range of salinity levels. During times of high salinity or low salinity opportunistic species will come in as long as there is a connection open. Opportunistic species only reside in the Inlet when the conditions are habitable i.e. marine fish will enter the Inlet when the sandbar is open while freshwater fish from the rivers will only enter the Inlet when the water salinity is low.

Comprehensive lists of native flora and fauna can be found in the Wilson Inlet Foreshore Reserves Management Plan (2008). A link to the Management Plan (Denmark Shire website) is located in the reference section.

FLORA

Before being cleared for agriculture most of the lower rainfall, upper catchment was Jarrah-Marri (*Eucalyptus marginata-Corymbia calophylla*) forest, Jarrah (*E. marginata*) low forests and Wandoo (*E. wandoo*) open woodlands. In addition there were a variety of other open woodlands and a range of heath and shrubs in sandy swampy soils (Mitchell 2008). The higher rainfall, lower catchment area supported stands of Karri (*E. diversicolor*) with Red Tingle (*E. Jacksonii* and *E. guilfoylei*), Marri (*Corymbia calophylla*) or Jarrah (*E. marginata*) on higher ground. Lower sand ridges carried Banksia woodland, while other low ground was occupied by Paperbark (*Melaleuca preissiana*) woodland and sedge swamps (Hodgkin and Clark 1988:4). Granitic outcrops on the coastal plain supported a range of woodlands and heath. Healthy stands of these flora communities still exist in the catchment but are more fragmented with areas of cleared land between.

Within the Wilson Inlet, seagrass beds of Ruppia megacarpa cover much of the Inlet and algae varieties are also prevalent in the Inlet. There are numerous types of algae, with numbers and species varying throughout the year depending on water quality and climatic conditions.

FAUNA

The Wilson Inlet and surrounding catchment supports a variety of fauna. Terrestrial and avian fauna include mammals (e.g. Southern Brown Bandicoot (*Isodon obesulus*), reptiles (e.g. Tiger snakes (*Notechis scutatus*) (Mitchell, 2008)), birds (e.g. Fairy-wrens (*Malurus spp*) and numerous invertebrates species.

While all species are protected at a State level, some are also protected under national and international laws'; for example:

- The Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo are declared Endangered and Vulnerable respectively and protected under the National Environment Protection and Biodiversity Conservation (EPBC) Act 1999 as well as being declared endangered and protected at a State level by the Wildlife Conservation Act 1950.

- Migratory shorebirds, which are present at the Wilson Inlet from mid-spring to mid-autumn, are protected under the EPBC Act 1999 as well as several international treaties (JAMBA, CAMBA, ROKAMBA)* to which Australia is a signatory.

The Inlet itself provides a habitat for aquatic fauna species including benthic dwelling invertebrates; crabs, prawns and native mussels as well as the introduced Blue Mussel (*Mytilus edulis*), commonly used in aquaculture. Unfortunately there is a lack of previous statistical data on invertebrate numbers hence only verbal references are available for past numbers on those species.

Fish species found in the Wilson Inlet can generally be divided into three basic groups. Estuarine species that undergo their whole life cycle within the estuarine environment (e.g. Black Bream (*Acanthopagrus butcheri*)); marine/estuarine opportunists which use the estuary predominantly as a nursery area while the breeding population is found in the ocean (e.g. King George Whiting (*Sillaginodes punctatus*)) and Marine stragglers which use the estuary as a feeding ground at some stage after their first year of life (e.g.Tailor (*Pomatomus saltator*)). Within the rivers draining into the Inlet there are a number of native endemic freshwater fish species. In a study undertaken in 2009 ten fish species were recorded in the Denmark and Hay Rivers (Chuwen, et. al, 2009). In surveys undertaken in 2008/2009 the Hay River was found to be a "hotspot" for total fish species and the Denmark River recorded a number of vulnerable species including the nationally vulnerable Balston's Pygmy Perch (*Nannatherina balstoni*), which is regarded as the rarest of all the endemic freshwater species (Cook et. al., 2008).

*Japan-Australia Migratory Bird Agreement JAMBA, China-Australia Migratory Bird Agreement CAMBA, Republic of Korea-Australia Migratory Bird Agreement ROKAMBA

3.6 CULTURE AND HERITAGE

INDIGENOUS HERITAGE

Archaeological evidence in the Albany-Denmark area indicates a history of occupation and use by social groups extending from at least 18,000 years before present (Ferguson 1985). The Inlet formed a focal point for Noongar people who managed and utilised the Inlet and abundant natural resources. In the summer months, with plentiful freshwater in the area, small groups would travel from inland areas to enjoy the Inlet's rich natural resources and hold ceremonies on the water's edge. Fish traps, gnamma holes (granite waterholes), burial sites, stone artefacts, tool making sites and ceremonial materials all exist in different locations around the Wilson Inlet today as physical manifestations of the ways in which Noongar people engaged with the Wilson Inlet in the past (Mitchell, 2008).

Noongar custodians place a high importance on the whole of the Wilson Inlet and its tributaries. There are numerous registered aboriginal heritage sites within and around the Wilson Inlet which are listed on the Department of Indigenous Affairs (DIA) register of Aboriginal sites. Places associated with or significant to Aboriginal people are classified as sites and are protected under the Aboriginal Heritage Act 1972. This applies to all sites whether or not they have been formally registered with the DIA. Today, these cultural sites need protecting and preserving.

NON-INDIGENOUS HERITAGE

Historical uses of the Inlet and surrounding catchment include farming, fishing, the historic railway line, the Springdale guesthouse and Rudgyard Beach Holiday Park.

Around 1885, timber leases were taken out in the Denmark River area. Karri timber was a sought after article with many roads in London paved with Karri blocks and British homes built with timber from Denmark. A railway line from Denmark to Albany was built to transport Karri timber and was also utilised to transport commercially caught fish from the Inlet in cool storage in the late 1920s and early 1930s.

Commercial fishing was occurring in the estuaries adjacent to Albany in the early 1890s. In the early 1900s J.D. Smith and brothers began operating as professional fishermen on the Inlet. Today, descendants of the Smith family continue to fish the Inlet (Green Skills, 2008).

In 1921 Springdale siding was opened by local resident Charles Smith as a tourist attraction with Springdale Guesthouse and Tea Gardens as well as camping grounds with fishing, shooting and tennis available. Between 1936 and 1938 a train was organised to bring people from the city and from other country areas to the south coast which included a stop at Springdale for sightseeing and swimming. An extension of the South Coast Railway from Torbay to Denmark was built when Millars started sawmilling at Denmark. At its peak the railway extended as far as Nornalup, with demand from an increasing population from the Group Settlement Scheme in Denmark (Green Skills, 2008). The section of the railway from Denmark to the Hay River is now part of the popular Denmark- Nornalup Heritage Trail (Green Skills, 2008).

4 KEY VALUES

4.1 HEALTHY FAUNA AND FLORA. MAINTAINING AND WHERE POSSIBLE, ENHANCING THE WILSON INLET AS A HABITAT AND BREEDING SITE.

The Wilson Inlet, including the surrounding catchment, is encompassed within the South West Botanical Province where the diversity of landform and soil types, together with a long history of isolation, have produced a very diverse flora, internationally recognised due to its high species diversity and number of endemic species (Department of Environment and Conservation, 2009). The health of native flora and fauna contributes to the beauty of the Inlet and to the local economy as well as providing ecological processes such as water and air purification and pollination of our food crops (South Coast NRM, 2011).

The Wilson Inlet is an important conservation site for many native flora and fauna, providing valuable habitat for both terrestrial and aquatic species. Numerous natural factors and human induced threats can impact on the native flora and fauna. Habitat degradation and loss due to nutrient pollution, clearing and fragmentation of habitat, the introduction of invasive weed species and predation and/or competition from domestic and feral animals pose the greatest risks to healthy native flora and fauna of the Wilson Inlet.

FAUNA

Situated within the Wilson Inlet catchment is the Mount Lindesay National Park, which is part of the Walpole Wilderness Area. The park contains a number of endemic species, many of which have relictual linkages to Gondwana times (South Coast NRM, 2011). Bushland linkages between the Walpole Wilderness area and Wilson Inlet are of vital importance for the movement of native fauna. Enabling the maintenance of a diverse gene pool, essential for the ongoing health of the populations.

The roles of native fauna need to be recognised in the importance of maintaining the health of the Inlet's ecosystem. For example mammals play a role in ameliorating soils through digging the top leaf litter into the soil profile where it can be broken down more quickly and nutrients cycled. Other beneficial interactions by fauna include; pollination, dispersal of native seeds and assisting germination of native seed. The reduction or loss of a species or number of species can cause an upset in the ecosystem balance. Often the effects of such an imbalance are small or slow to manifest but, when coupled with other imbalances, can place the health of the Inlet's ecosystem and that of the surrounding catchment under stress.

FLORA

Native vegetation in and around the Wilson Inlet contains flora of local and regional importance. Within the foreshore vegetation of the Inlet are four threatened flora species, including the endemic Selliera radicans species. With increasing development and population pressures around the Inlet and catchment area the retention, protection and enhancement of the Inlet's foreshore and fringing vegetation is essential to protecting the environmental values of the Inlet. A healthy foreshore acts as a buffer and filter for the Inlet from the influences of land practices in the catchment. This buffer zone helps to maintain water quality by preventing pollutants, nutrients and sediments from entering the Inlet, protecting the soil from erosion, providing resilience to weed invasion and providing valuable habitat for fauna.

The aquatic flora of the Inlet also plays an important role with the dominant flora species being varying types of algae and Ruppia megacarpa. Ruppia provides important nursery grounds, protection and food for numerous fish and other aquatic fauna as well as playing an important role in assimilating nutrients in the Inlet.

4.2 NATURAL BEAUTY OF INLET

The Wilson Inlet adds to the beauty and popularity of Denmark, with its natural and aesthetic features being a major draw card for tourists to the region. The Inlet is known for its quiet, natural beauty with many community members using the Inlet as a place for contemplation and relaxation. With the Inlet's scenic mixture of water, varying native flora and fauna and landscape, the Inlet attracts artists, writers and photographers alike.

Inappropriate development and uncontrolled recreational use can impinge on the quiet beauty of the Inlet. Increasing nutrient levels can stimulate algal and Ruppia growth, which when washed up on shorelines of the Inlet, begins to decompose and can cause visual and odour issues for users and nearby residents.

4.3 RECREATION; WALKING, BOATING, FISHING, BIRD WATCHING

Recreational use of the Inlet is an important community pastime. A wide variety of uses, including boating, fishing, walking and bird watching, are undertaken either on the Inlet itself or on adjacent foreshore areas.

Recreational fishing of the Wilson Inlet is a popular pastime, drawing both locals and visitors alike. Shore and boat-based fishing are both popular with most fish caught recreationally taken by line fishing. Controls on size and possession limits for these fish species are governed by Department of Fisheries; South Coast Bioregion 'Recreational Bag Limits'. Refer to the 'Recreational Fishing Guide – South Coast Bioregion' for details. A State-wide Recreational Fishing Boat Licence (RFBL) was introduced on 2nd March 2010. A RFBL is required to undertake any general fishing activity (including crabbing) conducted with the use of a powered boat anywhere in the State (Department of Fisheries, 2011).

The Denmark Strategic Boating Plan (Estill & Associates, 2007) was prepared for the Denmark Shire, working with Department of Planning in 2006 – 2007 and received by Council in October 2007. The strategy document provides direction for the long-term usage of the Denmark River and Wilson Inlet in terms of boating. Boating and other powered recreation on the Wilson Inlet, e.g. jet skis, are also covered under Department of Planning (2008) 'Marine Safety Restricted Areas of Navigable Waters',

Strategies for the provision of adequate recreational facilities and areas, as well as the control of recreational uses of the Inlet, are addressed in the 'Wilson Inlet Foreshore Reserves Management Plan 2008' and the development of surrounding infrastructure is covered in 'Denmark Town Planning Scheme No. 3'. The 'Wilson Inlet Foreshore Reserves Management Plan (2008)' includes the objective "To provide guidelines for recreation areas and facilities which are compatible with the foreshore landscape and have minimal environmental impact". Actions regarding this objective are to be used in conjunction with this Management Strategy.

4.4 COMMERCIAL; FISHING, AQUACULTURE, TOURISM

Commercial practices in the Inlet pertain to fishing, aquaculture and tourism. Tourism is a thriving industry in Denmark with peak periods occurring during Easter and Christmas holidays. It is estimated that 114,000 tourists visit the area annually, spending approximately $40 million p.a. (Drainage Review, 2009). The Wilson Inlet is central to the tourism industry in Denmark and also contributes to regional tourism. Two caravan parks and other holiday accommodation are located on or adjacent to the Inlet foreshore and tourism operators offer tours that include Wilson Inlet and/or its foreshore, taking in the scenery, fauna and flora (Green Skills, 2008). Visitors also bring and hire canoes, kayaks, boats and other craft, using both the Inlet and the lower sections of the Denmark and Hay Rivers. Maintaining the health of the Inlet's ecosystem is essential in keeping the local tourism industry viable and in maintaining healthy fish stocks and other aquatic fauna in the Inlet.

Since the early 1900's professional fisherman have fished in the Wilson Inlet. Today the Inlet is one of thirteen estuaries conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery and brings in approximately 50% of the commercial estuarine fish catch. Currently there are 25 fishing licences giving access to Wilson Inlet for commercial fishing purposes.

Aquaculture is a smaller commercial sector utilising the Wilson Inlet. Currently there are two licences held for growing and farming mussels and oysters. These enterprises require a significant influx of sea water for the maturation and spawning of the mussels and oysters.

The South Coast nearshore and estuarine commercial fisheries are governed by South Coast Estuarine Fishery Policies. Control is primarily through input controls in the form of limited entry and gear restrictions, as well as seasonal and time closures, area closures and size limits. Information regarding the South Coast Estuarine Fishery Policies can be sourced through Department of Fisheries.

4.5 SUSTAINABLE BALANCE OF AGRICULTURE, HEALTHY BUSHLAND AND WATERWAYS IN THE SURROUNDING LANDSCAPE

Agriculture is an important activity within the Wilson Inlet catchment providing both economic and cultural heritage value. Beef and sheep grazing make up the majority of agricultural practices, while cropping, forestry, dairy and other intensive practices make up a smaller but still significant portion. These practices, while being important, also have a large impact on the health of the Inlet. A number of threats to the Inlet (such as increased nutrients) have sources which originate from the catchment. Whilst returning the catchment to its state pre European settlement would greatly improve the ecological health of the Inlet it is obviously an unattainable goal. Finding a sustainable balance between agriculture and healthy bushland and waterways provides benefits to both people and the environment.

With the partially cleared landscape of the Wilson Inlet catchment, farmlands with corridors of native vegetation are essential for connectivity and native fauna populations. They provide shelter, refuge from predators, breeding sites and a food source. Healthy riparian vegetation is more resilient to weed invasion and can reduce the spread of invasive weed species downstream. Maintaining fenced vegetation can also provide benefits to the landowner through providing shelter from the sun, wind and rain for livestock, reducing stresses (such as heat stress) and improving the overall health of the animals.

Overall, management of current agricultural practices and the remaining remnant and riparian vegetation will assist in contributing both to land based primary production and to the protection of waterways and the Inlet by reducing erosion and sedimentation, and nutrient export from farmland to waterways.

4.6 PROTECTING CULTURE AND HERITAGE; INDIGENOUS AND NON-INDIGENOUS

INDIGENOUS HERITAGE

Waterways are a key component of the spiritual landscape of Noongar people and, consequently, conservation and management methods linked to waterways inherently address conservation and management of the cultural landscape (Guilfoyle, 2010). Traditional wild resource use is an important component of maintaining biodiversity that has quite often been overlooked in conservation and land management policy. Rehabilitating the waterway will protect the flora and fauna associated with it and will improve the water quality as well as support Indigenous heritage.

Noongar cultural systems of the Wilson Inlet are interwoven with the landscape and its ecosystems and, as such, need to be treated as an inherent part and integrated into management strategies and plans. Over recent years a number of plans have been developed, these plans are to be used in conjunction with the Management Strategy. 'Aboriginal Cultural Heritage Management Plan Koorabup Beelia (Denmark River), 2010' identifies methods of re-defining our approaches to waterway management by ensuring cultural heritage assessments and methods of protection are well integrated with environmental management plans and processes. The Wilson Inlet Community Cultural Management Project 2008 also forms a basis for ongoing Noongar community engagement in caring for the Inlet and sustaining cultural custodianship into the future.

NON-INDIGENOUS HERITAGE

The Wilson Inlet and surrounding catchment is situated within one of the oldest European established regions in WA. A number of long-time resident families still hold strong connections to the Inlet and the surrounding area. Locations including the Prawn Rock Channel area have been enjoyed by the local community and visitors alike since the 1930's. Camping occurred on both sides of Ocean Beach Road at Prawn Rock Channel during the summer holidays. Tea rooms, a store and picnic facilities added to day visitors' enjoyment of the Inlet (Green Skills, 2008).

The old railway line, which passed through Denmark has been recognised for its heritage value with the construction of the Denmark-Nornalup Heritage Trail. This rail trail is popular with walkers, cyclists and horse riders. A cement bench made by Mr Smith in 1934 can still be seen near the Heritage Trail shelter at Springdale Beach.

5 KEY ISSUES

Through community consultation and the gathering of technical advice, the major pressures and threats affecting the health of the Wilson Inlet's ecosystem were identified. These were prioritised using a value/threat matrix, evaluating the potential impacts of the threats on the Inlet and the likelihood of the occurrence of each threat to the values was identified.

- Nutrient levels and nutrient cycling within the Inlet
- Climate change
- Development and infrastructure around the Inlet foreshore and surrounding areas
- Changing land use within the catchment
- Water competition
- Soil acidity
- Introduced invasive species including domestic animals
- Diseases and pathogens
- Fire

5.1 NUTRIENT LEVELS AND NUTRIENT CYCLING WITHIN THE INLET

NUTRIENT LEVELS

As a consequence of land use changes in the catchment since european settlement, the Inlet is becoming increasingly nutrient enriched (eutrophic). This enrichment, if left unchecked, will lead to increased algal blooms, loss of Ruppia beds and, potentially, the collapse of the present ecosystem. The analysis on water quality of the Wilson Inlet (Appendix 9.1) shows that a number of the waterways entering the Wilson Inlet are above ANZECC water quality guidelines for median Total Nitrogen and median Total Phosphorus. Little River in particular has shown a slight increase in concentrations. In order to prevent the adverse impacts of increasing nutrient levels in the Wilson Inlet, it is first essential to understand the processes that contribute nutrients to the Inlet and the processes controlling the cycling and movement of the nutrients once they reach the Inlet.

Nutrients are the essential chemical elements required by plants, algae, bacteria and animals for growth. In the Wilson Inlet it has been found that the nutrients whose amounts limits the growth of plants and algae are primarily nitrogen and phosphorous.

There are three potential sources of nutrients to the Inlet which have been identified;

1. Nutrients entering the Inlet via the tributaries. While Denmark and Hay Rivers contribute a large proportion of the water flowing into the Inlet, it is the smaller catchments of Cuppup and Sunny Glen Creek that provide the greatest loads, per volume of water, of Phosphorus and Nitrogen into the Inlet.
2. Nutrients from groundwater flowing directly into the Inlet
3. Nutrients stored in the sediments of the Inlet. (Department of Water, 2008).

These nutrients originate from many different sources (point and diffuse) from both urban and rural land uses. Urban sources include; treated waste water discharge from the Denmark Waste Water Treatment Plant, nutrient enriched water leaching from septic systems, storm water and general run-off from the land. Rural sources in the surrounding landscape include; leaching of nutrients from fertilisersfrom farms into waterways and eventually into the Inlet. Nutrient point sources predominantly come from intensive agriculture (e.g. dairies, viticulture and horticulture). Diffuse sources are from broadscale farming enterprises undertaking animal grazing and cropping. Reducing nutrient inputs into the Inlet from the surrounding catchment is a vital component in managing Inlet nutrient levels. In order to assess the nutrient levels of the Inlet the ANZECC guidelines should be followed. These guidelines outline acceptable nutrient levels for Australian and New Zealand waters.

CYCLING OF NUTRIENTS WITHIN THE INLET

Each year there is a regular sequence of events affecting/influencing the water quality of the Inlet. This sequence reflects the annual cycles in the major drivers of the water quality. These drivers include rainfall and river flow, solar radiation, water temperature, ocean water levels and wind. Further information on these drivers and cycling of nutrients can be found in Department of Water's Wilson Inlet Report to the Community 5. 'Water quality in Wilson Inlet from 1995 – 2002'.

The sediment and benthic vegetation, mainly seagrass (Ruppia megacarpa), play important roles in cycling nutrients within the Inlet. Most of the available phosphorus and nitrogen in the Inlet are taken up into the Ruppia and attached algae epiphytes before open waters of the Inlet are reached. Biological cycles use nutrients on the time scale of hours, but transport down the Inlet (14km) works on the scale of days to months.

Annually the Ruppia goes through a period of senescence where the older foliage is shed. The shed seagrass wrack and attached algae accumulate on the shore or sink to the bottom of the Inlet. Along with organic matter delivered directly from the catchment they then become part of the sediment store of nutrients. Sediments accumulate organic matter over time and consequently store a large amount of nutrients (Department of Water, 2010). The concern with high nutrient loads in the sediment is that, if conditions become anoxic (oxygen deficient) during stratification events, nutrients will be released from the sediments into the water column.

Stratification occurs when the saline water from the ocean enters the Inlet. There can be a poor exchange of oxygen between the fresher water layer on the surface and heavier salty bottom waters creating anoxic conditions. Anoxic conditions can lead to fish kills as well as affecting benthic flora and fauna, altering the abundance and structure of benthic communities.

In nutrient enriched systems overall productivity, including fish abundance, increases up until the point where the system collapses through light limitation or a shift to a phytoplankton dominated system which, then, impedes the natural processes essential to aquatic biota (Department of Water, 2002a). It is usual in this sort of system for there to be a time lapse between catchment condition and estuarine condition; "In many cases catchment impacts have not manifested in estuary decline as yet. This incongruity between catchment condition and estuarine condition is a result of long response times. Time lags reflect the fact that groundwater is a significant input to estuaries." (Department of the Environment, Water, Heritage and the Arts, 2000.).

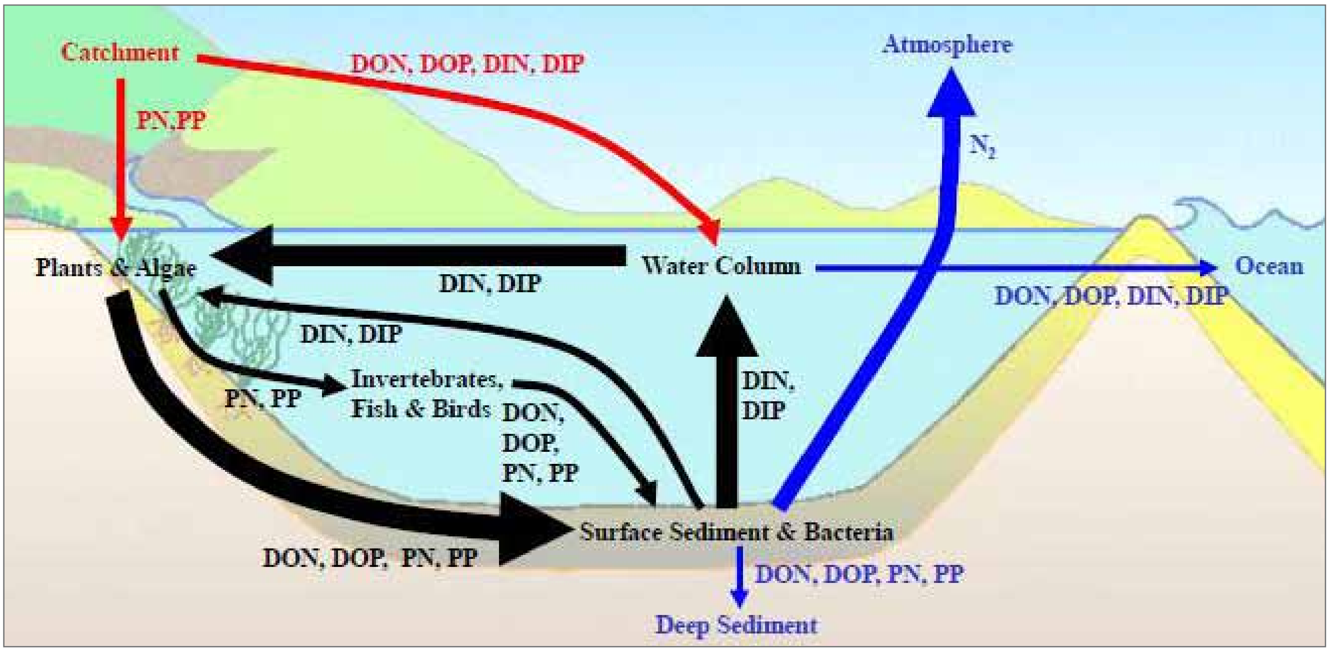

Figure 2: Simplified nitrogen and phosphorus cycle showing sources and sinks. The sizes of arrows are intended to give a general idea of the relative scales of the different nutrient flow paths. The nutrient sinks are recorded in blue, the catchment source in red and the internal recycling in black (taken from Department of Water, 2002).

5.2 CLIMATE CHANGE

Given the intrinsic uncertainty of climate change projections, identifying and quantifying the impacts of climate change on the Inlet is challenging.

There is evidence that the long term average rainfall for the Wilson Inlet catchment has been slowly declining. Rainfall average for Denmark has declined from 1054mm (1940-1975) to 994mm (2011), while the rainfall for Mount Barker has declined from 766mm (1940-1975) to 655mm (2011).

Climate change projections indicate that Western Australia's south west region is likely to become drier in the next century. Smith et al, (2009) used CO2 emission scenarios (high to low) and global climate models to project rainfall in the Denmark catchments from 1975 to 2100. Modelling undertaken on the Denmark River Catchment projected there would be a 3% rainfall reduction by 2030 which could lead to a 13.5% stream flow reduction. Any future planning needs to consider the potential stream flow decline which may also be further impacted by changes in the land use in the upper catchment.

