Wetland Conservation at Denmark WA

An Inventory, Assessment and Recommendations for Management for the Owingup Wetland Suite

A report produced by Green Skills for the South Coast Regional Initiative Planning Team

By Wetland Project Officer Patrick Gillespie

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OWINGUP SWAMP REPORT

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Do you have any comments or feedback you would like to give?

This report is intended to generate community discussion as to the most effective management practices that can be incorporated into the catchment planning activities of Owingup Swamp.

If you have any comments on the recommendations provided in this report, we would like to hear from you. Comments can be directed to:

Patrick Gillespie
Wetlands Project Manager
P.O. Box 5577, Albany W.A. 6332
Mon – Tue (Albany) Ph: (08) 9842 1334 Fax: (08) 9842 5010
Wed – Thur (Denmark) Ph: (08) 98 48 3310
Email pgillespie@greenskills.green.net.au
Web www.greenskills.green.net.au
Mobile: 0428 328 756

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1.0 Introduction

The following report provides an inventory of current information and an appraisal of the state of Owingup Swamp situated approximately 30 km west of Denmark in Western Australia. The report is intended to be viewed as part of our ongoing understanding of the wetland. It covers; how it originated, what processes are operating within the system, the values of the wetland, and whether these values are threatened. Where threats to the health or habitat value of the wetland have been identified management recommendations are made to mitigate these.

2.0 Project Background

During 1999, the Water and Rivers Commission (now Department of Environment-DoE) initiated a regional survey and evaluation of the wetlands of the entire South Coast Region between Walpole and Esperance. The survey for the Albany region was conducted by the V and C Semeniuk Research Group in 1998.

The objectives of the report were the:

- Identification of wetland regions.
- Classification of wetlands into consanguineous suites
- Identification of wetlands of significance.
- Identification of significant wetlands which are at risk.

The regional survey and evaluation of wetlands is part of a broader wetland conservation project being undertaken by the DoE and community group Green Skills. This project is a partnership program that has funded 11 wetland management plan projects since 1999. These are detailed below:

Wetland Suite	**Location**	**Completed**
Manypeaks/Pabelup	Bremer Bay	1999
Corimup	Manypeaks	2000
Mortijinup lakes	Esperance	2000
Mills Lake	Ongerup	2001
Coobidge Creek/Lake Gore	Esperance	2001
Coomalbidgup swamp	Esperance	2002
Unicup	Upper Kent River catchment	2002
Moates/Gardner lakes	Two Peoples Bay	2003
Roberts Swamp	Grass Patch, Nth Esperance	2003
Boyatup swamp	Cape Le Grand, Esperance	2004
Balicup	North Stirlings	2005
South of the Stirlings	South Stirling-Wellstead	2005

Table 1. Wetland management plan projects since 1999

During 2005, the South Coast Regional Initiative Planning Team (SCRIPT), in consultation with the South Coast community and regional stakeholders developed *Southern Prospects*, the investment plan for the South Coast regional natural resource management strategy.

Under this investment plan wetland management was considered a priority activity and consequently an expanded wetland program has been amongst the first to be funded, ensuring a continuation of the current wetland partnership program with Green Skills being directly contracted to SCRIPT to deliver the project outcomes.

Funding from the Federal Government Natural Heritage Trust (NHT) and the National Action Plan (NAP) provided through SCRIPT has been secured to provide limited on ground support for wetland fencing, revegetation and strategic earthworks (Hopkinson 2005).

The aim of the wetland project is to focus on catchment areas for the suites of significant or outstanding priority wetlands which have been identified, and develop and implement wetland management plans alongside existing catchment activities.