Reduced average rainfall will also impact on ground water recharge on local superficial aquifers, with reduced recharge seeping into the aquifers, and on soil moisture, with extended periods of reduced soil moisture placing stress on native flora.

CSIRO (2007) report indicates that, although there will be lower average rainfall with more dry days over a year, when it does rain there will be a higher proportion of light rain events (approx. 5mm) combined with some short, intense rainfall periods. The short, intense rain could cause erosion issues, with more sediment carried from farms, along waterways and, ultimately, into the Inlet. Any nutrients "attached" to the sediment will be carried into the Inlet as well. Increased severity of rainfall events will make fringing vegetation even more essential for stabilising the Inlet and the waterways which feed into it.

Other climatic factors to consider are temperature and sea level rise. Temperature is predicted to rise by about 1ºC over Australia by 2030. If emissions are low, warming of between 1ºC and 2.5ºC is likely by around 2070, with a best estimate of 1.8ºC. Under a high emission scenario, the best estimate warming is 3.4ºC, with a range of 2.2ºC to 5ºC (CSIRO, 2007).

Sea levels are predicted to rise by 0.9m over the next 100 years (2110) (Department of Transport, 2010).While this is a long term prediction low lying areas surrounding the Inlet and the Youngs Siding floodplain may be susceptible to sea level rise. This raises pertinent issues around limiting infrastructure and developments within these areas to maintain the natural flow of water and to limit the long term social and economic cost of developing in flood prone areas. The Department of Transport (2010) report recommends: "a vertical sea level rise of 0.9m be adopted when considering the setback distance and elevation to allow for the impact of coastal processes over a 100 year planning timeframe" and "when considering the setback to protect development from coastal processes". Local governments, including the Shire of Denmark and City of Albany, have policies in place pertaining to a sea level rise of 0.5m. It is pertinent that new planning policies continue to take into account sea level rise and account for changes to predictions.

Not all potential climatic changes are of detriment to the Inlet and waterways that feed it. There are also a number of opportunities that may arise from the changes. For example; if these conditions were to continue and recharge was to decline due to reduced rainfall, then salinity of rivers and streams may decline in the medium to long term as groundwater becomes disconnected from the streams (Mayer et al. 2005).

5.3 DEVELOPMENT AND INFRASTRUCTURE AROUND THE INLET FORESHORE AND SURROUNDING AREAS

Over the past years the population in and around the Inlet has been steadily increasing with the area becoming a popular destination for sea change life stylers and retirees as well as increasing holiday visitation. The increasing population has escalated pressure for new developments. Adjacent land use and development of the Inlet needs to be carefully managed and planned. Development can have direct and indirect detrimental impacts on terrestrial and aquatic flora and fauna. Development can reduce the water quality of the Inlet by increasing nutrient and sediment loads through stormwater runoff and on-site effluent systems (septic tanks). Poor design and construction can lead to erosion and the alteration of natural drainage systems, impacting on the health of the Inlet.

A key recommendation within the Wilson Inlet Community Cultural Management Project 2008 is to maintain a vegetation buffer zone around the extent of the Inlet's foreshore. The buffer zone is recommended to extend to a minimum of 50 metres above the high water mark.

Planning future infrastructure needs to carefully consider all uses of the Inlet including both human and environmental. Strategies and actions regarding development and infrastructure within and adjacent to the Denmark Foreshore Reserves have been outlined in the Wilson Inlet Foreshore Management Plans (City of Albany and Shire of Denmark) and in the draft Denmark Local Town Planning Strategy (2012). Compatible strategies and actions from these plans are to be used in conjunction with this Management Strategy.

5.4 CHANGING LAND USE IN THE CATCHMENT

Since the 1950's roughly 54% of the catchment has been cleared for agriculture. Historically the predominant land use in the catchment has been grazing (sheep and cattle) with other uses including horticulture (potatoes, fruit and vegetables), viticulture, plantations and intensive agriculture (piggeries and dairies). Over time there has been a shift in land use in the catchment with increasing viticulture and tree plantations as well as ever increasing peri-urban development.

Changing land use within the catchment can have undesirable impacts on the ecological health and function of the Inlet and other natural processes. Land clearance for agriculture and other rural industries, e.g. forestry at harvesting time, results in significant increases in catchment run-off. This run-off contains a combination of animal wastes, fertilisers, pesticides, agricultural chemicals and soil, and is a major source of elevated sediment and nutrient loadings in waterways (NSW Fisheries1999, Edgar et al.1999 cited by National Oceans Office, 2001).

Agroforestry in the catchment began in the early 1990s (Ferdowsian & Greenham 1992). By 2010 over 5200 ha of plantations had been established (Ward, et. al, 2011). The number of tree plantations, however, is unlikely to increase in the near future with current market conditions constraining the industry.

Modelling of the Denmark River showed land use change to have a greater impact on streamflow than projected climate change in the Denmark catchment (Department of Water, 2009). Tree plantations were found to have a large impact on streamflow with blue gums utilising more water than native species. The flip side of this is that plantations have played a major role in reducing salinity of rivers and streams with a prime example being the Denmark River. The Denmark River has reversed its increasing salinity trend and is now close to being fresh enough for a drinking water supply, making it the first river in Australia to be recovered from salinity (Ward et al, 2011). This was helped in a large part by clearing controls to retain native vegetation and the establishment of private tree plantations in the upper catchment area, as well as natural resource management projects supporting revegetation and fencing of environmentally sensitive areas.

Wineries and vineyards have also increase in number over recent years. Around the lower catchment area numerous boutique wineries have been developed while in the upper catchment vineyards have increased acreage under vines. Grape vines require irrigation, which can compete with other water users, impacting environmental water flows. On-farm water capture and storage facilities and improved irrigation techniques are required to reduce this impact. Saline water is also a by-product of wine making and the waste saline water needs to be carefully managed and not just drained directly into waterways.

In the lower catchment increasing peri-urban development has also imposed additional pressures on the Inlet including; nutrients from fertilisers and septic tanks; environmental weeds from garden escapees and an increased number of introduced fauna species, such as cats, which can predate on the native fauna.

Landuse change in the catchment provides both opportunities and threats for the health of the Inlet, only through careful, strategic management can the opportunities be recognised and threats mitigated.

5.5 WATER COMPETITION

Water is a precious commodity particularly with the current and future predicted trend of a drying climate. Water is essential for the ecosystem health of the Inlet which is in direct competition with human water use. At present local residents who are connected to scheme water utilise water from dams on the Quickup and Denmark Rivers (at certain times of the year) and from Albany sources. Since 2007 Water Corp has supplemented water from the Quickup Dam with water from Denmark River Dam (Water Corporation, 2010). To provide water to Denmark during periods of shortage, the Water Corporation dilutes the Denmark Dam water with fresh water carted from Albany (Department of Water, 2010a).

The dams on the Denmark and Quickup Rivers, combined with planting significant areas of timber plantation and a drying climate, have changed the hydrology of the catchment, affecting water recharge entering the Inlet from the surrounding catchment.

Non-scheme private water use (principally for stock and domestic purposes) through dams and water pumped from rivers accounts for about 40 ML pumped from the Denmark River annually (above its confluence with Scotsdale Brook and excluding tributaries) (Department of Water, 2009). Farm dam storage in the Scotsdale Brook catchment was estimated to be 720 ML/yr or about 5.5% of the mean annual stream flow of that catchment (Department of Water 2009). To date, no estimate of water stored in farm dams has been made for the entire Denmark catchment (Ward, et. al, 2011).

Environmental water requirements refer to the water required to maintain healthy populations of the native flora and fauna of the Wilson Inlet. The Inlet is naturally a system in flux, with flora and fauna tolerant of some change in salinity and water levels throughout the year. However, if flora and fauna are exposed to conditions beyond tolerance limits for too long, growth and survival are compromised. Reduced water flow and recharge impacts on a number of ecological processes of the Inlet and surrounding area. Reduced water can lead to shallower waterbodies, increasing the water temperature and, in turn, reducing the dissolved oxygen levels and potentially lead to an increase in phytoplankton growth and algal blooms. At most risk are a number of endemic flora and fauna which have narrow tolerance bands and are sensitive to changing conditions.

5.6 SOIL ACIDITY

Wilson Inlet as a whole has been identified as having a high to moderate risk of Acid Sulfate Soils (ASS) within 3 m of the natural soil surface. There is evidence of ASS at Ocean Beach and Springdale Beach subdivision (Green Skills, 2008).

ASS are naturally occurring soils that contain iron sulphide minerals. ASS that have not been exposed to air are known as potential ASS. While they remain waterlogged the iron sulfides in the soil are stable and the soil pH is usually around neutral at pH of 7. When exposed to air, due to drainage or disturbance, these soils produce sulphuric acid and may release toxic quantities of iron, aluminium and heavy metals. This in turn can kill fish, other aquatic organisms and vegetation and can degrade concrete and steel infrastructure to the point of failure. Stunted or dead vegetation, acid scalds and poor vegetation regrowth in previously disturbed areas are indicative of the impacts of ASS exposure.

Acid-sulphate soils typically occur in low-lying areas such as wetlands, estuaries, tidal flats, mangrove swamps and saltmarsh habitats (Cook et al. 2000 cited by National Oceans Office, 2001). Activities near the coast that drain or disturb waterlogged habitats, such as reclamation works, grazing, mining and urban development, can facilitate this chemical conversion, leading to acid sulphate run-off. This run-off often contains very high concentrations of heavy metals, which, together with the elevated acidity, form a lethal cocktail (Hyne and Wilson 1997, Corfield 2000 cited by National Oceans Office, 2001). Run-off is accentuated during high rainfalls, when large areas of estuaries may become acidic, causing disease and mortality of fish, loss of diversity in benthic communities and long-term habitat degradation (NSW Fisheries 1999, Cook et al. 2000 cited by National Oceans Office, 2001). To minimise this risk, careful management of development, particularly in areas of high ASS risk, is required. Strategies generally need to be undertaken in the planning phases of development and can include undertaking soil tests for ASS.

5.7 INTRODUCED INVASIVE SPECIES

Invasive flora and fauna species have major economic, environmental and social impacts throughout Australia, causing damage to natural landscapes, agricultural lands, waterways and coastal areas. Invasive species can threaten and change the natural diversity and balance of ecological communities, jeopardising the survival of native flora and fauna through both direct and indirect competition. Introduced species can compete with native species for food and habitat and can potentially bring diseases. Some introduced species prey on, or displace, native species while others can cause environmental damage to their terrestrial and aquatic habitats. The control of domestic animals and other introduced feral animals would also greatly enhance the habitat values of the Wilson Inlet and catchment.

INVASIVE AND FERAL FAUNA

Within the Wilson Inlet Catchment and around the Inlet itself several introduced and feral species have been regularly sighted. Typical invasive and feral species found include foxes, mice, cats, rabbits, pigs and rats. There have also been sightings of wild deer. Predation by feral cats and foxes has been implicated as a major factor in the decline of Australian mammals that weigh between 35g and 5500g and of some ground nesting birds (Department of Environment and Conservation, 2009).

Recently, there have been several reported sightings of Koi Carp (*Cyprinus carpio*) in the Denmark River. Carp are widely believed to have detrimental effects on the ecological health of waterways, particularly through their destructive feeding habits and effects on recruitment of native fish. Carp are omnivorous, they will feed on molluscs, crustaceans, insects, larvae and seeds and can also consume plant material and general organic matter (Department of Primary Industries, 2010).

Preventing the introduction of invasive species into natural systems is the highest priority although, where this is not possible, early detection and rapid response and control efforts are essential to protect native species and their habitats. A number of control methods for feral fauna have been utilised in the past with varying degrees of success. For any program to be truly effective however a more concerted, coordinated effort across the catchment and, indeed in adjoining catchments is required, using a variety of methods at the same time.

INVASIVE WEEDS

Environmental weeds are plants that establish themselves in natural ecosystems and modify natural processes, usually adversely, resulting in the decline of the native communities they invade. The invasion of these weeds can have significant impacts including; resource competition, prevention of seed recruitment, alteration of geomorphological processes, alteration of hydrological cycle, changes to soil nutrient status, alteration of fire regimes, changes to the abundance of native fauna and genetic changes (Gilfillan et al., 2009).

Weed invasion is of most threat in areas that have been disturbed or degraded and can occur both terrestrially and aquatically.

Aquatic weeds can severely impact aquatic systems by clogging watercourses, preventing transport for instream fauna/biota.

The majority of known weed infestations within the catchment have escaped from gardens or dumped garden waste and invaded surrounding bushland and waterways. The Department of Agriculture and Food have a Declared Plants list and the Shire of Denmark has local laws relating to pest plants that may restrict the introduction or movement of the plant species listed and can also require landowners and land managers to destroy, eradicate or control the plants listed therein.

Examples of invasive weeds in and around the Inlet include; Asparagus fern (*Asparagus scadens*), Blackberry (*Rubus spp*), Bridal Creeper (*Asparagus asparagoides*), Sydney Golden Wattle (*Acacia longifolia*), Agapanthus (*Agapanthus spp*) and Arum lily (*Zantedeschia aethiopica*).

5.8 DISEASES AND PATHOGENS

Pathogens are microscopic organisms (bacteria and viruses) which cause disease in flora and fauna (Water and Rivers Commission, 1997). Pathogens occur naturally in the environment but certain species, at given levels, can be harmful to flora and fauna, including humans. They can restrict recreation, spoil scenery and damage economic uses e.g. fisheries and aquaculture. Waste discharges, accidental spills, urban and agricultural (animal refuse) runoff and groundwater flow can potentially carry pathogens and diseases.

The Denmark Waste Water Treatment Plant (WWTP) is a potential point source of bacteria for the Inlet. With the outlet pipe from the WWTP draining into the Inlet, incidences of overloading and malfunctions of the WWTP can lead to harmful bacteria entering the estuary. Removing point sources such as the treated waste water from the WWTP would reduce the risk of contamination. Regular monitoring and maintenance of the outflow pipe area at the Inlet would assist with response to any incidences of pathogen contamination. At the time of this Management Strategy development, Shire of Denmark and Department of Health are discussing a bacterial monitoring program for the Inlet.

In the area surrounding the Inlet there are several plant pathogens present that threaten a large range of native flora. Many of these only cause damage or death of their host species when a plant (individual or community) is already under stress by another process, or combination of factors, such as drought, fire, weeds invasion and/or fragmentation. The most serious diseases that threaten the ecological health of the Inlet catchment area are Phytophthora cinnamomi (*P. cinnamomi*) and Marri Canker.

PHYTOPHTHORA CINNAMOMI

P. cinnamomi is a ‘water mould’ and its spores are spread by the movement of infested water, soil or plant material, through root to root contact, movement of soil due to human activities (e.g. on vehicle tyres, on shoe treads, soil transport) or animal activity. Over 40% of the plant species in Western Australia are susceptible to the disease, mostly in the plant families Proteaceae, Epacridaceae,Papilionaceae and Xanthorrhoea species are also susceptible (Department of Environment and Conservation, 2009).

With the high annual rainfall extremely conducive to spreading the disease, Phytophthora is widespread throughout the catchment and poses a high risk, particularly around low lying areas, along drainage lines, watercourses and road systems. Parts of the catchment area appear to be either potentially dieback free locations or dieback status unknown. In the absence of detailed and current mapping and data a precautionary approach is highly recommended with all activities involving soil movement.

Strict hygiene protocols should be adhered to when constructing roads, extracting soil, harvesting timber and other industries. The Shire of Denmark’s Town Planning Scheme Policy No. 1 for Dieback Disease Management (Shire of Denmark, 1997) acknowledges the need to prevent the spread of dieback on both private and public lands and outlines a number of actions and strategies by which this can be achieved (Shire of Denmark website).

Currently there is no method of eradication of Phytophthora and, therefore, the prevention of its spread is extremely important. There are, however, methods of treatment available to stimulate plants’ immunity. Treatment is either by stem injection or foliar spray with phosphite (phosphonate), a systemic fungicide. (Dieback Working Group, 2000 and Moore, 2005 cited by Lyons, 2008).

MARRI CANKER

In recent years the incidence of death and decline in Marri (*Corymbia calophylla*) due to cankers* has increased in severity and geographic range. This canker disease can cause a noticeable reduction in vigour in many trees and drastically reduce the expected lifespan of its host species, Marri. At its most severe this disease causes a dieback effect**. This canker disease may be a symptom of a complex disease syndrome where multiple underlying factors could be contributing to tree decline and death in Marri (Paap, 2006).

*Cankers of woody plants are sunken, necrotic lesions, often associated with a main stem, branch or root.

**Dieback is the progressive death of branches or shoots, usually starting in the upper crown.

To date, minimal research has been undertaken and the causal agent/s and control options are still unknown (Paap, 2006). A study assessing the incidence, severity and possible causes of canker disease of Marri in the southwest of Western Australia has confirmed cases of canker disease causing tree deaths in Marri in Denmark (Paap, 2006). This 'new' species of fungus is now formally described as Quambalaria coyrecup. This study emphasises the importance of determining the drivers of Marri decline and developing control and management options as the decline of Marri may have major implications for wildlife habitats, conservation of roadside verges and amenity values such as salinity and erosion control.

5.9 FIRE

Fire plays a significant role in the existence and evolution of many flora, and to a lesser extent, fauna in Australia. Although fire may advantage certain plants and animals, with a drying climate and increasing development and human pressure near the Inlet and surrounding catchment, there is an increased risk in the occurrence, frequency and intensity of planned and unplanned fires with the potential to endanger human life and property and decimate fire sensitive native plant and animal species (Department of Water, 2000b).

The ecological impacts of planned and unplanned fire events can be serious, potentially causing destruction of fauna habitat and species diversity, native fauna mortality and loss of vegetation. In turn, this can result in reduced biofiltering of incoming surface water flows and an increase in water temperature (as a result of the loss of vegetation and shade) which can increase the risk of algal blooms occurring. Native seed stock depletion, erosion of top soil and nutrients (causing increased water turbidity), increased weed invasion, increased severity and extent of Phytophthora cinnamomi, degradation or loss of peat soils (organic-rich soils), and changes in vegetation composition and structure (Department of Water, 2000b) are further possible detrimental impacts.

A good understanding of the ecology of the Inlet, the impact of fire upon the Inlet's ecology and post fire management such as weed, disease, erosion and feral animal control are essential for a comprehensive fire management plan. There is still much research needed to determine the effects of planned and unplanned fires on the biodiversity and ecological functions of the Inlet and surrounding catchment to contribute to the development of an appropriate fire management plan.

A master burn program has been developed by the Shire of Denmark for all Shire tenure (five year program beginning 2009/2010) and fire management plans are being developed for Shire reserves. Due to the potential impact on environmental and cultural values, no hazard reduction burning is undertaken within Wilson Inlet Foreshore Reserves, between the Inlet foreshore and the Denmark-Nornalup Heritage Rail Trail or within a 30 metre buffer zone from the high water mark of the Inlet foreshore.

The Wilson Inlet Foreshore Reserves Management Plan (2008) and the Denmark Foreshore Fire Management Plan (DFFMP) Wilson Inlet Foreshore Hay River – Mouth of Inlet (Fireplan WA, 2002) refers to fire management, strategies and actions for the Inlet foreshore and surrounding area to assist in addressing fire management issues for the Shire of Denmark and private property landowners adjoining foreshore reserves.

6 TARGETS

Below are listed the key targets which underpin all of the strategies and actions of this Management Strategy.

- **REDUCTION IN NUTRIENT CONCENTRATIONS FROM ALL SOURCES TO ACHIEVE DOWNWARD TREND**
  - Catchment sources
  - Rural sources
  - Urban sources
- **PROTECT AND ENHANCE BIODIVERSITY WITHIN THE CATCHMENT**
- **WATER BODIES FENCED TO PREVENT LIVESTOCK ACCESS**
  - A 50% increase in fencing of remaining unfenced water bodies from 2009 WICC mapped fencing
- **DEVELOP MITIGATION PLANS FOR CLIMATE CHANGE**
- **PLAN AND IMPLEMENT BETTER WATER RESOURCE USE AND REUSE EFFICIENCY**
  - Stormwater management
  - Retrofit water efficiency
- **WASTE WATER TREATMENT PLANTS TO BE UTILISING REUSE OPTIONS FOR TREATED WASTE WATER**
  - For Denmark Waste Water Treatment Plant to commit to a plan to cease effluent discharge into the Inlet
  - Waste Water Treatment Plants to utilize efficient reuse
- **MAINTAIN THE INLET'S CAPACITY TO BUFFER INPUTS AND OTHER THREATS**
  - Revegetate and where appropriate increase area of land ceded for foreshore reserve

7 STRATEGIES AND ACTIONS

The Management Strategy identifies three necessary strategies to improve the condition of the Wilson Inlet and the surrounding catchment. These are - reducing threats from the catchment, managing the Inlet to minimise threat effects and monitoring and reporting to modify and enhance the effectiveness of management strategies.

Throughout the actions a common thread of increasing community and stakeholder knowledge and identifying gaps is key to the success of the Management Strategy.

Actions have been prioritised based on an impact/likelihood matrix with numbers appointed for the potential impact the action will have on reducing a threat to the Inlet and the likelihood of the action occurring. These numbers were then combined and classed Low to High.

All actions are subject to funding and commitments by government agencies and to changes in government department core business, roles and direction.

7.1 REDUCING THREATS FROM THE CATCHMENT

The identified key threats to the ecological health of the Inlet need to be reduced from all potential sources, both urban and rural, with an emphasis on targeting main sources and areas where the greatest impact to reduce these threats can be achieved with the available resources.

The Wilson Inlet is the accumulation point of the catchment. A single diffuse source such as a farm may have minimal impact on the Inlet although, once all of these diffuse sources are combined, they can place enormous stress on the Inlet's ecological health. Reduction of both diffuse and point sources in the catchment is required.

While there have been a number of improvements over the years in management and on-ground work activity in the catchment, the continuation of improved management of existing land use and activities as well as integrated planning of land use change and future land use and activities both within the Inlet and surrounding catchment is required to further mitigate threats to the ecological health of the Inlet. In turn this will protect the community values of the Inlet including environmental, heritage, cultural, recreational, aesthetic and commercial values.

7.1.1 RURAL CATCHMENT MANAGEMENT

Broadacre farming, including grazing of pastures by livestock, plays an important role in nutrient discharge to the Inlet, water competition and loss/fragmentation of habitat for native fauna and flora. Other land uses in the catchment, including forestry plantations, also pose management issues and opportunities. Both the pros and cons of each landuse need to be considered. As an example, forestry plantations have been providing the opportunity for reducing the salinity of the downstream waterways however they also use higher volumes of water than native vegetation and traditional broadacre farming. During and after harvest the land is at a high risk for erosion and sediment loss into the waterways.

OBJECTIVE 1: REDUCE NUTRIENT EXPORT FROM LANDSCAPE INTO WATERWAYS AND THE INLET

Action 1.1

Conduct programme to promote "Best Practice" fertiliser management. Encourage soil testing prior to fertiliser application through workshops and targeted soil testing. Provision of advice on suitable type and timing of fertiliser application and soil amelioration to promote land capability and productivity components. Individual advice on fertiliser management should be sought from accredited advisers.

Key Stakeholders:	WICC, DAFWA (supporting role)
Time period:	Ongoing
Measurable	Output: Number of farmers taking up "best practice" fertiliser management; Participant numbers and feedback from workshops and soil testing.
Priority:	High

Action 1.2

Promote the establishment of deep rooted perennial pastures to reduce nutrient loss and for soil carbon storage. Seek funding to provide subsidised seed to targeted landowners.

Key Stakeholders:	WICC, DAFWA (supporting role)
Time period:	Ongoing
Measurable	Output: Number of hectares of perennial pastures established; Number of land owners involved.
Priority:	Medium

OBJECTIVE 2: MINIMISE EROSION AND SEDIMENT LOSS FROM LANDSCAPE INTO WATERWAYS AND THE INLET

Action 2.1

Source funding to strategically fence and revegetate waterways and remnant vegetation stands within catchment including associated alternative water points and stoc k crossings. Priority areas include Sunny Glen Creek, Sleeman River and 1st and 2nd order streams. Long term funding, using more diverse range of sources and sponsorship is a matter of urgency.

Key Stakeholders:	WICC, Green Skills
Time period:	2017
Measurable Output:	Number of kilometres of fencing and number of hectares revegetated; Number of land owners involved.
Priority:	Medium

Action 2.2

Promote the establishment of deep rooted perennial pastures to reduce erosion and sediment loss. Seek funding to provide subsidised seed to targeted landowners. Areas of high erosion risk to be prioritised. Provision of suitable species and promote productivity components.

Key Stakeholders:	WICC, DAFWA (supporting role)
Time period:	Ongoing
Measurable Output:	Number of hectares of perennial pastures established; Number of land owners involved.
Priority:	Low

Action 2.3

Engage farmers through workshops to encourage and educate on "best practice" management for soil health, including information packages and demonstration sites. Any workshop or education to involve catchment groups, agencies and relevant commercial businesses where possible.

Key Stakeholders:	WICC, DAFWA (supporting role)
Time period:	Ongoing
Measurable Output:	Number of workshops and information packages distributed; Number of participants and feedback
Priority:	Medium

OBJECTIVE 3: MAINTAIN AND ENHANCE NATIVE FLORA AND FAUNA THROUGH STRATEGIC MANAGEMENT OF PATHOGENS AND DISEASE, CONTAINING AND WHERE POSSIBLE, REDUCING DISTRIBUTION

Action 3.1

Implement hygiene protocols in all areas to reduce the spread of pathogens and diseases. There are a number of protocols and strategies for hygiene at both local and regional level. All areas within the catchment should be considered at risk from pathogens including those areas where distribution of diseases and pathogens are unknown. Promotion of hygiene will be encouraged as the most effective method to prevent the spread of Phytopthora.

Key Stakeholders: LGA's, DoF, DPCWG, DEC (supporting role), DAFWA (supporting role)
Time period: Ongoing
Measurable Output: No increase of Phytophthora Dieback distribution and where distribution is unknown source funding to survey and map Phytophthora, prioritising remnant vegetation of high biodiversity value. Increased awareness and compliance with policies
Priority: High

Action 3.2

Manage the impacts of priority pathogens and diseases through information sharing, training and on-ground works including utilising signage and educational material. Workshops to be undertaken to inform the community on priority diseases and pathogens. Utilise opportunities to piggy back on related workshops where appropriate. Prioritise high biodiversity areas for signage.

Key Stakeholders: WICC, SCNRM, DPCWG, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of workshops and training days; Participant numbers and feedback
Priority: Medium

Action 3.3

Promote communication between key stakeholders to protect high-value areas of biodiversity significance. Meetings on an as needs basis involving local, state, community groups and appropriate industry bodies for better flow of information and provide platform for coordinated programs and on-ground works. Community groups also provide role as conduit to the community.

Key Stakeholders: WICC, SCNRM, DEC, Industry, LGA's, DPCWG.
Time period: Ongoing
Measurable Output: Number of interagency and industry meetings undertaken; Meeting minutes detailing actions and objectives.
Priority: Medium

Action 3.4

Phosphite treatment of high biodiversity value bushland identified as having Phytophthora present.

Key Stakeholders: WICC, SCNRM, DEC, LGA's, DPCWG.
Time period: Ongoing
Measurable Output: Flora treated with phosphite remain in present state or improved condition
Priority: Medium

OBJECTIVE 4: MAINTAIN AND ENHANCE NATIVE FLORA AND FAUNA BY STRATEGICALLY MANAGING INVASIVE SPECIES

Action 4.1

Refer to Local, Regional, State and National Invasive Species Management Plans and implement relevant actions. Prioritise weed management based on invasiveness, distribution and environmental impact of weed species.

Key Stakeholders: WICC, LGA's, DoF, DWAG, Green Skills, DEC and DAFWA (supporting roles)
Time period: Ongoing
Measurable Output: Reduce the extent or vigour or contain populations of invasive species; Improvement in bushland condition using Keighery's scale; Number of hectares of weed control undertaken
Priority: High

Action 4.2

Utilise and update weed infestation sites in public database "Weed Watcher". Seek funding for a Project Officer to collate all currently known weed populations in the Wilson Inlet Catchment and surrounding area and input data into "Weed Watcher" program to form a comprehensive database of up to date information

Key Stakeholders: WICC, NGO's, DEC, SCNRM, LGA's.
Time period: 2015
Measurable Output: Funding sourced and data entered into Weed Watcher
Priority: Low

Action 4.3

Promotion and coordination of feral animal control programs. Key stakeholders to use a collaborative approach to maximise effectiveness of feral animal control methods; Source funding to subsidise baiting and feral animal shoots.

Key Stakeholders: WICC, DEC, LGA's, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of coordinated programs implemented and number of participants; Number of animals controlled where possible.
Priority: Medium

Action 4.4

Source funding for invasive weed control and implement on-ground works. Sourcing long term funding is essential to minimise reinfestation. Utilise best management practice when undertaking on-ground works i.e. work from the areas of least infestation first where native vegetation is of good quality and along waterways work from upper most infestation first.

Key Stakeholders: WICC, SCNRM, DWAG, Green Skills, LGA', DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Funding sourced for at least 3 consecutive years
Priority: Medium

Action 4.5

Source funding and implement post wildfire feral animal and invasive flora species management. A quick response program including strategic removal of weeds and baiting of feral animals directly after a fire will assist in the prevention of opportunistic species outcompeting native fauna and flora.

Key Stakeholders: DEC, WICC, LGA's, DWAG
Time period: Ongoing
Measurable Output: Baiting program implemented; Number of hectares controlled
Priority: Low

Action 4.6

Promote regular meetings and maintain interaction between community groups, local government and state agencies for strategic and comprehensive invasive species control. Interagency weed group to continue to meet on a 2 – 3 month basis to discuss on-ground works occurring and potential funding opportunities.

Key Stakeholders: WICC, DWAG, LGA's, DEC, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of meetings; Meeting minutes detailing actions and objectives.
Priority: Low

OBJECTIVE 5: BALANCING WATER REQUIREMENTS FOR HUMANS AND THE ENVIRONMENT.

Action 5.1

Encourage local government to develop and implement bylaw/policies which governs the building, size and placement of new dams within catchment. Building new dams on waterways should generally not be permitted. Denmark Shire already has in place policy to govern size and placement of dams where not covered by state policy. Encourage City of Albany and Shire of Plantagenet to develop similar policies.

Key Stakeholders: LGA's, DoW
Time period: 2017
Measurable Output: Policies developed and implemented; Compliance to policies for Albany, Denmark and Plantagenet local government areas
Priority: Medium

Action 5.2

Research to be undertaken on environmental water requirements to maintain healthy native flora and fauna in Wilson Inlet Catchment, utilising research on the Denmark River for other river systems within catchment. An Environmental Water Requirement (EWR) study has been undertaken for the Denmark River. This information can be extrapolated for other major waterways leading into the Inlet to give a better understanding of the overall water resource requirements of the Wilson Inlet and its catchment.

Key Stakeholders: CENRM
Time period: 2020
Measurable Output: EWR met for Wilson Inlet and its waterways
Priority: Low

Action 5.3

Forestry and carbon plantations to follow industry best practice, Forest Stewardship Council (FSC) and Australian Forestry Standards (AFS) for water management. Work with plantation managers to undertake watercourse rehabilitation and protection works and other water management practices as per standards.

Key Stakeholders: Industry bodies, LGA's
Time period: Ongoing
Measurable Output: Number of plantations compliant with FSC and AFS.
Priority: Low

OBJECTIVE 6: DEVELOP MITIGATION STRATEGIES TO MINIMIZE THE IMPACT OF CLIMATE CHANGE AND VARIABILITY ON WATER BODIES LEADING INTO THE INLET

Action 6.1

Fence off and revegetate waterways strategically, especially river pools for shade creation, and to minimise stock degradation of current exposed riparian vegetation in order to build the resilience of native fauna and flora. On-ground works to be prioritised so as to protect areas vulnerable to temperature changes and evaporation, creating refugia for fauna and flora.

Key Stakeholders: WICC, LGA's, Green Skills, DoW (supporting role)
Time period: Ongoing
Measurable Output: Number of kilometres of fencing erected; Number of landowners involved; Number of hectares of riparian zone revegetated.
Priority: High

OBJECTIVE 7: EFFICIENT WATER USE AND REUSE OF WATER ON RURAL PROPERTIES

Action 7.1

Develop and Implement extension program for water use efficiency, capture and storage improvement techniques.

Key Stakeholders: WICC, WC, LGA's, DAFWA (supporting role), DoW (supporting role)
Time period: 2017
Measurable Output: Number of events and landowners engaged
Priority: Medium

OBJECTIVE 8: MAINTAIN AND ENHANCE BIODIVERSITY OF THE ENVIRONMENT BY INCREASING WILDLIFE CORRIDORS FROM THE INLET TO REMNANT VEGETATION, RESERVES AND NATIONAL PARKS

Action 8.1

Continue to strategically fence and rehabilitate waterways and remnant vegetation stands within catchment.

Target areas of high biodiversity value and those which provide links between high biodiversity areas. Source funding to subsidise fencing, alternative water points, stock crossings and revegetation.

Key Stakeholder: DEC, WICC, DoW (supporting role), Gondwana Link, SCNRM, Green Skills
Time period: 2017
Measurable Output: Number of kilometres of fencing; Number of landowners involved; Number of hectares revegetated
Priority: High

7.1.2 INTENSIVE RURAL LAND USES

Intensive rural land uses includes intensive animal husbandry (e.g. feedlots and dairy) and horticulture (including vineyards and potato growing). Although limited in size and number within the Wilson Inlet catchment, these operations can produce considerable amounts of nutrients and utilise sizable quantities of water (e.g. for irrigation).

OBJECTIVE 9: IMPROVE MANAGEMENT TECHNIQUES TO REDUCE NUTRIENT EXPORT AND IMPROVE WATER USE EFFICIENCY FROM INTENSIVE LAND USES

Action 9.1

New intensive rural land use activities should only be located in areas where nutrient export can be effectively managed. Intensive rural land uses with the potential to export significant levels of nutrients should require approval under Town Planning Schemes. Approval should not be given where nutrient exports cannot be managed (e.g. flood risk areas, land with low Phosphorus Buffering Index).

Key Stakeholders: LGA's, DEC, DoW (supporting role), DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Policies in place for Albany, Denmark and Plantagenet local government areas
Priority: Medium

Action 9.2

Promote development of efficient nutrient and waste management practices for existing intensive rural landuse activities. Management practices to be developed for sites with the greatest risk of nutrient loss, and partnerships with industry promoted to access funds, technical help and reduce risk of nutrient export

Key Stakeholders: WICC, DAFWA (supporting role)
Time period: 2022
Measurable Output: Nutrient management plans developed and implemented for intensive industries
Priority: Low

Action 9.3

Ensure aquaculture ponds are located "off-stream", out of a stream channel and floodway. Through planning approval and Fisheries licensing, aquaculture ponds can be required to locate away from stream and floodwaters. Best practice management to be promoted.

Key Stakeholders: LGA's, DoF, DoW (supporting role).
Time period: Ongoing
Measurable Output: Applications complying with requirements
Priority: Low

7.1.3 DRAINAGE MANAGEMENT OF THE FLOODPLAIN AND CATCHMENT

An Inlet's floodplain is important in assimilating nutrients and providing refugia for native fauna and flora. Artificial breaching of the sandbar has lowered Inlet levels and reduced the size of the floodplain. Originally the floodplain would have been extensive, covering land to over 2m AHD. The present floodplain has development and land uses that are not compatible with nutrient assimilation, with most of the hydrology of the area vastly changed to a drainage system. Sections of the waterways have little or no native vegetation, reducing the habitat for both aquatic and terrestrial fauna. Recent efforts to fence off and revegetate waterways in the floodplain have seen a reversal of that trend but there is still a need for further works.
The Cuppup, Sleeman and Lake Saide catchments still have the highest level of nutrient export (per hectare) in the Wilson Inlet Catchment. The proximity to the Inlet, the level of inundation, type of land use and drainage design all contribute to the higher levels of nutrient export. Cuppup Creek is a priority for further rehabilitation works. Provision for controlling development below 2.5m AHD occurs in both the Shire of Denmark and the City of Albany through their town planning schemes. This needs to continue and be a part of any new amendments to ensure appropriate and compatible future development occurs.

The drains are managed by the Water Corporation or private landowners. The Water Corporation has a responsibility to ensure flooding does not adversely impact landowners.

OBJECTIVE 10: ENHANCE BIODIVERSITY AND WILDLIFE CORRIDORS OF DRAINS

Action 10.1

Promote fencing and revegetation of private and Water Corporation drains, revegetating at least one side with native flora species. Source funding to subsidise fencing, associated alternative water points, strategic stock crossings and revegetation. Due to maintenance requirements, Water Corporation drains can only be revegetated on one side of the drain or upon approval by Water Corporation the other side may be revegetated with low vegetation which machinery can work over.

Key Stakeholders: WC, WICC, DoW (supporting role)
Time period: 2018
Measurable Output: Number of kilometres of waterway fenced and hectares revegetated; Number of alternative water points and strategic stock crossings installed.
Priority: High

Action 10.2

Water Corporation to continue to manage drains by slashing rather than spraying for vegetation control. Consideration to be given allowing native vegetation to grow unrestricted on one side of drainage reserve, where practical.

Key Stakeholders: WC
Time period: Ongoing
Measurable Output: All Water Corporation drains slashed
Priority: Medium

Action 10.3

Continue to incorporate Best Management Practices into drainage network to improve wildlife corridors. Incorporating Best Practice weed and feral animal control. Constructed wetlands and recontouring to be undertaken at new demonstration sites. Utilise existing demonstration sites on field trips.

Key Stakeholders: WC, WICC, DoW (supporting role)
Time period: 2022
Measurable Output: Number of demonstration sites
Priority: Medium

Action 10.4

Continue to implement existing stream foreshore survey report's recommendations and undertake new surveys for priority sub-catchments. New surveys to include 1st and 2nd order streams.

Key Stakeholders: WICC, NGO's, DoW (supporting role), LGA's
Time period: Ongoing
Measurable Output: Implementation of existing stream foreshore survey report recommendations; Number of new foreshore surveys undertaken.
Priority: Medium

OBJECTIVE 11: MINIMISE NUTRIENT AND SEDIMENT LOSS FROM DRAINS IN FLOODPLAIN AND CATCHMENT AREA INTO INLET THROUGH STRATEGIC MANAGEMENT

Action 11.1

New drains connecting into the Water Corporation's drainage network should be designed to minimise the risk of nutrient and sediment export. Water Corporation has approval powers for all new drains connected to their drainage network. This approval will only be given for drains designed to minimise nutrient and sediment export.

Key Stakeholders: WC, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: All new drains connecting to WC drainage compliant
Priority: Medium

Action 11.2

Continue to incorporate Best Management Practices into drainage network to reduce sediment export. Constructed wetlands, recontouring and riffle work to be undertaken at new demonstration sites.

Key Stakeholders: WC, WICC, DoW (supporting role)
Time period: 2022
Measurable Output: Number of demonstration sites
Priority: Low

Action 11.3

In partnership with landowners, undertake works to minimise nutrient export from existing land uses in the Wilson Inlet floodplain. Source funding to facilitate works. Management plans and corrective work to be undertaken in partnership with industry and landowners.

Key Stakeholders: Industry, WICC
Time period: 2022
Measurable Output: Indication of changes in farming practices with new land use with less nutrient risk
Priority: High

Action 11.4

Land use planning strategies and approvals to recognise the importance of the Wilson Inlet floodplain, and ensure future development is compatible with conservation of the Inlet. New development should only be permitted within the floodplain if it can demonstrate no increase in nutrient release will occur, and the development is compatible with nutrient assimilation. Clearing of native vegetation within the floodplain should not generally be permitted. The floodplain should be shown in Regional and local Planning strategies as a Special Control Area in order to meet objectives.

Key Stakeholders: LGA's, DoP, DoW
Time period: Ongoing
Measurable Output: New Shire of Denmark and City of Albany's local Planning Strategies and Planning Schemes to contain Special Control Area for Inlet floodplain.
Priority: Medium

OBJECTIVE 12: PLAN FOR LONG TERM (100 YEAR) FUTURE PREDICTION OF 0.9M SEA LEVEL RISE

Action 12.1

Future LGA planning and infrastructure policies to continue to take into account long term sea level rise predictions. Current local government planning schemes/policies control development below 2.5m AHD. Any future amendments and changes to continue to take sea level rise predictions into account.

Key Stakeholders: Shire of Denmark, City of Albany
Time period: 2022
Measurable Output: Policies in place Albany and Denmark
Priority: Medium

7.1.4 URBAN SOURCES

The urban area of the Denmark town site occupies only 0.1% of the Inlet's catchment. While urban sources probably contribute only a small percentage of nutrients, modelling has indicated that, per hectare, this loss is greater than general rural areas. Septic tanks, urban stormwater and landfill are the main urban sources of nutrients. During the development of this Strategy, the Denmark Waste Water Treatment Plant, which is a point source of nutrient input, was still pumping treated effluent into the Inlet. Options for the treated waste water, including reuse, have been discussed by key stakeholders for a number of years, with the preferred option being to cease discharge of waste water into the Inlet.

Urban areas are also a source of sediment to the Inlet, have a high number of domestic animals which can predate on small native fauna and are a source of invasive weed species. Due to the urban area's close proximity to the Inlet "garden plant escapees" often find their way onto the Inlet's foreshore and into nearby vegetation, competing with native flora.

With increasing population in urban areas there is direct competition with the Inlet's ecosystem for water resources. New urban development to support the increasing population can lead to the loss of native remnant and riparian vegetation.

OBJECTIVE 13: REDUCE WATER USAGE BY HUMANS THROUGH INCREASED WATER EFFICIENCY PRACTICES AND APPLIANCES.

Action 13.1

Continue to promote water saving practices in urban areas, including planting of water efficient native plants, shorter showers etc. Source funding for workshops and to subsidise water efficient devices.

Key Stakeholders: LGA's, NGO's
Time period: Ongoing
Measurable Output: Number of workshops and information flyers developed. Number of workshop participants.
Priority: Medium

Action 13.2

New developments to include in their planning storm water harvesting and reuse designs including rainwater tanks.

Key Stakeholders: GA's, NGO's, WC, DoW, DoP, DoH
Time period: Ongoing
Measurable Output: Policies in place Albany, Denmark and Plantagenet
Priority: Medium

Action 13.3

Promote the retrofitting of water efficiency and recycling appliances to established properties. Follow on from Water Corporation's "water efficiency program". Promote new technologies as they become available.

Key Stakeholders: LGA's, WC
Time period: 2022
Measurable Output: Number of properties retrofitted
Priority: Medium

Action 13.4

Encourage the efficient use of water by industries located within the Wilson Inlet Catchment. Distribute informative material on best practice for water use to industries.

Key Stakeholders: Industry bodies, WICC, LGA's , DoW
Time period: 2022
Measurable Output: Number of industries implementing water efficiency techniques
Priority: Medium

OBJECTIVE 14: REDUCE NUTRIENT EXPORT INTO INLET FROM URBAN SOURCES, INCLUDING MANAGEMENT OF WASTE WATER.

Action 14.1

Water Corporation to commit to undertaking an environmental improvement plan looking into all possible options for Denmark treated waste water which will include reuse as the <u>preferred option</u> from key stakeholders including; Shire of Denmark, WICC and local community.

Key Stakeholders: WC, Shire of Denmark, DEC, DoW (supporting role)
Time period: 2014
Measurable Output: Water Corporation to have an Environmental Improvement Plan in place by 2014
Priority: High

Action 14.2

Water Corporation to commit to implementing the outcome(s) of the Environmental Improvement Plan within the life of the Strategy.

Key stakeholders: WC, Shire of Denmark, DEC, DoW (supporting role)
Time period: 2022
Measurable outputs: Outcomes of Environmental Improvement Plan implemented
Priority: High

Action 14.3

Key stakeholders to encourage and support Water Corporation to seek funding for improvements for reuse options. Key stakeholders to assist Water Corporations with joint funding applications and, where appropriate, provide letters of support.

Key Stakeholders: Shire of Denmark, DoW, WICC, WC
Time period: 2017
Measurable Output: Number of funding applications developed; Successful sourcing of funding
Priority: High

Action 14.4

Where available new residential developments will be expected to connect to sewers or appropriate self-contained facilities and should be located to accommodate this requirement.

Key Stakeholders: LGA's, DoH, WC, DoP
Time period: Ongoing
Measurable Output: New residential development connected to sewer or providing self-contained facilities.
Priority: Medium

Action 14.5

Increase connection to reticulated sewage in urban areas presently utilising on site effluent disposal systems in close proximity to Wilson Inlet.

Key Stakeholders: Denmark Shire, WC, DoP
Time period: Ongoing
Measurable Output: Reticulated sewage provided to targeted areas.
Priority: High

Action 14.6

Educational material to be provided highlighting the importance of urban stormwater and its impact on the Wilson Inlet.
Leaflets and letters are a means of communicating the role of urban stormwater management.

Key Stakeholders: WICC, DoW (supporting role)
Time period: 2017
Measurable Output: Educational materials developed and distributed
Priority: Medium

Action 14.7

Distribute educational material regarding the management of septic systems.
Prioritise areas close to the Wilson Inlet foreshore.

Key Stakeholders: LGA's, DoH
Time period: 2017
Measurable Output: Educational materials developed and distributed
Priority: Low

OBJECTIVE 15: MINIMISE IMPACT OF URBAN DEVELOPMENT ON REMAINING NATIVE VEGETATION AND FAUNA.

Action 15.1

The existence of native vegetation should be considered when future urban areas are identified in Planning Strategies, Structural Plans or Scheme Amendments. Measures for the retention and protection of existing native vegetation should be implemented. Development should be set back from foreshore and riparian vegetation, consistent with DoW guidelines. Management of riparian and foreshore areas should be undertaken in a manner sympathetic to vegetation retention and protection.

Key Stakeholders: LGA's, DoP
Time period: Ongoing
Measurable Output: Policies and strategies promoting protection of remnant vegetation in place for Albany, Denmark and Plantagenet local government areas
Priority: Medium

Action 15.2

Special Rural and Rural residential developments should be sited and designed to reduce the potential of nutrient loss and native fauna habitat loss.
Scheme provisions will be required to retain and protect existing native vegetation, fence and rehabilitate streamlines as per environmental codes of conduct, manage stormwater and effluent, set-back development from foreshore and streams and manage nutrient sources.

Key Stakeholders: LGA's, DoP, DoW, DEC
Time period: Ongoing
Measurable Output: Land capability study undertaken for each new Rural Residential development
Priority: High

OBJECTIVE 16 MAINTAIN AND ENHANCE NATIVE FLORA AND FAUNA BY MANAGING INVASIVE SPECIES, PATHOGENS AND DISEASE THROUGH EDUCATIONAL ACTIVITIES, TOOLS AND AWARENESS RAISING.

Action 16.1

Encourage local native flora species alternatives in urban gardens. Promote participation in the Waterwise garden scheme.

Key Stakeholders: LGA's, DWAG, Nursery and Garden Industry of Western Australia (NGIWA)
Time period: Ongoing
Measurable Output: Number of participants involved in the Waterwise program
Priority: Medium

Action 16.2

Undertake educational workshops on serious environmental weeds and methods for prevention and control. Focus on serious environmental weeds and garden escapees, their identification and control in urban and peri-urban areas. Educate public about the role and importance of native fauna and flora and how they are adversely impacted by invasive weed species.

Key Stakeholders: WICC, DWAG, LGA's (including through community groups), NGIWA
Time period: Ongoing
Measurable Output: Number of workshops held; Participant numbers and feedback
Priority: High

OBJECTIVE 17: REDUCE EXPOSURE OF POTENTIAL ACID SULFATE SOILS

Action 17.1

New developments in areas of moderate and high Acid Sulfate Soil (ASS) risk to undertake soil tests for ASS as part of planning approval process. Where possible, ASS should not be disturbed. ASS are benign when left in a waterlogged, undisturbed environment. Where development is deemed essential, ensure that strategies and management techniques are employed to mitigate potential adverse effects of acid sulfate soils for any development.

Key Stakeholders: LGA's, DEC, DoP
Time period: Ongoing
Measurable Output: Policies in place for Albany, Denmark and Plantagenet local government areas
Priority: High

7.1.5 CATCHMENT SUPPORTT

Natural Resource Management groups as well as individual landowners implement on ground works using funds from a range of sources. Maintaining Catchment Coordinators to facilitate the implementation of on-ground works is essential to the success of this Management Strategy. Through funding, natural resource management groups as well as individual landowners can continue to implement landcare initiatives and maintain momentum created through previous projects and strategies.

Better catchment management requires community understanding and support for changes in management and attitudes. Local and State Government agencies can assist not only by subsiding funds but also through providing technical expertise and assistance.

OBJECTIVE 18: PROVIDE SUPPORT FOR CATCHMENT GROUPS WORKING ON IMPLEMENTATION OF THE MANAGEMENT STRATEGY

Action 18.1

Maintain a Project Officer is a priority.

Seek funding to maintain the Project Officer position to coordinate and facilitate activities identified in these strategies and actions as well as collate progress of measurable outputs on an annual basis.

Key Stakeholders: SCNRM, WICC, DoW (supporting role)
Time period: Ongoing
Measurable Output: Employment secured for project officer
Priority: High

Action 18.2

Develop a Management Group to oversee the progress of the Management Strategy. Group to consist of representatives from key stakeholders. Group should meet twice a year or as necessary to discuss and collate progress of measurable outputs.

Key Stakeholders: SCNRM, WICC, DoW, LGA's, WC, DoF, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of meetings per year
Priority: High

Action 18.3

Lobby for external funds to implement catchment works recommended in the Management Strategy. Make joint applications for funding to assist catchment groups in delivering recommendations of the Management Strategy where works to be undertaken align with, and contribute to, outputs and outcomes that satisfy government organisations charters as specified in their strategic and operational plans

Key Stakeholders: SCNRM, WICC, DoW (supporting role), LGA's, NGO's, DAFWA (supporting role)
Time period: 2020
Measurable Output: Successful sourcing of funding
Priority: High

OBJECTIVE 19: ENCOURAGE AND EXPLORE FUTURE OPPORTUNITIES TO MAINTAIN RELEVANCE AND MOMENTUM OF THE MANAGEMENT STRATEGY

Action 19.1

Explore and exploit any new techniques and opportunities that fit the Management Strategy objectives and values.

Key Stakeholders: SCNRM, WICC, DOW (supporting role), LGA's, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of new techniques and opportunities developed
Priority: Medium

Action 19.2

Identify new stakeholders to assist in implementation of objectives and values of the Management Strategy. Key stakeholders to utilise opportunities as they arise to encourage new stakeholders to assist in implementation of objectives and values. This includes commercial companies where appropriate.

Key Stakeholders: SCNRM, WICC, DoW (supporting role), LGA's, DAFWA (supporting role)
Time period: Ongoing
Measurable Output: Number of new stakeholders engaged
Priority: Low

OBJECTIVE 20: IDENTIFY AND FILL GAPS IN STAKEHOLDER CAPACITY TO IMPLEMENT KEY WORKS OF THE MANAGEMENT STRATEGY

Action 20.1

Interagency meetings to discuss works undertaken from the Management Strategy and to identify gaps in capacity to undertake further works. Initial joint meeting to discuss current capacity and ascertain where gaps can be filled and where funding is required. Future meetings as required.

Key Stakeholders: All
Time period: 2020
Measurable Output: Number of Interagency meetings; Meeting minutes detailing actions and objectives.
Priority: Low

7.2 MANAGING THE INLET TO MINIMISE THREAT EFFECTS

It is considered that the Inlet's ability to process nutrients and buffer other threats will be assisted by controlling development, balancing recreational and commercial needs with the environmental needs and providing consistent bar openings with the EPA bar opening protocols, taking into account the multiple users requirements/needs.

The foreshore of the Wilson Inlet fulfils a number of roles for the values identified in this Management Strategy by providing habitat for native fauna, providing a vegetation buffer that protects soil from erosion and reduces sedimentation of the Inlet, protecting natural, cultural, heritage and landscape values of the area and providing opportunities for recreation and tourism.

The management of foreshore areas is covered within Wilson Inlet Foreshore Management Plan 2008, Wilson Inlet Community Cultural Management Project 2008, Wilson Inlet Foreshore Management Plan Hay River to Nullaki 2002. Actions and recommendations from these management plans are to be used in conjunction with Wilson Inlet Management Strategy.

7.2.1 REMOVAL OF RUPPIA AND ALGAE

The removal of organic material in Wilson Inlet is not considered a realistic management option, particularly as Ruppia plays an important role in cycling nutrients and providing food and habitat for a number of aquatic fauna and flora. Experience elsewhere has shown it to be costly and ineffective, as has mechanical removal of algae. The removal of Ruppia or algae that has washed up on shorelines may provide short-term benefits in terms of visual amenity, odour and boating access. Certain strategic places along the Inlet shoreline, e.g. Poddyshot, are of particular concern to local residents.

OBJECTIVE 21: MANAGEMENT OF ALGAE AND RUPPIA BUNDS AT PODDYSHOT AND OTHER SHORE LOCATIONS ALONG THE WILSON INLET.

Action 21.1

Continue to utilise agreement between the Denmark Shire and the Department of Water for removal of built up Ruppia and algal bund at Poddyshot and other shore locations within Shire of Denmark boundaries.

Ruppia and algal removal from shoreline to be undertaken where deemed appropriate as per the agreement.

Key Stakeholders: Denmark Shire, DoW
Time period: Ongoing
Measurable Output: Compliance with agreement for Denmark Shire
Priority: Low

7.2.2 PROTECTING AND RE-ESTABLISHING THE INLET'S FORESHORE VEGETATION

The fringing vegetation of the Inlet plays a number of important roles. It acts as a buffer, assists in the filtering of pollutants and nutrients, helps reduce bank erosion, provides habitat for native fauna and adds value to the visual amenity of the Inlet's landscape. Development around the Inlet and uncontrolled access to remaining healthy vegetation is placing pressure on the foreshore vegetation. In conjunction with recommendations from Foreshore Management Plans further actions have been included in this Management Strategy.

OBJECTIVE 22: MAINTAIN AND ENHANCE NATIVE VEGETATION AND FAUNA OF THE INLET AND SURROUNDING FORESHORE.

Action 22.1

Support compliance with National, State and Local legislation and LGA Bylaws regarding illegal clearing of native foreshore vegetation

Key Stakeholders: LGA's, DEC
Time period: Ongoing
Measurable Output: Policies in place for Albany and Denmark local government areas; Decrease in recorded incidences of illegal clearing.
Priority: Medium

Action 22.2

Encourage protection and enhancement of the Inlet's fringing native vegetation by promoting and raising awareness of the value of native vegetation. Use of educational material promoting the value of native foreshore vegetation

Key Stakeholders: LGA's, DEC, WICC
Time period: 2017
Measurable Output: Number of flyers distributed; Feedback response
Priority: Medium

Action 22.3

Strategically manage foreshore reserve to conserve areas where cultural heritage sites have been identified in Foreshore Management Plans and Wilson Inlet Cultural Management Plan. Support and follow recommendations as per Management Plans.

Key Stakeholders: LGA's DEC, DIA, Albany Heritage Reference Group Aboriginal Corporation, Minang and Pibulmun Elders, SWLASC (South West Land and Sea Council), SCNRM
Time period: Ongoing
Measurable Output: Areas of reserves where sites located protected
Priority: High

Action 22.4

Strategically manage foreshore vegetation with an appropriate fire management plan to conserve native flora while reducing risk of wildfire to community members and infrastructure. Refer to recommendations from the Foreshore Management Plans and the Denmark Foreshore Fire Management Plan.

Key Stakeholders: LGA's DEC, FESA
Time period: Ongoing
Measurable Output: Recommendations followed and undertaken as per Management Plans
Priority: Medium

7.2.3 MANAGING PATHOGENS AND THEIR SOURCES IN THE WILSON INLET

Certain species of pathogen at high levels can have detrimental effects to native flora and fauna as well as pose a threat to the community members. In the past, bacteria monitoring at certain sites within the Inlet have shown levels which are above Department of Environment guidelines. Management, monitoring and quick response for pathogens within the Inlet will help ensure that the threat is minimised.

OBJECTIVE 23: REDUCE POTENTIAL INCIDENCES OF HARMFUL PATHOGENS ENTERING THE INLET AND MANAGE KEY LOCATIONS.

Action 23.1

Maintain Denmark Waste Water Treatment Plant outflow area to allow pedestrian access for visual assessment and monitoring to be undertaken. Area surrounding outflow pipe to be maintained to allow pedestrian access for monitoring and visual assessment of area. Care should be taken to minimise disturbance to native vegetation, particularly the fringing riparian vegetation.

Key Stakeholders: Denmark Shire, WC
Time period: Ongoing
Measurable output: Outflow area visible with easy pedestrian access for sampling
Priority: Medium

Action 23.2

Encourage appropriate monitoring program for Denmark Water Waste Water Treatment Plant and along outfall pipe. This could include remote monitoring as an efficient way of monitoring and to enable quick response.

Key Stakeholders: Denmark Shire, WC, DEC
Time period: 014
Measurable output: A regular monitoring program in place with an annual report
Priority: High

Action 23.3

Encourage the Water Corporation to develop a remediation strategy for the outflow area of the Denmark Waste Water Treatment Plant. This includes a region extending approximately 100-200m distance from the outfall into the Wilson Inlet. In conjunction with other key stakeholders.

Key Stakeholders: Denmark Shire, DEC, WC
Time period: 2015
Measurable output: Remediation strategy in progress by 2015
Priority: High

Action 23.4:

Regular bacterial monitoring at major stormwater outlets and key recreational sites, particularly where there is primary contact with water along the Wilson Inlet foreshore. Obtain funding to assist monitoring. Monitoring and analysis of results to be undertaken in accordance to NHMRC, 2008 Guidelines for Managing Risks in Recreational Water. Bacterial monitoring should include: enterococci, presumptive thermotolerant coliforms and E.coli.

Key Stakeholders: Denmark Shire, DoH
Time period: Ongoing
Measurable output: A regular, on-going monitoring bacterial program and an annual report
Priority: High

7.2.4 SANDBAR OPENINGS

The Wilson Inlet sand bar has been artificially breached each winter since the 1920's to reduce flooding in low lying areas around the Inlet. The bar was not opened however in 2007 and 2010 due to low rainfall and water levels in the Inlet. The bar is completely blocked usually between July and February. There are four drivers of water exchange and sand movement in Wilson Inlet that include rainfall, runoff or river flow, wind conditions over the inlet as well as ocean wave conditions and sea level conditions at the mouth of the Inlet. The great range of natural variability in these drivers influences the degree of marine exchange between years. A difference between barometric pressures, for example, and the number of low pressure systems between years plays a large part in the volume of water exchange between the Inlet and ocean. The bar naturally builds and erodes and the degree of scouring is influenced by the mean sea level at opening, the build up of sand from previous openings and river flow following the opening.

Artificial breaching of the sandbar has occurred in various locations with most recent openings located within 100m of the western cliffs. Through the drainage review process a "Bar opening tool" has been developed which outlines timing of the bar opening. Considerations that have been taken into account include:

- nutrient management
- marine exchange
- impact of low and high water dependent ecosystems e.g. shorebirds, marine fish/crustacean recruitment, Inlet fish spawning and migration and riparian vegetation.
- impact of low and high water level on activity in Drainage district

Research undertaken by the Department of Water indicates most nutrients are not lost out through the sandbar but are taken up in seagrass, algae or sediment, or lost through a variety of processes to the atmosphere. Sea water intrusions vary greatly from year to year, based on natural processes including sea level, magnitude of astronomical and barometric tides and amount of river flow.

The review of the Drainage Management Plan (2009) takes account of the social, environmental and economic impacts and implications of the bar opening decision on a range of stakeholders, statutory obligations, and which options seek to minimise adverse impacts resulting from the decision. However the topic of where to breach the sand bar is not covered in this review. There is still contention over the exact location of the bar opening with pros and cons to community values for both eastern and western openings. Currently, the Shire of Denmark determines the location of the opening, based on community interest. Community input may be formally provided through the Shire in deciding the location of the sandbar opening. The Shire, Department of Water and Water Corporation make the final decision on the timing of the opening using the bar opening tool. See appendix 9.2.

OBJECTIVE 24: BALANCE ENVIRONMENTAL, COMMUNITY AND COMMERCIAL VALUES OF THE INLET.

Action 24.1

Continue to artificially breach sandbar according to bar opening protocols.
Key Stakeholders: EPA, Shire of Denmark, WC, DoW
Time period: Ongoing
Measurable Output: Number of years that bar opening protocol is followed; Feedback response
Priority: High

Action 24.2

When Bar opening protocols are reviewed, consideration should be given to the effects of timing and placement of bar opening on fauna, flora, recreational and commercial users.
Key Stakeholders: EPA, Shire of Denmark, DoW, WC, DEC
Time period: Ongoing
Measurable Output: Review of bar opening protocols undertaken
Priority: High

Action 24.3

Monitor sand accumulation at the Inlet mouth. Cost effective monitoring may include aerial photographs.
Key Stakeholders: Local community, DoW (supporting role)
Time period: Ongoing
Measurable Output: Photographic records kept of Inlet data
Priority: Low

7.2.5 DREDGING OF CHANNELS THROUGH INLET DELTA

Various proposals for dredged channels have been put forward to 'flush' Wilson Inlet, to reduce nutrient and sediment build-up, or restore historical channels in the Inlet.
Hydraulic modelling has indicated minor dredging of the Inlet's existing delta, at key 'pinch points', would provide the greatest increase in water exchange for the lowest cost and allow the risks to be managed. Such work could be used to evaluate the benefits of future dredging.

Any dredging has financial costs associated with it and has a risk of environmental damage. There is a presumption against dredging of estuaries without benefits being demonstrated.

Community support is divided on the need for dredging or any particular dredging option.

OBJECTIVE 25: WHERE APPROPRIATE PROVIDE OPPORTUNITY FOR DREDGING TO ENHANCE WATER FLOW AND WATER QUALITY.

Action 25.1

Dredging in the Wilson Inlet to enhance water flow and water quality to be limited to works to the existing channel. Such works to be guided by the hydraulic modelling undertaken. A survey of the channel needs to be undertaken prior to any dredging, to establish whether deepening is already occurring as a consequence of recent regular western openings. Any dredging is dependent on community support (as reflected by the Shire of Denmark) and approval from Department of Water.
Key Stakeholder: Shire of Denmark, DoW.
Time Period: Ongoing.
Measurable Output: Any dredging to be limited to works as described.
Priority: Low

7.2.6 MITIGATION STRATEGIES ON THE IMPACT OF CLIMATE CHANGE AND VARIABILITY ON THE INLET

Future predictions indicate cold pressure cells are moving south, which in turn has the potential for increased storm surges along the South Coast including Ocean Beach. Climate change predictions need to be observed carefully, keeping in mind that as new information comes to light the predictions can alter and mitigation strategies need to factor this in and allow for continual reviews and adjustments.

OBJECTIVE 26: DEVELOP MITIGATION STRATEGIES TO MINIMIZE THE IMPACT OF CLIMATE CHANGE AND VARIABILITY ON THE INLET

Action 26.1

Use current and developing scientific knowledge and predictive modelling to improve planning for potential impacts on Inlet and system processes. Source funding for a project officer or CENRM student to collate data on future climatic changes that have the potential to affect the Wilson Inlet and research any current management tools that can be utilised to mitigate any detrimental impacts of the climatic changes.

Key Stakeholders: CENRM, CSIRO
Time period: 2017
Measurable Output: Number of projects undertaken
Priority: Medium

Action 26.2

Plan accordingly for potential impacts of predicted climate change e.g. development set backs for mitigating storm surges should be incorporated into future planning schemes and policies.

Key Stakeholders: LGA's, DoP
Time period: Ongoing
Measurable Output: Policies in place for Albany and Denmark local government areas
Priority: Medium

7.2.7 EDUCATION ON SYSTEM PROCESSES WITHIN THE WILSON INLET

The Wilson Inlet is a complex system, humans, other living organisms and inert compounds are linked through a series of system processes. Understanding these processes and interactions is vital to maintaining the ecological health of the Inlet.

OBJECTIVE 27: EDUCATE COMMUNITY ABOUT SYSTEM PROCESSES OF THE WILSON INLET AND HOW VALUES ARE INTERLINKED AND ASSOCIATED WITHIN THE SYSTEM PROCESS

Action 27.1

Circulate conceptual models linking processes and values. Obtain funding and approach a student from CENRM to develop models for community education that follow principles of transformational learning.

Key Stakeholders: CENRM, WICC, NGO's, SCNRM, DoW (supporting role)
Time period: 2017
Measurable Output: Number of conceptual models developed
Priority: Medium

Action 27.2

Undertake educational activities to improve community understanding of the Wilson Inlet Catchment, nutrient sources, their management and the environmental needs of native flora and fauna.

Key Stakeholders: WICC, LGA's, DAFWA (supporting role), SCNRM, DoW (supporting Role)
Time period: 2022
Measurable Output: Number of activities undertaken and number of participants involved
Priority: High

7.3 MONITORING AND REPORTING TO GUIDE, MODIFY AND ENHANCE THE EFFECTIVENESS OF MANAGEMENT STRATEGIES.

Monitoring is required to assess the Inlet's ecological health. Changes in environmental trends can take a long time to express. A priority is ensuring information is collected with consistent, robust methods, with results on the condition of the Inlet reported to the community in a form that best suits their needs. When analysing water samples, ANZECC water quality guidelines should continue to be used to assist in assessing the ecological health of the Inlet. National Health and Medical Research Council (NHMRC) 2008, "Guidelines for Managing Risks in Recreational Water" should also be utilised for monitoring bacterial water quality.

OBJECTIVE 28: MONITOR AND REPORT ON NUTRIENT MANAGEMENT TO MEASURE CHANGES AND GAUGE EFFECTIVENESS OF ON-GROUND ACTIVITIES

Action 28.1

Source funding and continue to monitor the Wilson Inlet to measure changes in its condition and provide annual reports to the community. Monitoring to directly relate to indicators of eutrophic conditions and to detect any deterioration in the Inlet's condition. DoW (2012) do not currently have funding for nutrients sampling in the Inlet. Nutrient monitoring stopped at the end of 2011.Physical profiles (all 2012 sites) and phytoplankton as well as chlorophyll a at 2 sites are sampled on a monthly to 2 monthly basis. Sourcing funding to boost the current monitoring program is important. Pending funding capacity, factors to be monitored include the duration and extent of anoxic events, inlet nutrient levels in spring and summer, algal bloom frequency and duration, extent of Ruppia, occurrence of harmful phytoplankton species and macroalgae abundance. Community involvement in monitoring is desired, including involvement of local residents and commercial fishers. Annual reports to be written along with results displayed in web sites.

Key Stakeholders: DoW, LGA's
Time period: Ongoing
Measurable Output: Monitoring and Analysis undertaken pending funding; Annual report to community
Priority: High

Action 28.2

Survey soil heath workshop participants on an annual basis for 3 years to ascertain if soil tests have been undertaken and if soil test analysis results have been applied.

Key Stakeholders: ...DAFWA (supporting role), WICC
Time period: 2017
Measurable Output: Number of participants surveyed; Number of soil test analysis results applied.
Priority: High

Action 28.3

River nutrient loadings into the Wilson Inlet to be monitored as well as other indicators of river health. Pending funding capacity present monitoring of nutrient concentrations and loads to be continued to establish trends over time and flow. Other monitoring, for example macroinvertebrates could be monitored as indicators of river health.

Key Stakeholders: DoW
Time period: Ongoing
Measurable Output: Monitoring undertaken; Annual reports on nutrient inputs compiled; Analysis of trends in nutrient concentrations made and reported at least every 3 years.
Priority: Medium

OBJECTIVE 29: MONITOR NATIVE VEGETATION AND FAUNA OF THE INLET AND SURROUNDING LANDSCAPE TO MEASURE CHANGES

Action 29.1

Undertake annual photographing of the Inlet foreshore vegetation, following on from the 2011 survey to ascertain if illegal foreshore vegetation clearing is occurring and to what extent. Where changes have been identified follow up with ground truthing and visual assessment. Source funding to allow photographs to be taken on an annual basis.

Key Stakeholders: LGA's, WICC, SCNRM
Time period: Ongoing
Measurable Output: Annual photographs taken; Area of foreshore native vegetation in the same condition as 2011 or better
Priority: Low

Action 29.2

River restoration projects to be recorded, mapped and reported to the community. Fencing and restoration projects need to be mapped and maintained in a Geographical Information System. Appropriate photographic records of sites to be kept.

Key Stakeholders: WICC, DoW (Supporting role), SCNRM, Green Skills
Time period: Ongoing
Measurable Output: Number of projects mapped and photographed; Reports to the community
Priority: High

Action 29.3

Source funding to continue surveying flora and fauna within the Inlet and along foreshore. To gauge the health of the Inlet's native flora and fauna, ongoing monitoring over a number of years is required to ascertain patterns and trends. This includes continuing macroinvertebrate sampling undertaken in 2011 and 2012 as well as flora surveys of Inlet foreshore vegetation undertaken in 2011.

Key Stakeholders: CENRM, Denmark Environment Centre, WICC, LGA's
Time period: Ongoing
Measurable Output: Number of funded projects undertaken
Priority: Medium

Action 29.4

Source funding for Project Officer to collate measurable outcomes annually. Project Officer to collate progress for all measurable outcomes of Management Strategy into a brief report which will be circulated to key stakeholders and made available for community members.

Key Stakeholders: WICC, DoW (supporting role), SCNRM,
Time period: 2014
Measurable Output: Outputs and outcomes recorded and collated each year over the span of the Management Strategy.
Priority: Medium

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13.3	Promote the retrofitting of water efficiency and recycling appliances to established properties	34
13.4	Encourage the efficient use of water by industries located within the Wilson Inlet Catchment.	34
14: REDUCE NUTRIENT EXPORT INTO THE INLET FROM URBAN SOURCES; INCLUDING MANAGEMENT OF WASTE WATER.		
14.1	Water Corporation to commit undertaking an environmental improvement plan looking into all possible options for Denmark treated waste water which will include reuse as the preferred option from key stakeholders including; Shire of Denmark, WICC and local community.	34
14.2	Water Corporation to commit to implementing the outcome(s) of the Environmental Improvement Plan within the life of the Strategy.	34
14.3	Key stakeholders to encourage and support the Water Corporation to seek funding for improvements for reuse options.	34
14.4	Where available new residential development will be expected to connect to sewer or appropriate self-contained facilities, and should be located to accommodate this requirement.	35
14.5	Increase connection to reticulated sewage in urban areas presently utilising on site effluent disposal systems in close proximity to Wilson Inlet.	35
14.6	Educational material to be provided highlighting the importance of urban stormwater and its impact on the Wilson Inlet	35
14.7	Distribute educational material regarding the management of septic systems.	35
15: MINIMISE IMPACT OF URBAN DEVELOPMENT ON REMAINING NATIVE VEGETATION AND FAUNA.		
15.1	The existence of native vegetation should be considered when future urban areas are identified in Planning Strategies, Structural Plans or Scheme Amendments.	35
15.2	Special Rural and Rural residential developments should be sited and designed to reduce the potential of nutrient loss and native fauna habitat loss.	35
16 MAINTAIN AND ENHANCE NATIVE FLORA AND FAUNA BY MANAGING INVASIVE SPECIES, PATHOGENS AND DISEASE THROUGH EDUCATIONAL ACTIVITIES, TOOLS AND AWARENESS RAISING.		
16.1	Encourage local native flora species alternatives in urban gardens.	36
16.2	Undertake educational workshops on serious environmental weeds and methods for prevention and control.	36
17: REDUCE EXPOSURE OF POTENTIAL ACID SULFATE SOILS.		
17.1	New developments in areas of moderate and high Acid Sulfate Soil (ASS) risk to undertake soil tests for ASS as part of planning approval process.	36

ACTION	OBJECTIVES	PAGE
18: PROVIDE SUPPORT FOR CATCHMENT GROUPS WORKING ON IMPLEMENTATION OF THE MANAGEMENT STRATEGY.		
18.1	Maintaining a Project Officer is a priority.	36
18.2	Develop a Management Group to oversee the progress of the Management Strategy.	37
18.3	Lobby for external funds to implement catchment works recommended in the Management strategy.	37
19: ENCOURAGE AND EXPLORE FUTURE OPPORTUNITIES TO MAINTAIN RELEVANCE AND MOMENTUM OF THE MANAGEMENT STRATEGY		
19.1	Explore and exploit any new techniques and opportunities that fit the Management Strategy objectives and values.	37
19.2	Identify new stakeholders to assist in implementation of objectives and values of the Management Strategy.	37
20: IDENTIFY AND FILL GAPS IN STAKEHOLDER CAPACITY TO IMPLEMENT KEY WORKS OF THE MANAGEMENT STRATEGY.		
20.1	Interagency meetings to discuss works undertaken from the Management Strategy and to identify gaps in capacity to undertake further works.	37
21: MANAGEMENT OF ALGAE AND RUPPIA BUNDS AT PODDYSHOT AND OTHER SHORE LOCATIONS ALONG THE WILSON INLET.		
21.1	Continue to utilise agreement between the Denmark Shire and the Department of Water for removal of built up Ruppia and algal bund at Poddyshot and other shore locations within Shire of Denmark boundaries	38
22: MAINTAIN AND ENHANCE NATIVE VEGETATION AND FAUNA OF THE INLET AND SURROUNDING FORESHORE.		
22.1	Support compliance with National, State and Local legislation and LGA Bylaws regarding illegal clearing of native foreshore vegetation.	38
22.2	Encourage protection and enhancement of the Inlet's fringing native vegetation by promoting and raising awareness of the value of native vegetation	39
22.3	Strategically manage foreshore reserve to conserve areas where cultural heritage sites have been identified in the Foreshore Management Plans and the Wilson Inlet Cultural Management Plan.	39
22.4	Strategically manage foreshore vegetation with an appropriate fire management plan to conserve native flora while reducing risk of wildfire to community members and infrastructure.	39
23: REDUCE POTENTIAL INCIDENCES OF HARMFUL PATHOGENS ENTERING THE INLET AND MANAGE KEY LOCATIONS.		
23.1	Maintain Denmark Waste Water Treatment Plant outflow area to allow pedestrian access for visual assessment and monitoring to be undertaken.	39
23.2	Encourage appropriate monitoring program for Denmark Water Waste Water Treatment Plant and along outfall pipe.	39
23.3	Encourage the development of a remediation strategy by the Water Corporation for the outflow area of the Denmark Waste Water Treatment Plant.	40
23.4	Regular bacterial monitoring at major stormwater outlets and key recreational sites, particularly where there is primary contact with water along the Wilson Inlet foreshore.	40
24: BALANCE ENVIRONMENTAL, COMMUNITY AND COMMERCIAL VALUES OF THE INLET.		
24.1	Continue to artificially breach sandbar according to bar opening protocols.	41
24.2	When bar opening protocols are reviewed, consideration should be given to the effects of timing and placement of bar opening on fauna, flora, recreational and commercial users.	41

ACTION	OBJECTIVES	PAGE
24.3	Monitor sand accumulation at Inlet mouth.	**41**
25: WHERE APPROPRIATE PROVIDE OPPORTUNITY FOR DREDGING TO ENHANCE WATER FLOW AND WATER QUALITY.		
25.1	Dredging in the Wilson Inlet to enhance water flow and water quality to be limited to works to the existing channel.	**41**
26: DEVELOP MITIGATION STRATEGIES TO MINIMIZE THE IMPACT OF CLIMATE CHANGE AND VARIABILITY ON THE INLET		
26.1	Use current scientific knowledge/ predictions to improve planning for potential impacts on Inlet and system processes.	**42**
26.2	Plan accordingly for potential impacts of predicted climate change	**42**
27: EDUCATE COMMUNITY ABOUT SYSTEM PROCESSES OF THE WILSON INLET AND HOW VALUES ARE INTERLINKED AND ASSOCIATED WITHIN THE SYSTEM PROCESS.		
27.1	Circulate conceptual models linking processes and values	**42**
27.2	Undertake educational activities to improve community understanding of the Wilson Inlet Catchment, nutrient sources, their management and environmental needs of native flora and fauna.	**42**
28: MONITOR AND REPORT ON NUTRIENT MANAGEMENT TO MEASURE CHANGES AND GAUGE EFFECTIVENESS OF ON-GROUND ACTIVITIES.		
28.1	Continue to monitor the Wilson Inlet to measure changes in its condition.	**43**
28.2	Survey soil heath workshop participants on an annual basis for 3 years to ascertain if soil tests have been undertaken and if soil test analysis results have been applied.	**43**
28.3	River nutrient loadings into the Wilson Inlet to be monitored as well as other indicators of river health.	**43**
29: MONITOR NATIVE VEGETATION AND FAUNA OF THE INLET AND SURROUNDING LANDSCAPE TO MEASURE CHANGES.		
29.1	Undertake annual photographing of Inlet foreshore vegetation, following on from the 2011 survey to ascertain if illegal foreshore vegetation clearing is occurring and to what extent.	**43**
29.2	River restoration projects to be recorded, mapped and reported to the community.	**44**
29.3	Source funding to continue surveying flora and fauna within the Inlet and along foreshore.	**44**
29.4	Source funding for Project Officer to collate measurable outcomes annually.	**44**

9 GLOSSARY

Anoxic ....Lack or absence of oxygen

Benthic...............................Close to or in the sediments

Key stakeholders ....Are those organisations that are influential or will directly impact on the actions contained in the Management Strategy. Without the support of these groups, the objectives/actions would be unlikely to succeed.

Ecosystem Health ....Refers to the maintenance of the ecosystem's integrity in terms of structure (e.g. biodiversity, biomass, and abundance of biota) and function (e.g. food chains and nutrient cycles).

Epiphyte ....A plant that lives by growing on another plant, but does not take nutrients directly from that plant like a parasite does.

Eutrophication ....The process of increasing nutrient enrichment in a waterway. Eutrophication is a natural process but is accelerated by human activities.

Relictua ....A group of animals or plants that exists as a remnant of a formerly widely distributed group in an environment different from that in which it originated. A persistent, isolated remnant of a once-abundant species.

Riparian vegetation.............Vegetation growing along banks of waterbodies.

Stratification.......................Formation of layers in a body of water.

Senescence ....The seasonal die off of plants in response to changing seasonal factors such as water temperature or light.

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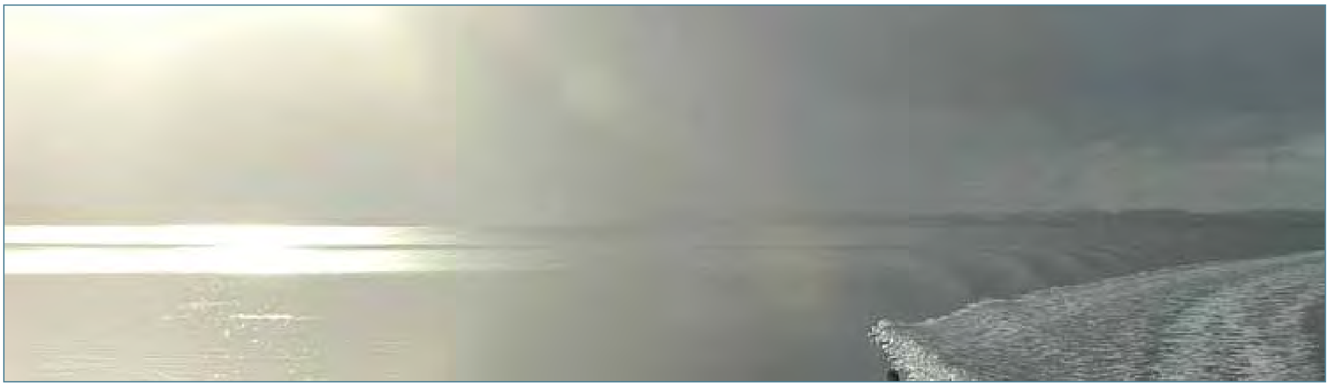


11 APPENDICES

11.1 ANALYSIS OF WILSON INLET WATER QUALITY 2005 - 2011

Summary of Wilson Inlet and Catchment water quality, 2005-2011
Compiled by the Department of Water, South Coast Region, 2012

SUMMARY OF WILSON INLET AND CATCHMENT WATER QUALITY

This summary report is provided to assist the Wilson Inlet Catchment Committee (WICC) to review the Wilson Inlet Nutrient Reduction Plan with particular focus on the following water quality improvement actions:

Action M1: Monitoring of Wilson Inlet to be continued to objectively measure changes in its condition. Monitoring to directly relate to indicators of eutrophic conditions and to detect any deterioration in its condition. Factors to be monitored include increase in duration and extent of anoxic events, inlet nutrient levels in spring and summer, algal bloom frequency and duration, extent of Ruppia, increased occurrence of harmful phytoplankton species, increase in macroalgae abundance.

Action M4: River nutrient loadings into Wilson Inlet to be monitored as well as other indicators of river health. Present monitoring of nutrient concentrations and loads to be continued to establish trends over time and flow conditions. Other monitoring, for example of macroinvertebrates, to be used to monitor river health compared with nutrient levels. (WRC- ongoing).

Action M5: Implement monitoring programs to identify localised sources of nutrients at the sub-catchment scale within priority catchments. Priority catchments are Sunny Glen, Cuppup, Sleeman and Lake Sadie. Monitoring results to be mapped and used to guide management actions. (WRC – 2 years).

Action M1: Water quality monitoring in Wilson Inlet commenced in 1995 with the aim to understand the dynamics within the system and to monitor any changes in water quality over the years. Chemical (nutrients and chlorophyll a), physical (including oxygen and salinity) and biological information were collected at a number of sites throughout the Inlet on a fortnightly to monthly basis.

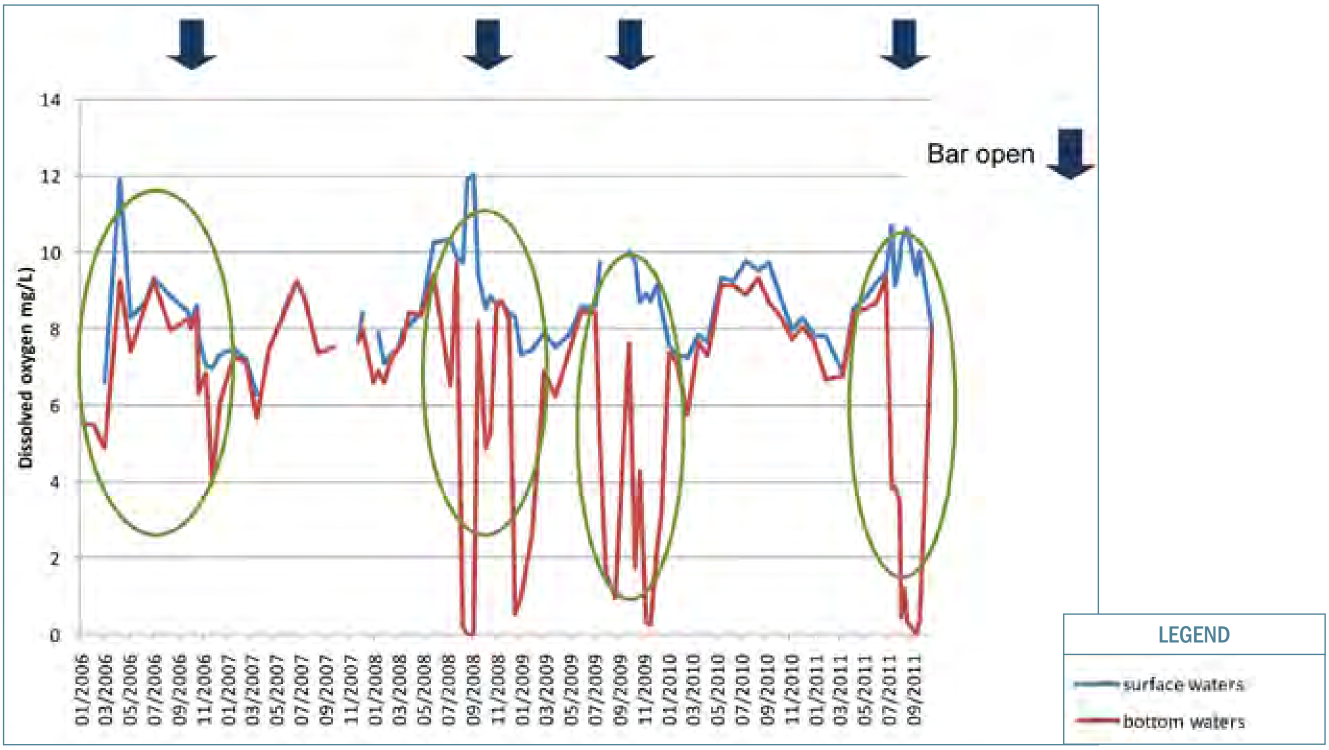
To describe the characteristics of the Inlet and determine any changes or deterioration in the Inlet condition over the years this section provides a summary of water quality data in Wilson Inlet from 2006 to 2011. Comparisons between water quality reporting in Wilson Inlet Report to the Community (no. 5) 1995 to 2002 and Wilson Inlet Report to the Community (no. 9) 2002 to 2006 will be made where possible. Information is compared between site 12 situated in the basin near the Hay and Sleeman Rivers and site 6 situated opposite the Denmark River. These sites were chosen as they have consistent long term records and are reflective of the two main basins within the Inlet.

1A. ANOXIC EVENTS

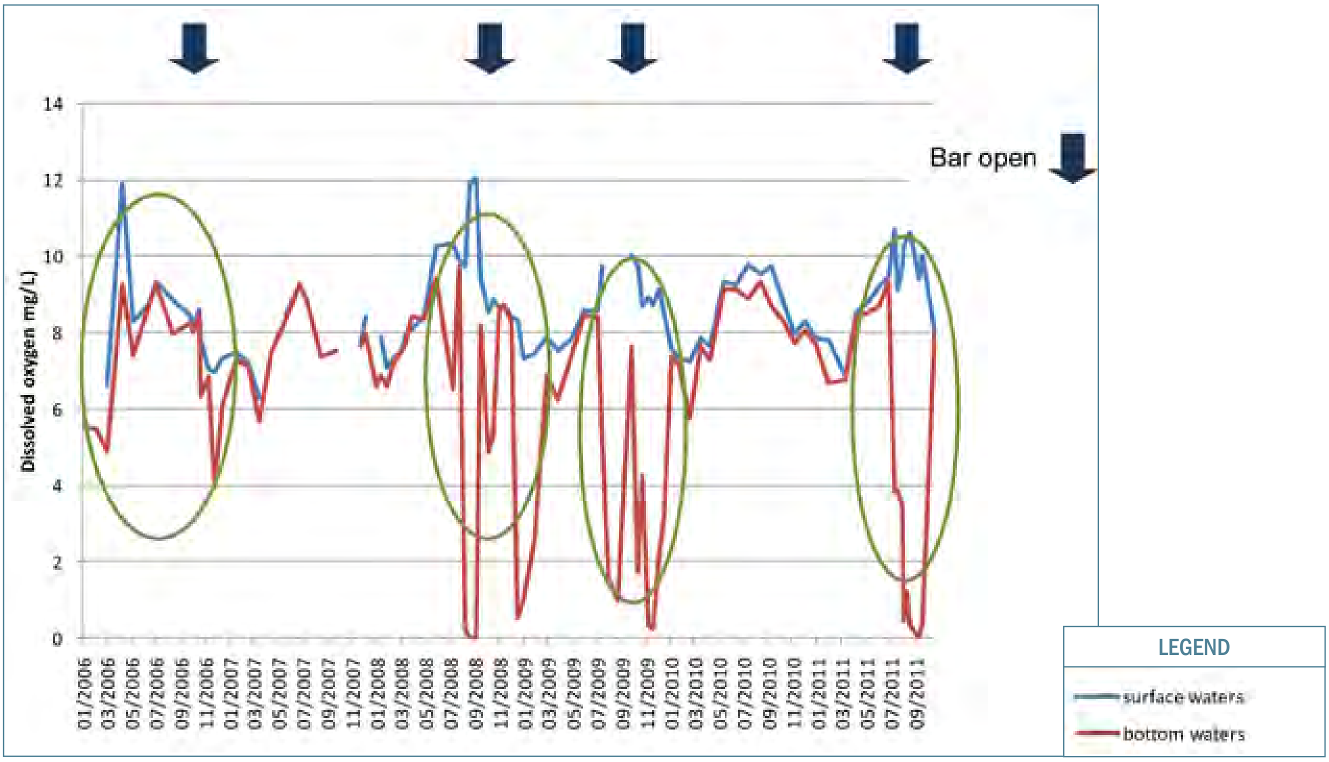
A clear pattern has emerged over the years in relation to oxygen concentrations in the Inlet. Surface waters remain well oxygenated throughout the year which is consistent to what was reported in previous reports to the community.

Bottom water oxygen concentrations show a consistent trend over the years. Conditions remained well oxygenated except during the sand bar opening period when there is the presence of a salt wedge or salinity stratification. During this time there is poor exchange of oxygen between fresher layers and heavier salty bottom waters creating anoxic conditions.

Surface water oxygen concentrations ranged between 8 to>10mg/L and bottom waters ranging between 0mg/L -10mg/L. It appears the longer the bar opening period the greater the number of anoxic episodes. This was observed in 2003 and 2005 as well as 2008 and 2009. The sand bar was not opened in 2007 and 2010 and during these years the Inlet remained well oxygenated in both surface and bottom waters due to the lack of stratification.



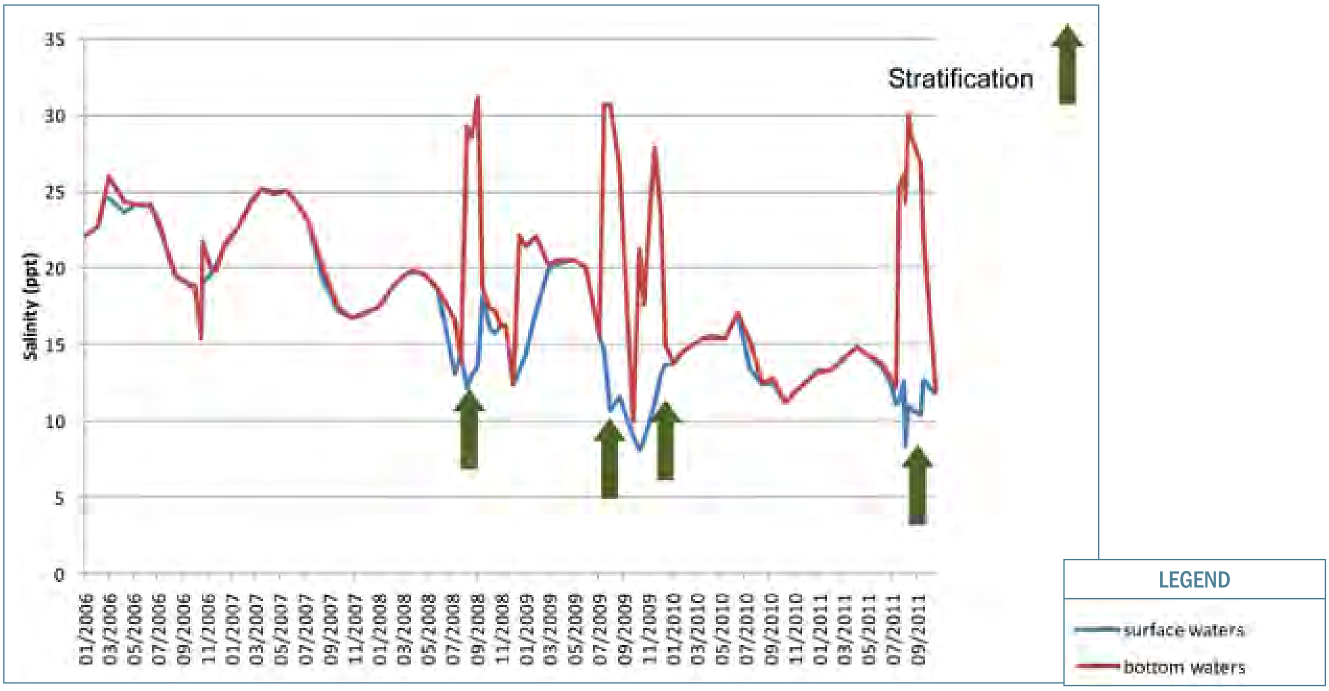
Dissolved oxygen (mg/L) site 6



Dissolved oxygen (mg/L) site 12

SALINITY

From 2006 to 2011 salinities ranged between 8.06 to 31.25ppts and salinities ranged between 4 and 35ppt between 2002 and 2006. Salinities reduce when the bar is closed and there are fresh inflows from the catchment during the winter months. During this time the Inlet is well mixed and surface and bottom salinities are similar. Once the sand bar is open the surface and bottom salinities diverge due to inflow of seawater and stratification. This is consistent with the pattern that has been occurring since monitoring began in 1995. The lack of difference between surface and bottom waters in 2006 may relate to the late bar opening and early closure. During September 2009 surface and bottom water salinities at site 6 were similar which relates to high rainfall and catchment inflows. Stratification returned in November as a result of low rainfall and the dominance of tidal exchange. It is also interesting to note that following the sand bar opening in 2011 there was little divergence between surface and bottom waters at site 12 indicating the seawater may not have reached the upper end of the Inlet that year in contrast to site 6 in the lower part of the Inlet where there was strong stratification.



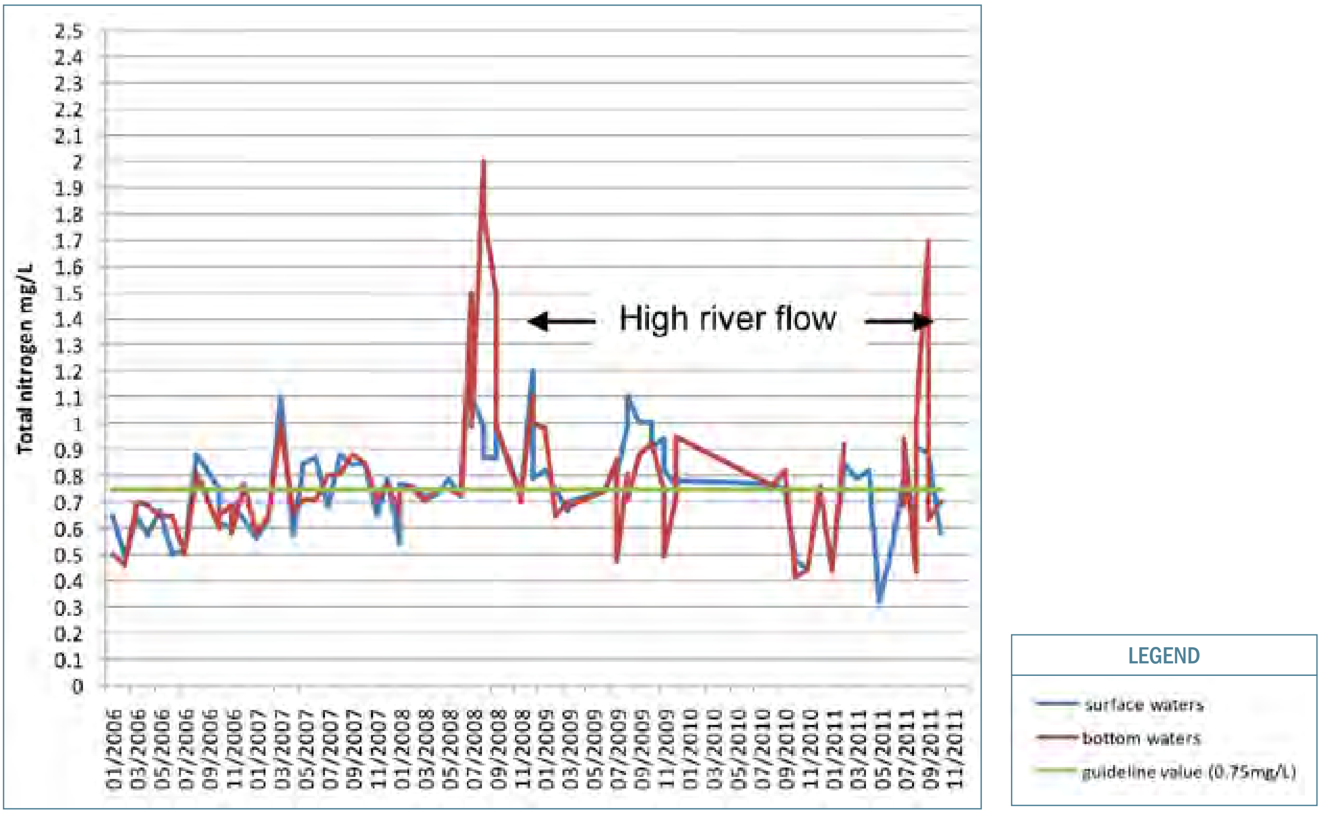
Salinity (ppt) site 6 2006-2011

Salinity (ppt) site 12 2006-2011

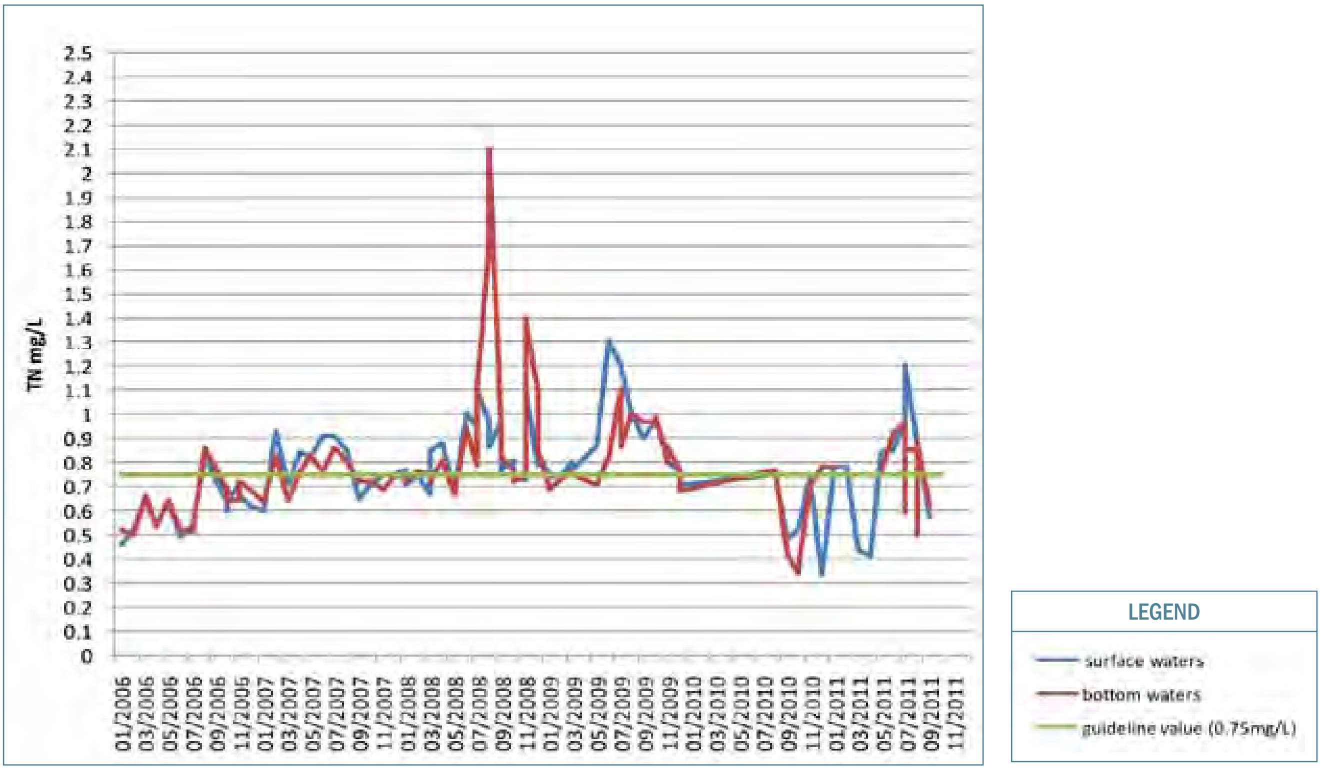
NUTRIENT CONCENTRATIONS

2006 to 2011 nutrient data showed similar characteristics to the previous years within the Inlet. All available nutrient components generally remain low throughout all years which may reflect the rapid biological uptake by plants and algae. Maximum and minimum nutrient concentrations were similar between the various reporting periods at the two sites. The maximum Soluble Reactive Phosphorus was however elevated during the 2006-2011 reporting period compared to other years.

Increases in total nitrogen correspond with ammonium release from the sediments as well as during times of elevated total oxidised nitrogen which is derived from the catchments. For most of the year, available nutrient components make up a small part of the total nitrogen and as indicated in previous reports. Most of the nitrogen is likely to be in the form of dissolved organic nitrogen or trapped in phytoplankton as particulate organic nitrogen which is not immediately available for uptake.

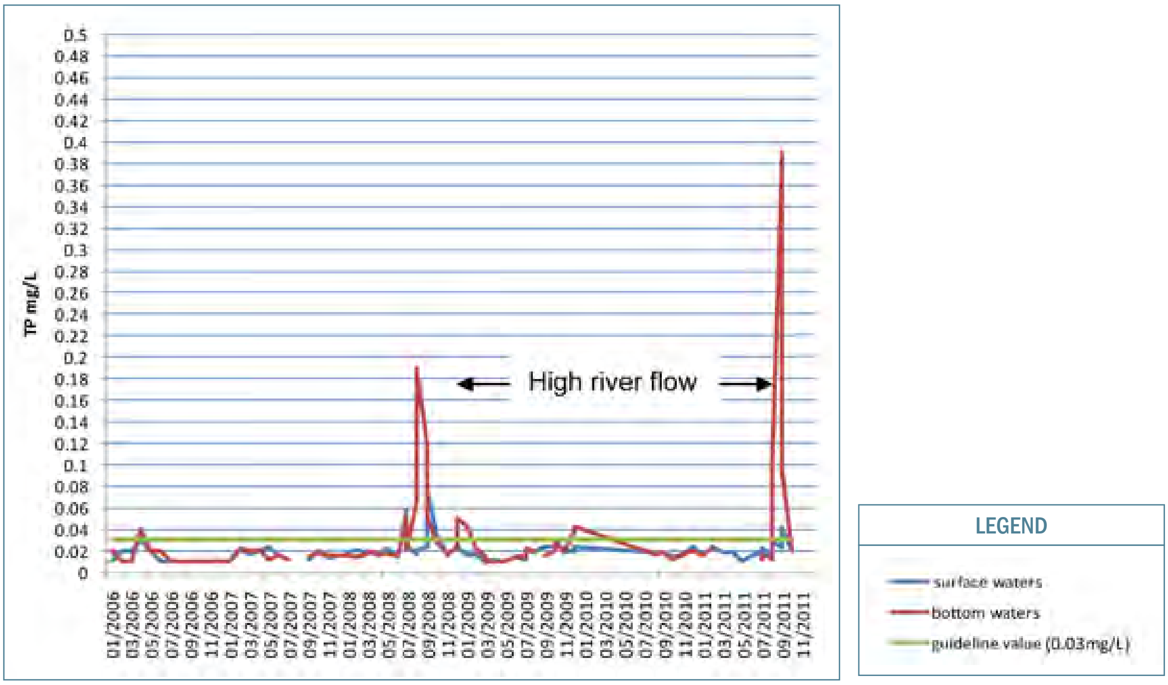


Total Nitrogen (mg/L) site 6 2006-2011

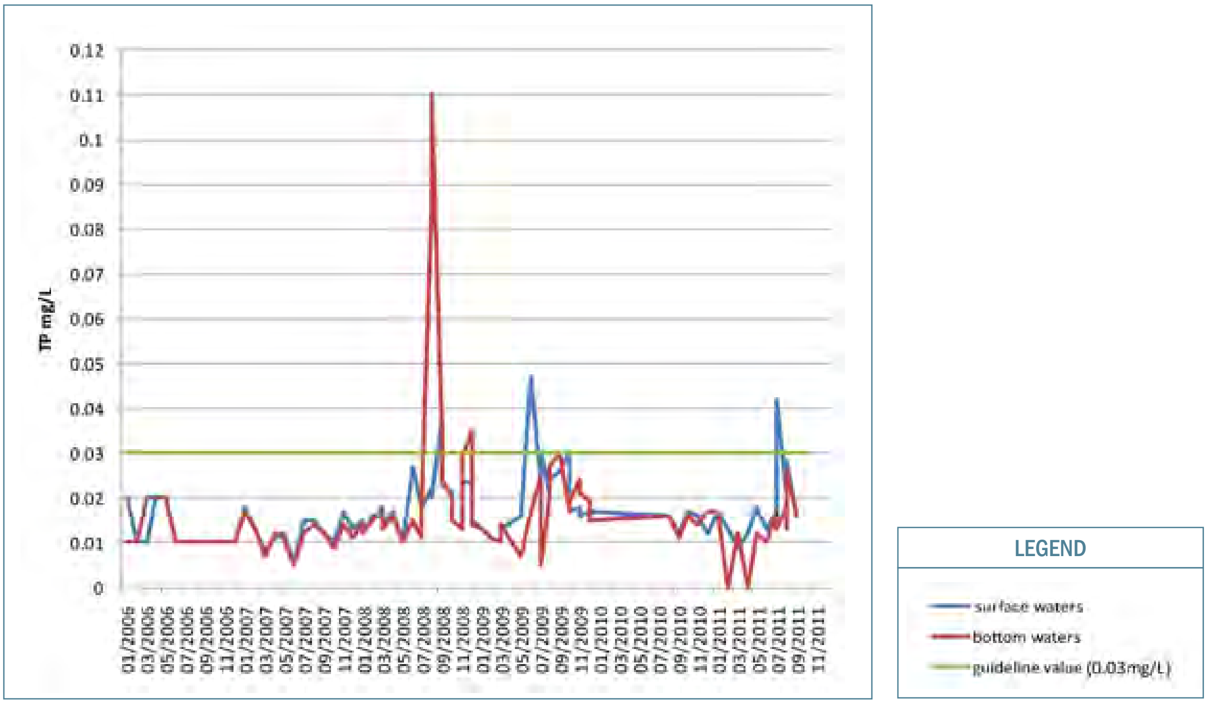


Total Nitrogen (mg/L) site 12 2006-2011

The characteristics of total phosphorus were similar to total nitrogen in that concentrations increased in response to river flow and/or anoxic conditions. The two peaks that occurred between 2006 and 2011 may have corresponded to the higher river flows at that time (August 2008 and October 2011) and/or the anoxic conditions that prevailed at that time as well.

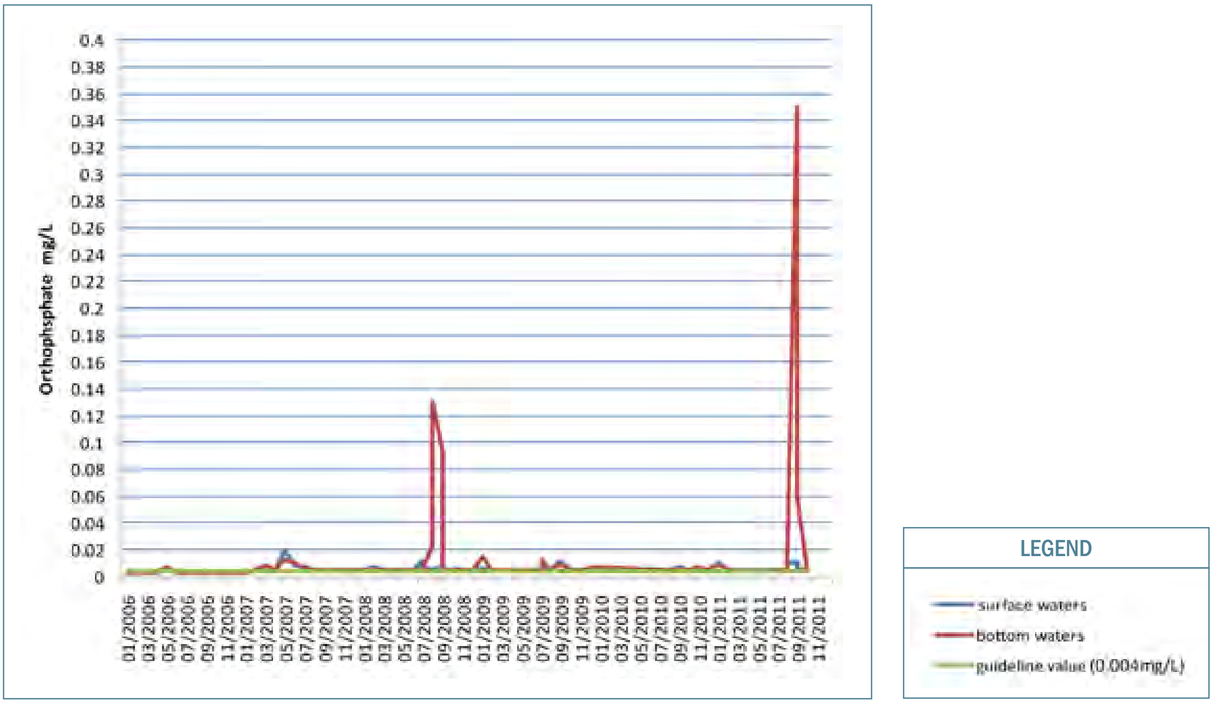


Total Phosporus (mg/L) site 6 2006-2011

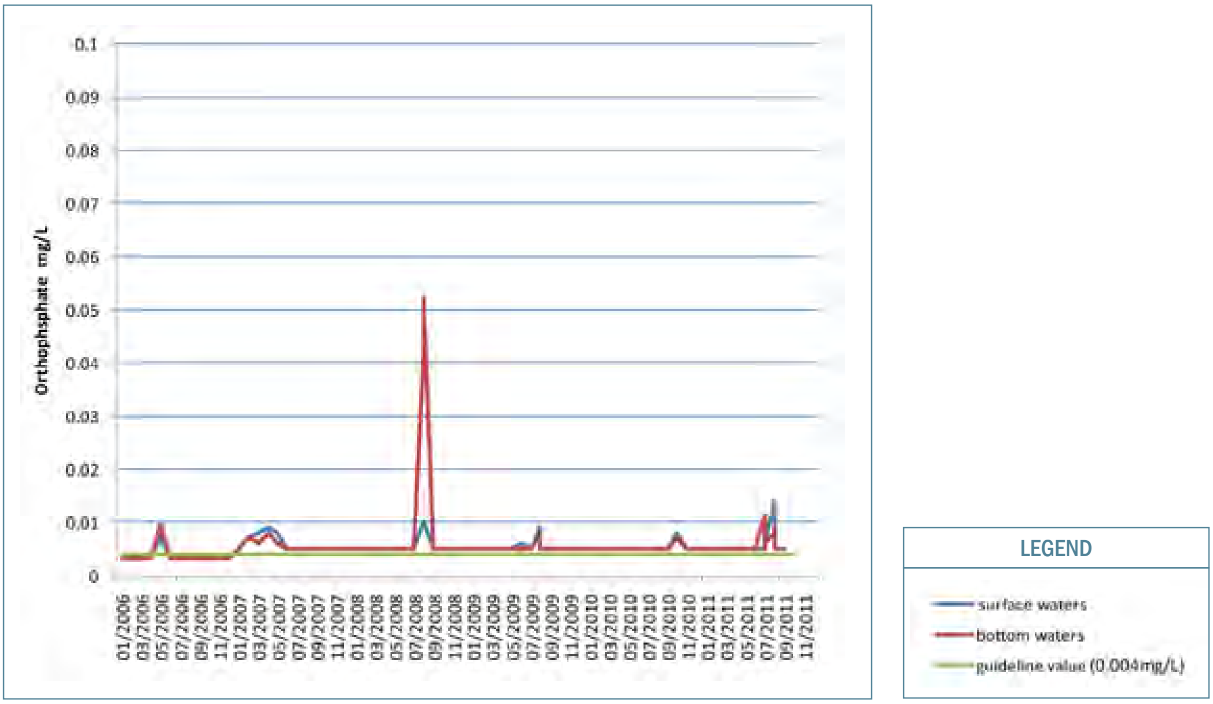


Totall Phosporus (mg/L) site 12 2006-2011

Increases in total phosphorus also correspond to the elevated available phosphorus (orthophosphate) as shown in the graphs below. As indicated in previous reports, orthophosphate can be resuspended under anoxic conditions due to the reduced ability of the sediments to bind phosphorus or may be delivered from the catchment through high flows. Low concentrations of phosphorus for most of the year indicate most of the phosphorus maybe adsorbed to sediments, in the form of particulate organic phosphate (bound in macrophytes and algae) or insoluble phosphorus minerals.



Orthophsphate (mg/L) site 6 2006-2011



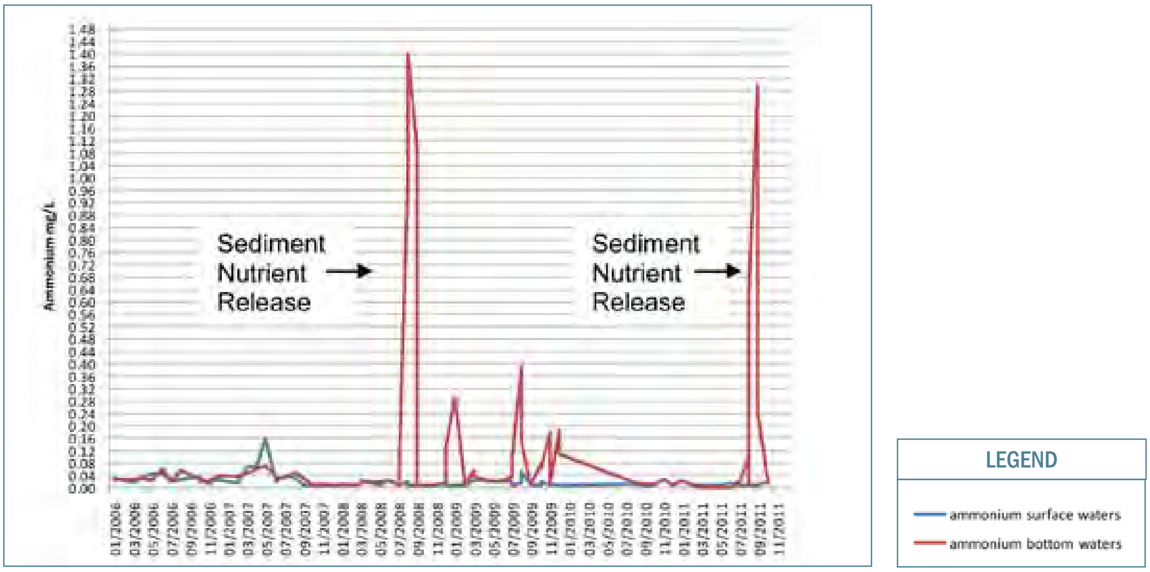
Orthophsphate (mg/L) site 12 2006-2011

The available form of nutrients between 2006 and 2011 (ammonium, total oxidised nitrogen and soluble reactive phosphorus) were close to or well below the detection limits of 0.005mg/L, 0.005mg/L and 0.003mg/L respectively. On the whole, the median values of all nutrient components were below the ANZECC&ARMCANZ 2000 trigger guideline values for estuarine waters.

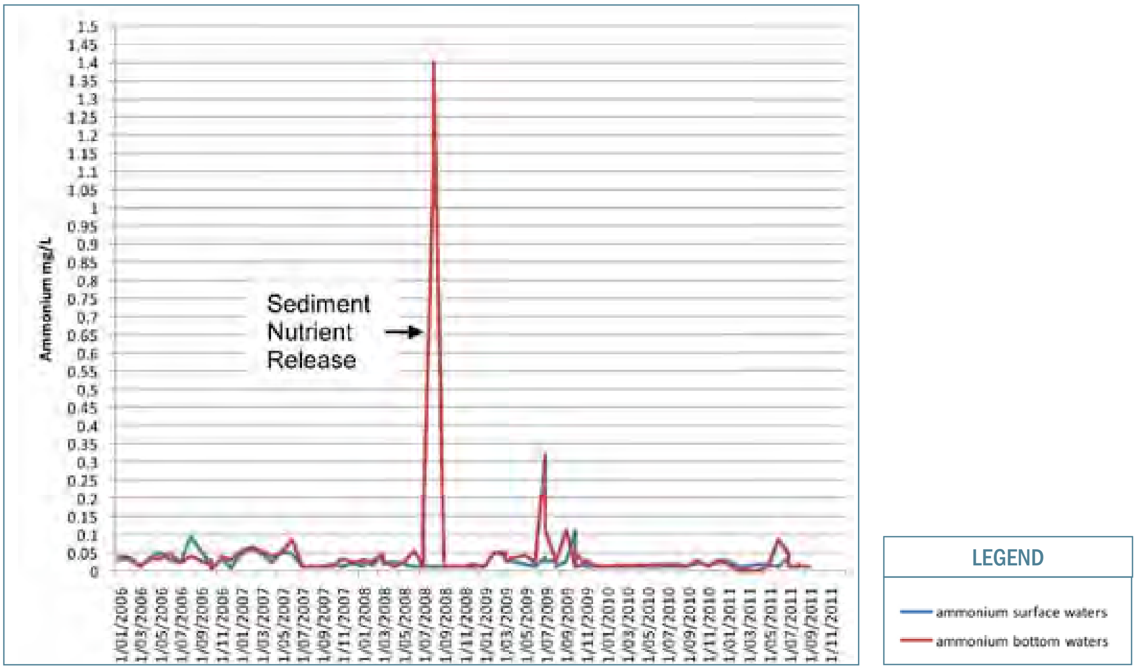
Site 6	mg/L	Total nitrogen	Ammonium	Total oxidised nitrogen	Total Phosphorus	Orthophosphate
1995-2002	Max	2.1	1.6	0.3	0.56	0.12
	Min	0.046	<0.005	<0.005	0.01	<0.003
2002-2006	Max	1.6	0.91	0.37	0.22	0.1
	Min	0.16	<0.005	<0.005	0.01	<0.003
2006-2011	Max	2.0	1.4	0.21	0.39	0.35
	Min	0.32	0.01	<0.005	<0.005	<0.003

Site 12	mg/L	Total nitrogen	Ammonium	Total oxidised nitrogen	Total Phosphorus	Orthophosphate
1995-2002	Max	1.6	0.78	0.4	0.15	0.082
	Min	0.4	<0.005	<0.005	<0.007	<0.003
2002-2006	Max	2.3	1.4	0.28	0.12	0.08
	Min	0.35	<0.005	<0.005	<0.005	<0.003
2006-2011	Max	2.1	1.4	0.28	0.12	0.053
	Min	0.33	<0.005	<0.005	<0.005	<0.003

Comparison of maximum and minimum nutrient concentrations between reporting periods



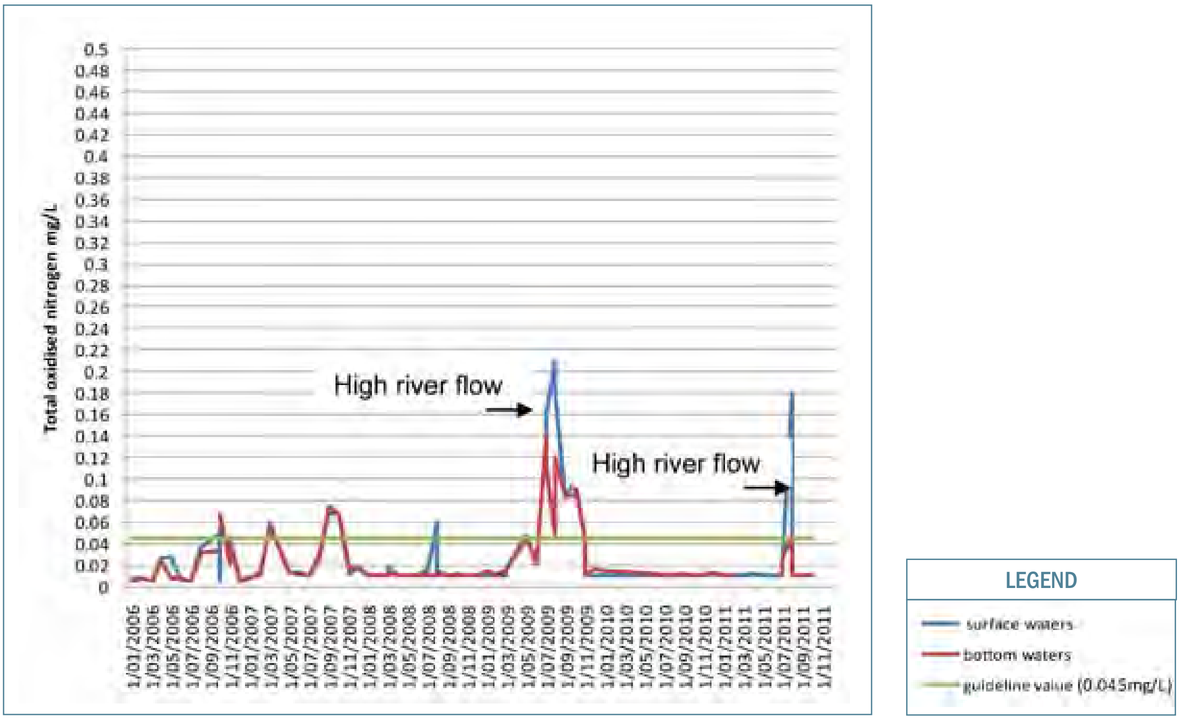
Ammonium (mg/L) site 6 2006-2011



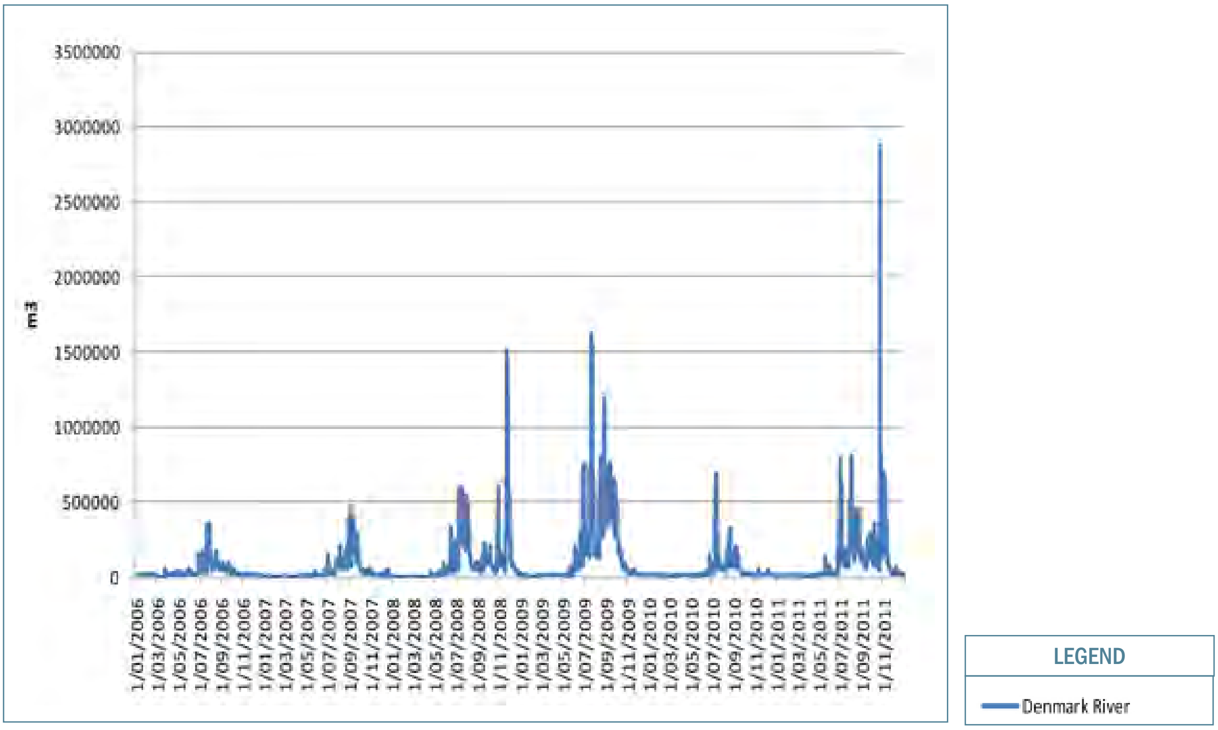
Ammonium (mg/L) site 12 2006-2011

Ammonium concentrations again followed a similar pattern to the past with low concentrations for most of the year and increased concentrations through sediment nutrient release in response to salinity stratification and anoxia (<4mg/L oxygen).

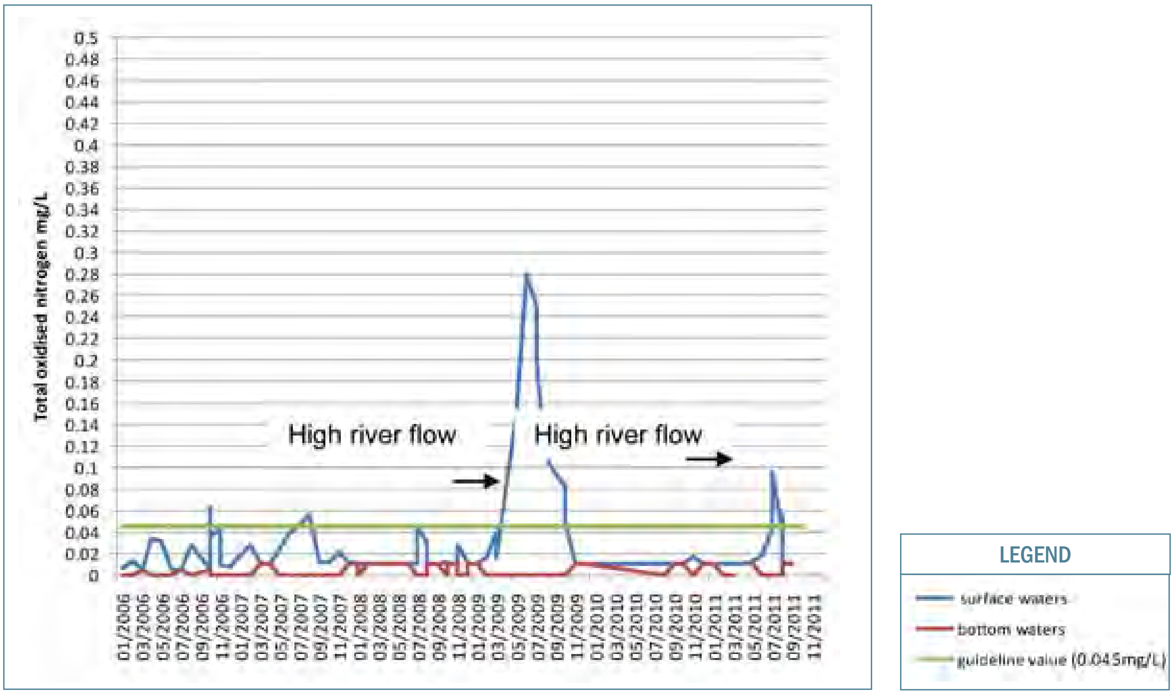
Total oxidised nitrogen concentrations also followed a similar pattern to the past with concentrations were below detectable limits during most of each year. Elevations in concentrations correspond to high river flow events indicated by generally higher surface concentrations than bottom concentrations.



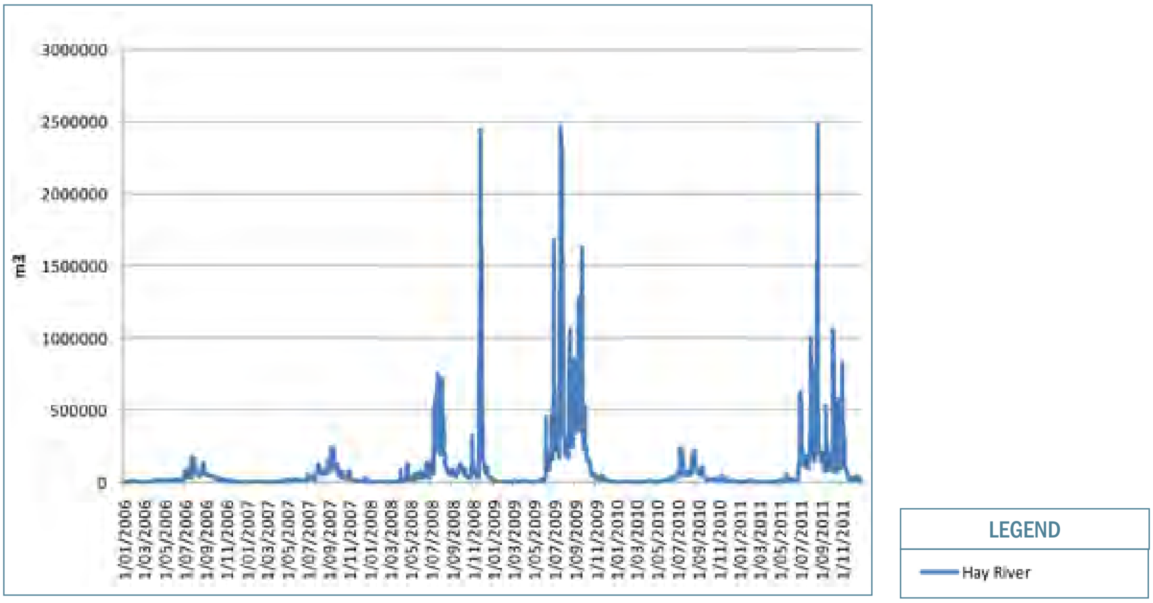
Total oxidised nitrogen (mg/L) site 6 2006-2011



Denmark River Discharge



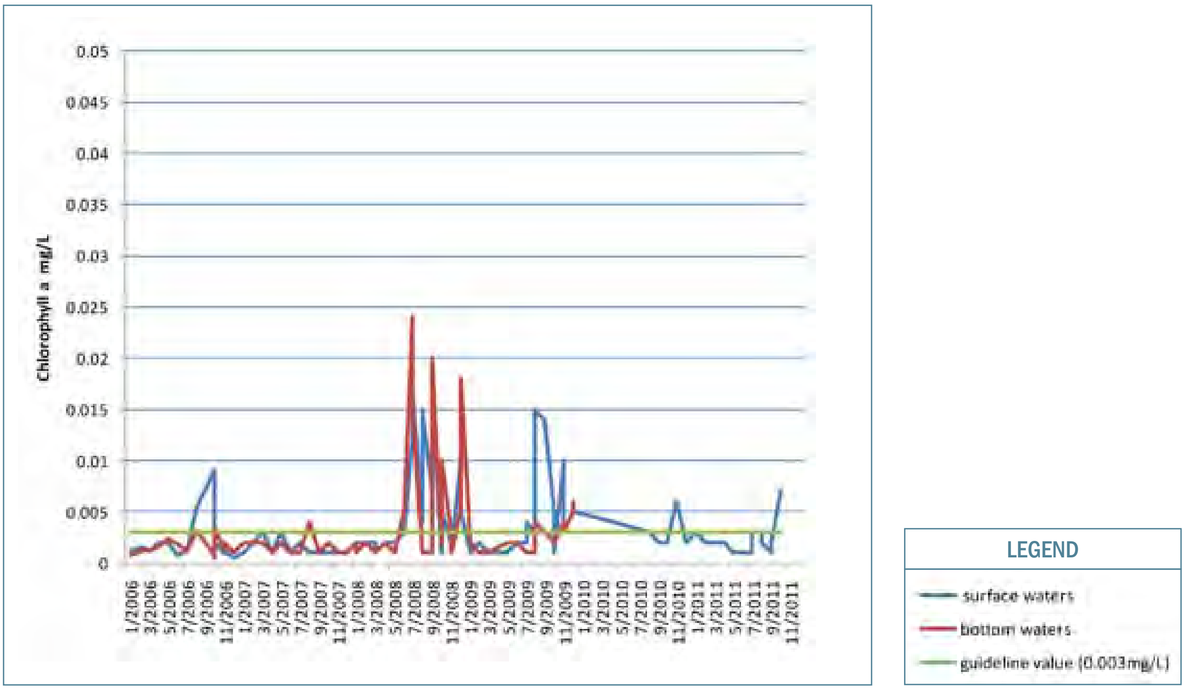
Total oxidised nitrogen (mg/L) site 12 2006-2011



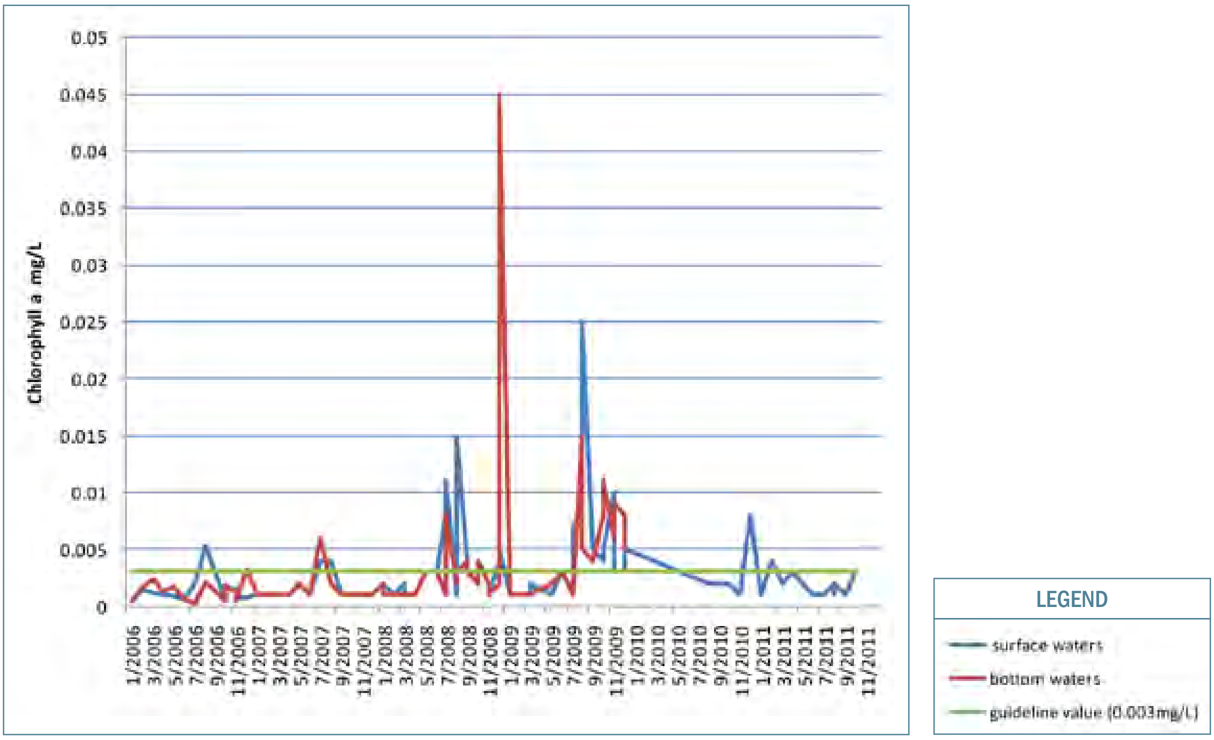
Hay River discharge

CHLOROPHYLL *a* AND PHYTOPLANKTON

Chlorophyll *a* concentrations were generally low (less than 0.003mg/L) between 2006 and 2011 with increases relating to nutrient availability (inputs from the catchment during high flows and sediment nutrient release). Peaks in chlorophyll a were variable but tended to occur in winter and early spring similar to previous years. However, there was a large peak in chlorophyll a in summer of 2009.

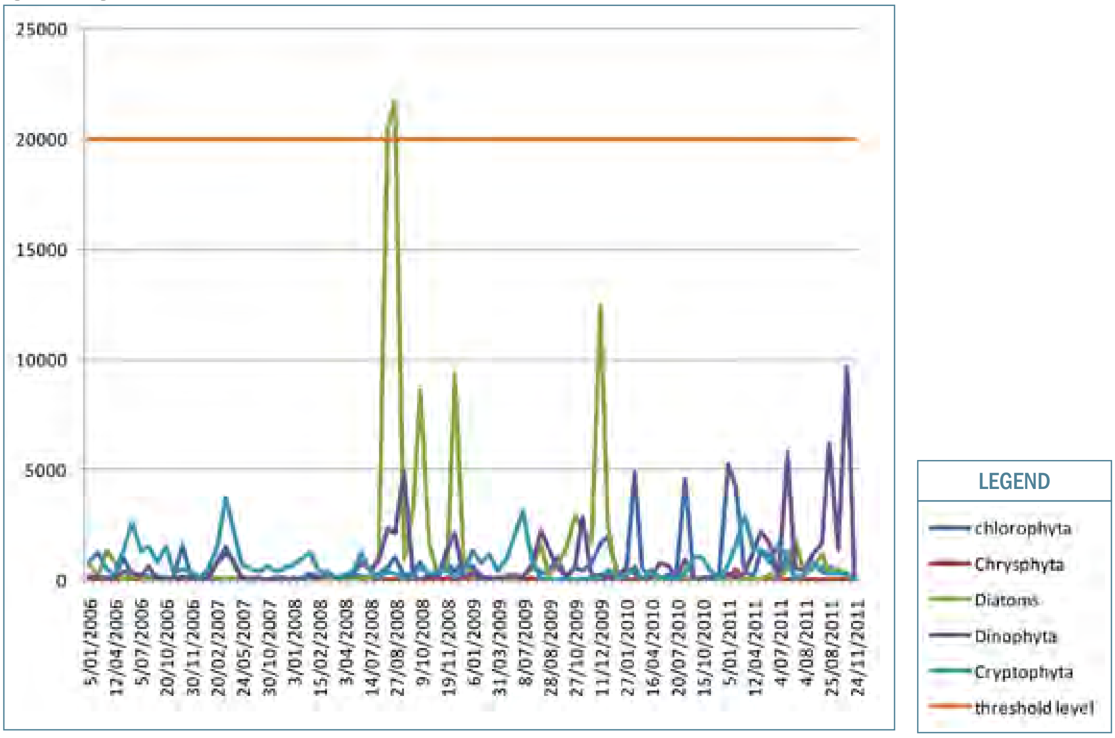


Chlorophyll a (mg/L) site 6 2006-2011

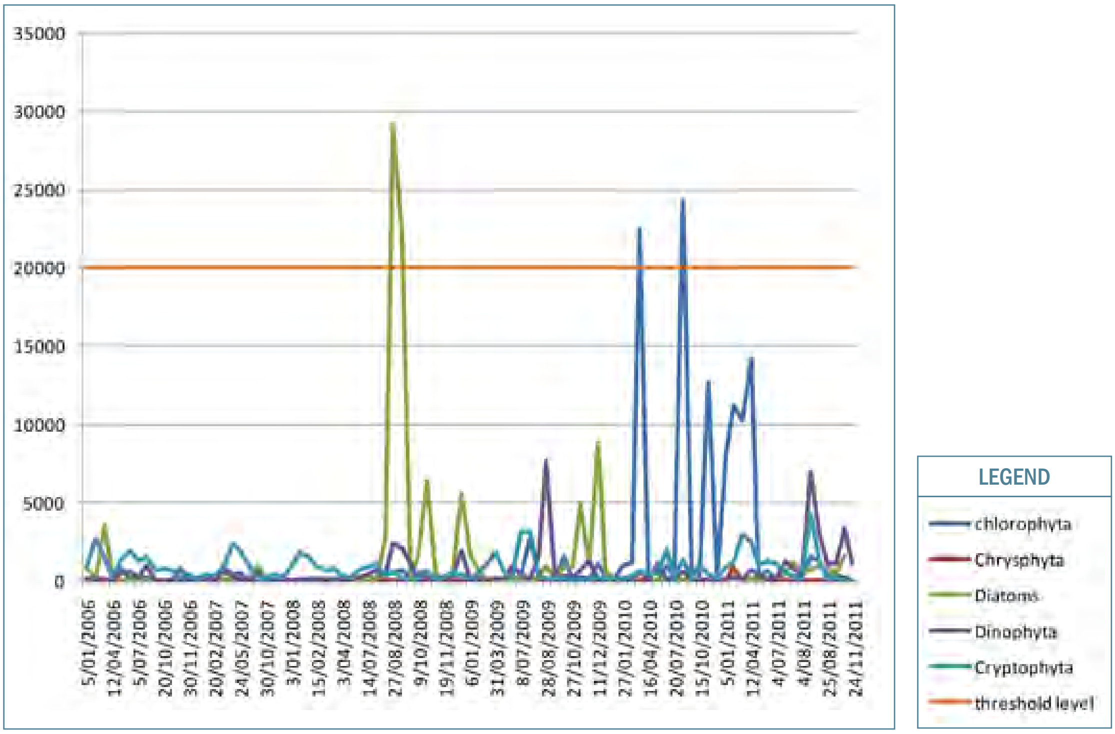


Chlorophyll a (mg/L) site 12 2006-2011

At site 6 there was one episode where diatom cell densities breached the algae bloom threshold of 20,000cells/mL. This bloom may have related to the high river flows in July and August 2008 and the availability of nutrients. At site 12 the algae bloom threshold was breached on three occasions with one diatom bloom event in July/August 2008 and two Chlorophyte (green algae) bloom events occurred on the 24/03/2010 and 20/08/2010.



Phytoplankton Density (cells/mL) site 6 2006-2011



Phytoplankton Density (cells/mL) site 12 2006-2011

Between 2002 and 2006 there were two blooms of potentially harmful algal species. In 2005 a bloom resulted after to high rainfall in April that year. It was observed and reported that high flows delivered sediment and nutrient to the Inlet creating ideal conditions for algal growth.

Blooms of Dinophysis acuminata which is a potential shellfish affecting algae was recorded in 2008 and 2009. This algae tends to take advantage of the available nutrients released from the sediments during anoxic periods. This is supported as on all occasions during 2008 and 2009 stratification and anoxic conditions prevailed.

During 2006 and 2011 there were three occurrences of potentially harmful algal species as outlined in the following table:

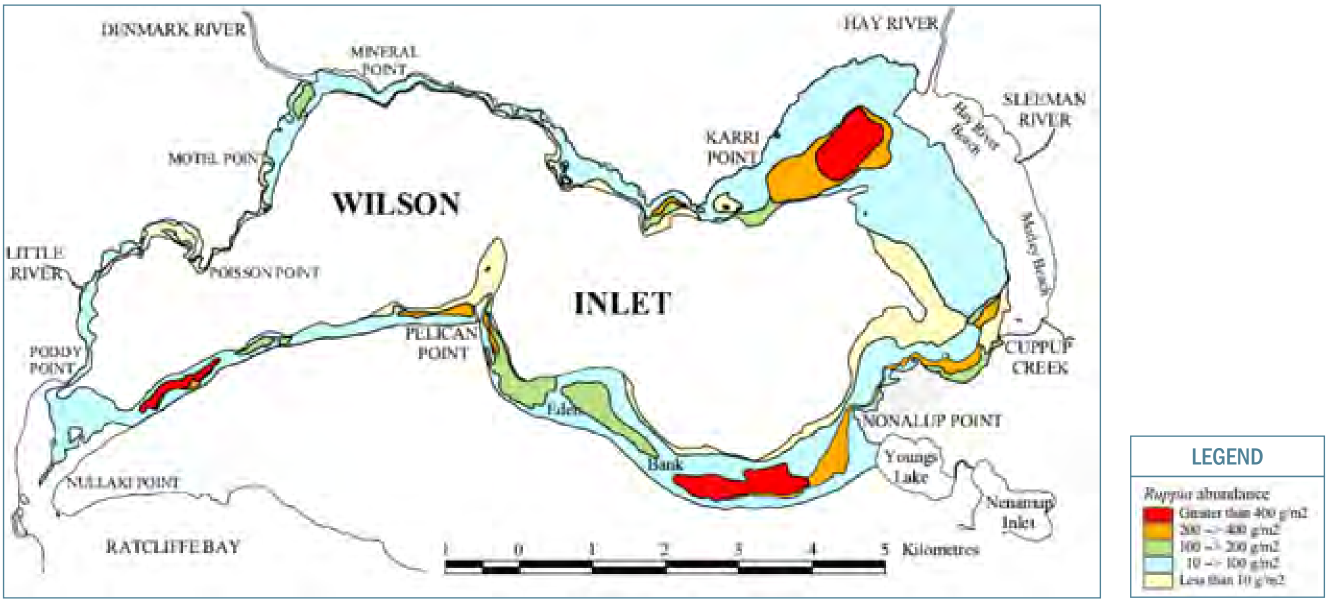
Date	Dinoflagellate Species
1/05/2008	Dinophysis acuminata
30/09/2009	Dinophysis acuminata
15/10/2009	Dinophysis acuminata

Comparison of maximum and minimum nutrient concentrations between reporting periods

RUPPIA EXTENT

Two surveys have been conducted to determine the extent of Ruppia megacarpa in the Inlet, one in 1994 and the other in 2007. Although the survey measured gram of dry weight per m2 in 1994 and measured in % density cover in 2007, there are similarities in Ruppia coverage in the Inlet between years. Densities in both surveys for example were low at Nonalup Point and remained high in the Karri point area.

A comparison of Ruppia cover was made between years and showed an estimated increase from 16 km2 in 1994 to 26 km2 in the 2007 survey.



The distribution of Ruppia megacarpa *in Wilson Inlet in December 1994.*

% density cover of Ruppia megacarpa *in Wilson Inlet in 2007.*

In 2007, based on the interpolation technique used in Spatial Analyst, Ruppia megacarpa was shown to occur over a total area of 26.03 km2 (or 54 %) of the Wilson Inlet basin. Seagrass density, measured as percentage cover, ranged from 1 % to 75 % cover, but most areas of seagrass were of densities between 1 % and 30 % (Table 1). The highest density of seagrass was recorded around Karri Point on the northern shore of the eastern basin. Seagrass density generally decreased with increasing water depth.

Category	Area (km2)	% Area surveyed	% Area of basin
Category 1 (1-10 %)	8.68	33.10	17.97
Category 2 (11-30 %)	15.81	60.31	32.74
Category 3 (31-50 %)	1.53	5.83	3.16
Category 4 (51-75 %)	0.02	0.07	0.04
Category 5 (76-100 %)	0	0	0
Area of seagrass	26.03	99.31	53.91
Area of bare sand	0.18	0.69	46.10
Total area surveyed (< 2m)	26.21		54.28
Area > 2m (deep basin not surveyed)	22.07		45.72
Total area of basin	48.28		100

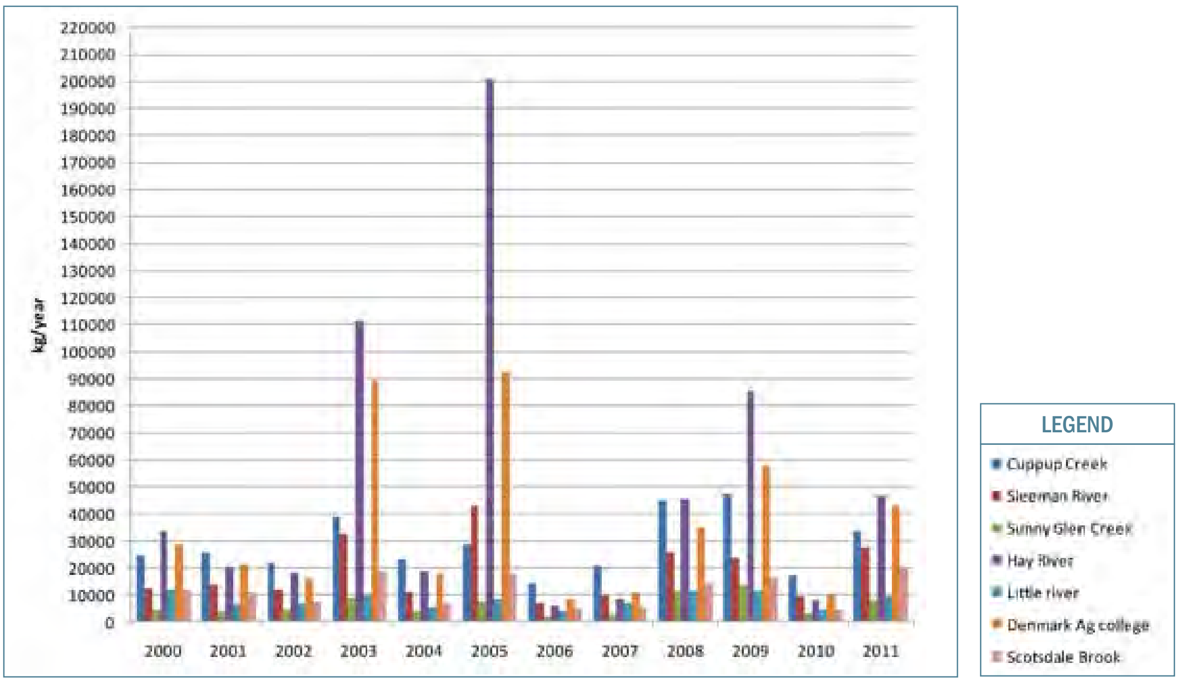
Table 1 Estimated coverage of the Ruppia megacarpa in squarekilometers, an as a percentage of the surveyed area and the total basin area in Wilson Inlet, February 2007.

Growth of macroalgae including free floating and attached (epiphytes) was not formally assessed in 2007 however it was noted on all transects surveyed. Most transects had a light to medium coverage of diatomaceous epiphytic algae (attached to the Ruppia). There was also an abundance of Cladophora (goat weed) accumulating in very shallow waters and on bare sediments at the bar end of the Inlet. This could be due to the late 2006 bar opening and low water levels that created ideal conditions for algae growth. Overall there seemed to be abundance of macroalgae (mostly epiphytic algae) during the 2007 survey. Over the years there has been an accumulation of decaying Ruppia and macroalgae on the Inlet shoreline. This coincides with annual senescence and potential strong winds that up root the Ruppia. Ruppia and algae wrack often accumulates on the western shores in summer and eastern to south eastern shores during winter due to prevailing winds.

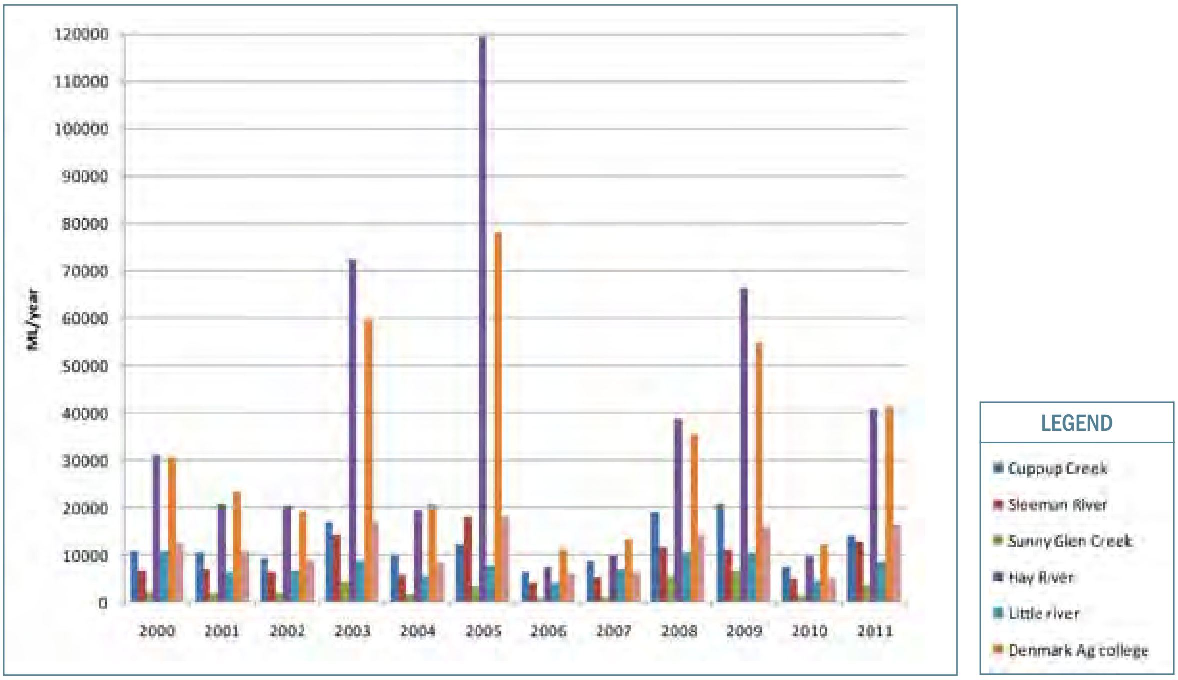
M4 CATCHMENT NUTRIENT LOADS

The Denmark catchment total nitrogen (TN) loads ranged from 1647.57kg/year and 201387.66kg/year between 2000 and 2011. The Hay River presented with the highest nitrogen loads during 2000, 2003, 2005, 2009 and 2011 and the Denmark Agricultural College site presented the second highest during most years followed by Cuppup Creek and Sleeman River.

Higher nitrogen loads occurred during the years of high rainfall and river flow. This is especially noticeable with the high rainfall events in 2003 and 2005. The smallest loads were recorded at the Scotsdale Brook sites.



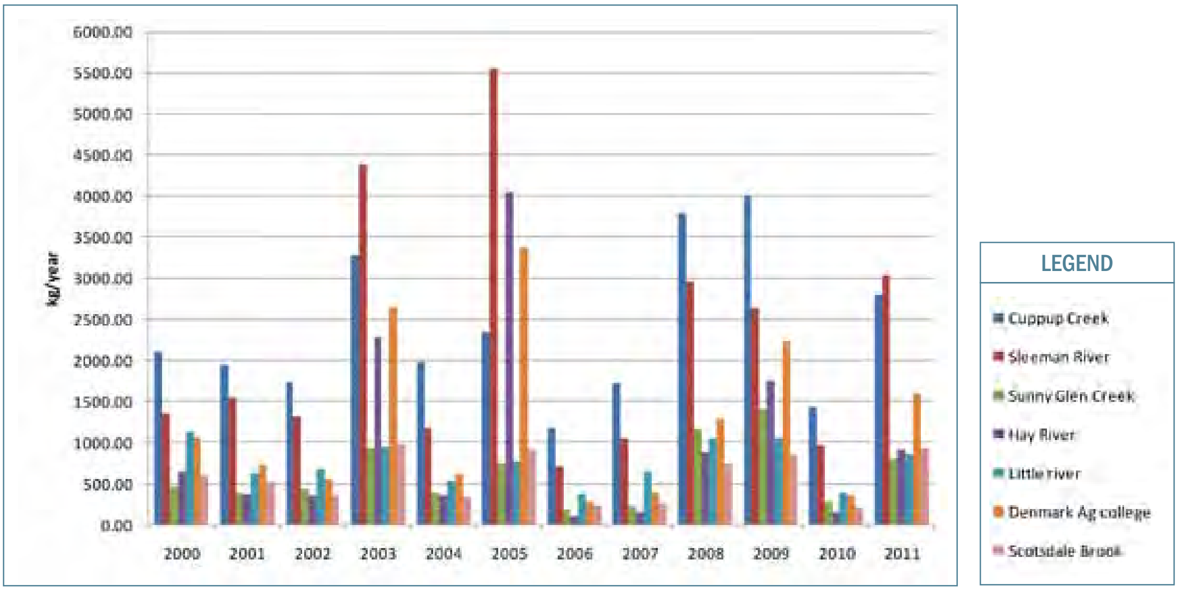
Total TN Loads kg/year Wilson Inlet catchment



Total Flows ML/year Wilson Inlet catchment

The Denmark catchment total phosphorus (TP) loads ranged from 34.09kg/year to 5546.20kg/year between 2000 and 2011. Cuppup Creek and Sleeman River presented with the highest loads during all years followed by the Denmark River Agricultural College site. Again higher phosphorus loads corresponded to years of high flow.

The smallest loads were recorded at Scotsdale Brook and Hay River sites.

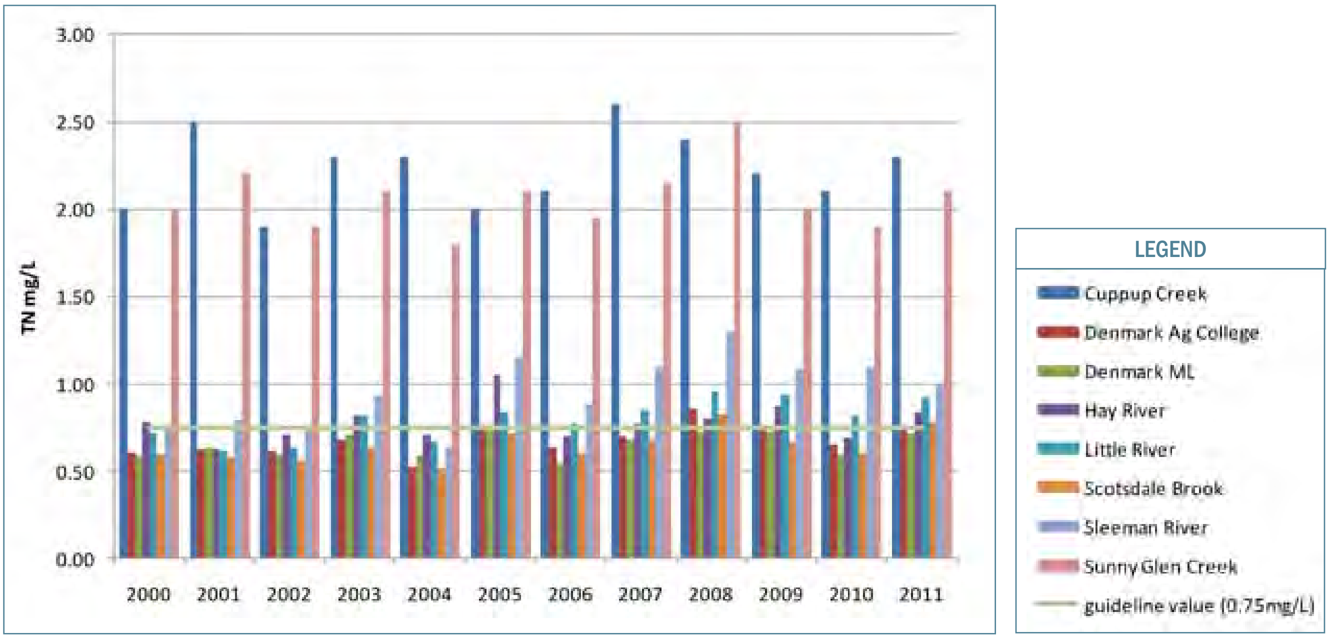


Total TP Loads kg/year Wilson Inlet catchment

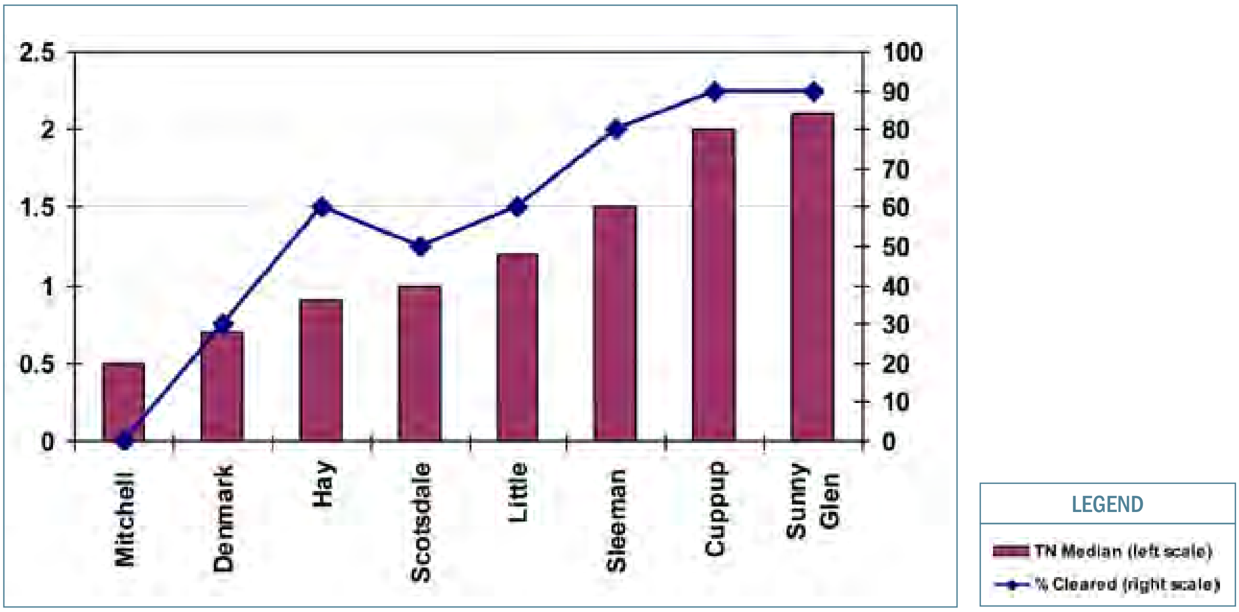
M5 CATCHMENT NUTRIENT CONCENTRATIONS

The graphs below show the median total nitrogen (TN) concentrations in the rivers in the Wilson Inlet Catchment between 2000 and 2011. Cuppup Creek and Sunny Glen Creek had the highest concentrations with Sleeman and Hay River just over the guideline level most of the time. Little River concentrations have been increasing over time with higher concentrations in past years. Denmark River Ag college site was high on one occasion and Scotsdale Brook and Denmark River (Mt Lindesay) had the lowest concentrations.

Note: Mt Lindesay is reported in this following section however considering how high up the site is in the catchment there would be no influence on the Inlet.



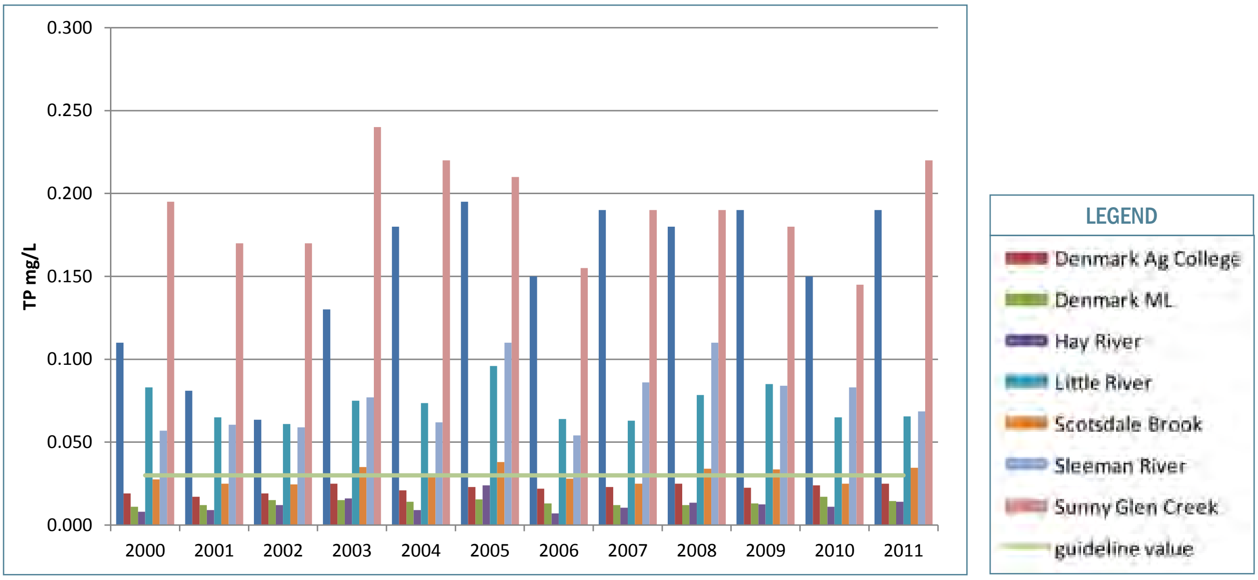
Denmark catchment median TN (mg/L)



Median TN concentration (mg/L) and approx % cleared for Wilson Inlet sub-catchments

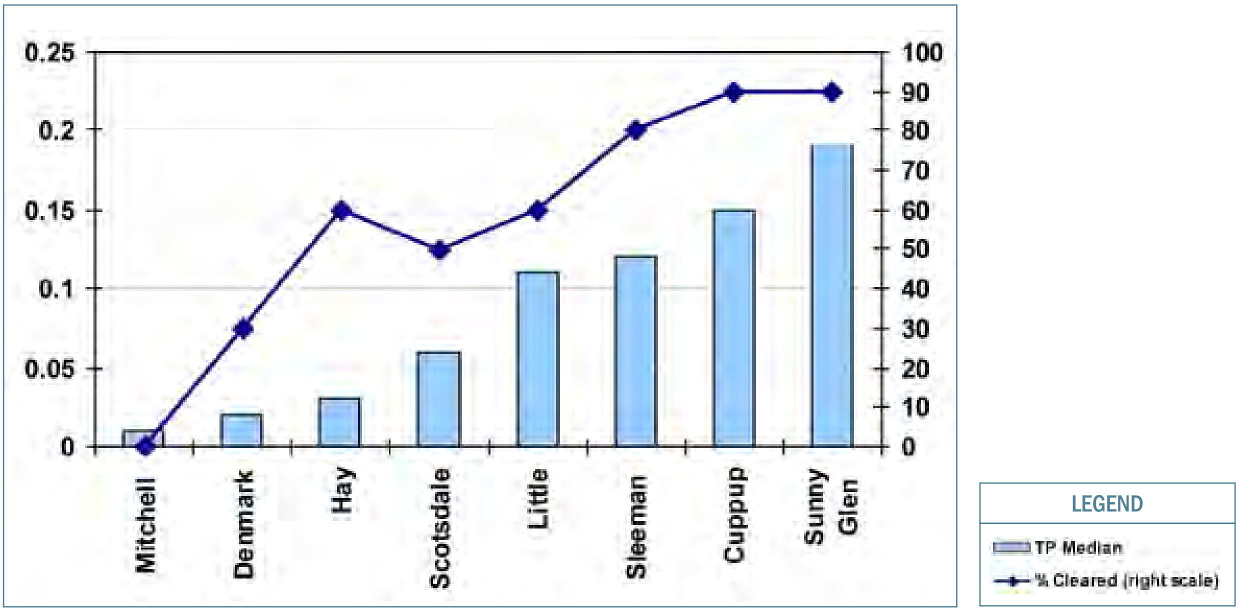
Overall there was a similar pattern to those results previously reported (Wilson Inlet Report to community No.8). At Sleeman River, Cuppup Creek and Sunny Glen TN concentrations continue to be the highest however comparing median concentrations between 2000 and 2011 Cuppup creek had higher concentrations than Sunny Glen Creek. Median TN concentrations at Sleeman between years were less than previously reported (1.5mg/L) which may indicate some reduction in TN concentrations. Median concentrations however were higher than the recommended guideline value of 0.75mg/L in Cuppup, Sunny Glen and the Sleeman River.

The median concentrations of total phosphorus (TP) showed a similar result to the TN concentrations with the highest concentrations at Sunny Glen Creek Cuppup Creek and Sleeman River. Median concentrations in the Cuppup Creek, Sunny Glen, Sleeman and Little Rivers were also higher than the recommended guideline during all years.



Total TN Loads kg/year Wilson Inlet catchment

Again there was a similar pattern to previously reported (Wilson Inlet Report to community No.8) with highest median TP concentrations in Sunny Glen, Cuppup creek, Sleeman and Little Rivers.



Total TP Loads kg/year Wilson Inlet catchment

NUTRIENT TRENDS

The following table outlines the nutrient trends in the Denmark Catchment Rivers.
(Note: the comment about the number of samples required to more accurately determine trends)

Site	Parameter	From	To	Comment
Cuppup Creek	TN	2007	2011	No trend
Cuppup Creek	TP	2007	2011	Emerging increasing trend of 0.024mg/L/yr. A total of 75 independent samples were required to verify this trend, only 22 were available.
Cuppup Creek	TSS	2005	2009	No trend
Denmark River Ag	TN	2007	2011	No trend
Denmark River Ag	TP	2007	2011	No trend
Denmark River Ag	TSS	2005	2009	No trend
Denmark River ML	TN	2007	2011	No trend
Denmark River ML	TP	2007	2011	No trend
Denmark River ML	TSS	2005	2009	No trend
Hay River	TN	2007	2011	No trend
Hay River	TP	2007	2011	Emerging increasing trend of 0.001mg/L/yr. A total of 124 independent samples were required to verify this trend, only 102 were available.
Hay River	TSS	2005	2009	No trend
Little River	TN	2007	2011	Increasing trend of 0.072mg/L/yr.
Little River	TP	2007	2011	Emerging increasing trend of 0.006mg/L/yr. A total of 140 independent samples were required to verify this trend, only 110 were available.
Little River	TSS	2005	2009	Emerging increasing trend of 0.804mg/L/yr. A total of 184 independent samples were required to verify this trend, only 81 were available.
Scotsdale Brook	TN	2007	2011	No trend
Scotsdale Brook	TP	2007	2011	Emerging increasing trend of 0.002mg/L/yr. A total of 109 independent samples were required to verify this trend, only 68 were available.
Scotsdale Brook	TSS	2005	2009	No trend
Sleeman River	TN	2007	2011	No trend
Sleeman River	TP	2007	2011	No trend
Sleeman River	TSS	2005	2009	Emerging increasing trend of 0.682mg/L/yr. A total of 159 independent samples were required to verify this trend, only 127 were available.
Sunny Glen Creek	TN	2007	2011	No trend
Sunny Glen Creek	TP	2007	2011	No trend
Sunny Glen Creek	TSS	2005	2009	No trend

As previously reported (Wilson Inlet Report to community No.8) TN concentrations have remained relatively stable. Between 2005 and 2011 the only increasing trend was at Little River with an increasing trend of 0.072mg/L/year. Previously (1999-2005) there was an increasing trend in Scotsdale Brook. There was no trend in the Denmark River, Scotsdale Brook and Sunny Glen.

Sites that showed an increasing trend in TP concentrations during 2005-2011 included Cuppup Creek, Hay River, Little River and Scotsdale Brook. There was no trend in Sleeman River, Denmark River (Ag College and Mount Lindsay).

In comparison to the 1999-2005 trend calculations, increasing TP trends have been small for example increasing TP trend in Little River has emerged from 0.003mg/L/year to 0.006mg/L. Cuppup Creek on the other hand has shown a difference of a decreasing emerging trend of 0.2mg/L/year (199-2005) to an increasing trend of 0.024mg/L/year (2005-2011).

SUMMARY

M1

There continues to be a strong relationship between anoxic events during the sand bar opening periods and stratification. This trend is consistent with previous reports. At other times of the year waters in the Inlet remain well oxygenated. During years when there was no bar opening (2007 and 2010) the Inlet also remained well oxygenated throughout the year.

Salinity ranged between marginal to saline between 2005 -2011. During times when the bar is closed salinities are consistent throughout the water column. Once the bar opens and there is marine exchange the surface and bottom salinities diverge with fresher surface water and saltier bottom waters. This situation creates a poor exchange of oxygen between the two layers and anoxic conditions in bottom waters.

Inlet nutrient concentrations showed similar characteristics to previous years with maximum minimum and median concentrations remaining low for most of the year (below the recommended guidelines) except on high flow occasions and periods of bottom water anoxia during bar opening periods.

Chlorophyll a concentrations were generally low with peaks corresponding with increased nutrient concentrations.

Phytoplankton densities were below the threshold level of 20,000cell/mL except during higher flow events when diatom and chlorophyte (microscopic green algae) bloom events occurred.

Harmful algae species were present above the recommended guideline value on three occasions since 2005. Blooms of Dinophysis acuminata (shell fish effecting Algae) occurred during periods of anoxia and nutrient release from the sediments during bar opening periods in 2008 and 2009.

Percent density cover of Ruppia megacarpa has remained similar between the surveys undertaken in 1994 and 2007. There has been an increase in overall coverage between surveys with an estimated coverage of 26 km2 in the 2007 survey compared to 16 km2 in the 1994 survey.

Catchment Total Nitrogen loads between 2000 and 2011 were highest in the Hay River followed by the Denmark River (Ag College) then Cuppup Creek and Sleeman River.

Total Phosphorus loads were highest in Cuppup Creek and Sleeman River.

Median nitrogen concentrations showed a similar pattern to previous years where Sleeman River, Cuppup creek and Sunny Glen creek continue to be the highest although Cuppup creek had higher concentrations in the past years compared to Sunny Glen.

Median phosphorus concentrations were highest in Sunny Glen, Cuppup Creek and the Sleeman River. Median concentrations were also above the recommended guidelines in all these rivers as well as Little River.

Nitrogen trends in most of the Wilson Inlet Catchment were relatively stable with no trend in most rivers from 2007 to 2009/2011. Little River however has now moved to an emerging increasing nitrogen trend of 0.072mg/L/year.

Emerging increasing Phosphorus trends were recorded at Cuppup Creek, Hay River, Little River and Scotsdale Brook from 2007 to 2009/2011. Cuppup Creek has moved from a decreasing emerging trend of 0.2mg/L to an increasing trend of 0.024mg/L. No trend was recorded at the Denmark River sites, Sleeman River or Sunny Glen sites.

Total Suspended Solids (TSS) trends recorded no trend at most sites and a decreasing trend at Little River and Sleeman River.

APPENDIX 1: WILSON INLET BAR OPENING LEVELS AND TIMES

This table has been prepared by the Department of Water/Water and Rivers Commission with data from the former Public Works Department and Water Authority, from Water Corporation and Commission records and with assistance from Neville Boughton. Some figures and dates may be considered subjective and can be difficult to verify, therefore some inaccuracies may occur.

Note: The levels from 1958 to 1975 (inclusive) have been converted from imperial measurement to metric measurement at AHD. All measurements were adjusted by 0.584m which was the height of the old gauge board on the Nornalup Rail Bridge adjacent to the River Mouth Caravan Park.

YEAR	WHERE OPENED	DATE OPENED	DATE CLOSED	No. OF DAYS OPEN	LEVEL AT OPENING RL
1954		NA			
1955	300m	15 June 1955			
1956	340m	10 June 1956			
1957	300m	8 August 1957			
1958	340m	7 August 1958	28 December 1958	143	1.042
1959	350m	6 October 1959	5 January 1960	91	0.737
1960	400m	12 July 1960	24 December 1960	165	1.016
1961	400m	4 July 1961	15 January 1962	195	1.118
1962	360m	1 August 1962	9 January 1963	161	
1963	160m	4 July 1963			1.067
1964	200m	22 July 1964			1.143
1965	200m	24 August 1965			1.042
1966	200m	27 July 1966	14 January 1967	171	1.042
1967	200m	17 July 1967	10 April 1968	268	1.219
1968	200m	31 July 1968	12 February 1969	196	1.042
1969	442m	1 September 1969	22 December 1969	112	1.118
1970	440m	2 August 1970	27 February 1971	209	1.143
1971	50m	16 July 1971	4 March 1972	232	0.991
1972	100m	10 August 1972	15 December 1972	127	1.067
1973	100m	13 August 1973	14 February 1974	185	1.016
1974	100m	5 August 1974	1 December 1974	118	1.042
1975	100m	30 July 1975	1 February 1976	186	1.016
1976	100m	6 July 1976	10 February 1977	219	1.015
1977	100m	7 August 1977	6 February 1978	183	1.1
1978	100m	30 June 1978	2 March 1979	245	1.25
1979	100m	16 July 1979	1 February 1980	203	1.13
1980	100m	1 August 1980	24 January 1981	176	1.05
1981	300m	3 July 1981	8 March 1982	248	0.9
1982	100m	21 July 1982	9 September 1982	50	0.96m
1983	100m	13 September 1983	26 January 1984	135	1.15m
1984	80m	5 August 1984	10 April 1985	248	1.14m
1985	80m	13 August 1985	19 February 1986	190	1.00m
1986	300m	28 August 1986	27 February 1987	183	1.12m
1987	100m	13 October 1987	18 December 1987	66	0.75m
1988	100m	14 June 1988	14 May 1989	334	1.04m
1989	100m	14 July 1989	23 February 1990	224	1.12m

YEAR	WHERE OPENED	DATE OPENED	DATE CLOSED	No. OF DAYS OPEN	LEVEL AT OPENING RL
1990	450m	17 July 1990	10 February 1991	208	1.05m
1991	450m	22 July 1991	15 March 1992	237	1.15m
1992	100m	3 August 1992	2 April 1993	242	1.15m
1993		3 July 1993	2 February 1994	216	1.06m
1994		16 July 1994	3 February 1995	202	0.98m
1995		19 August 1995	26 February 1996	180	0.99
1996		5 August 1996	23 February 1996	216	1.04m
1997		18 August 1997	19 January 1998	155	1.02m
1998		7 August 1998	23 May 1999	284	1.04m
1999	100m	30 June 1999	6 March 2000	250	1.10m
2000	80m	21 July 2000	19 November 2000	122	1.05m
2001	80m	3 October 2001			1.04m
2002		6 September 2002			1.03m
2003		20 August 2003			1.12m
2004	100m	11 August 2004			1.08m
2005		3 June 2005	28 February 2006		1.09
2006	100m	3 October 2006	12 December 2006	74	0.845
2007	Non-opening				
2008	100m	17 July 2008	17 March 2009		1.14
2009	100m	10 July 2009	19 January 2010		1.04
2010	Bar not opened				
2011		14 July 2011	20 January 2012		0.90

11.2 WILSON INLET DRAINAGE REVIEW TOOL

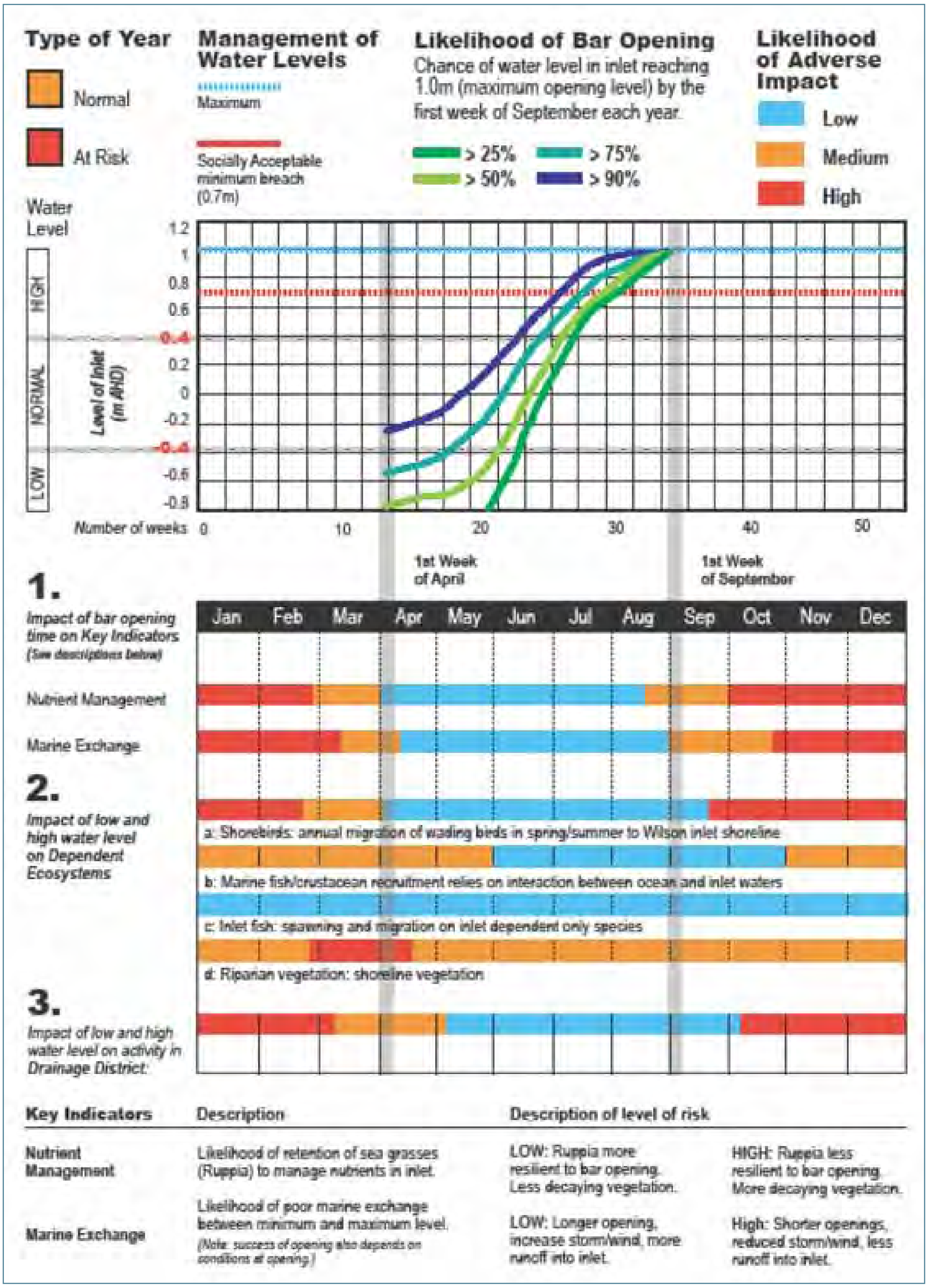


Figure 3 Wilson Inlet management of Bar opening - taken from Denmark Shire website; Wilson Inlet Drainage Review (see reference)

11.3 WILSON INLET CATCHMENT LANDUSE MAP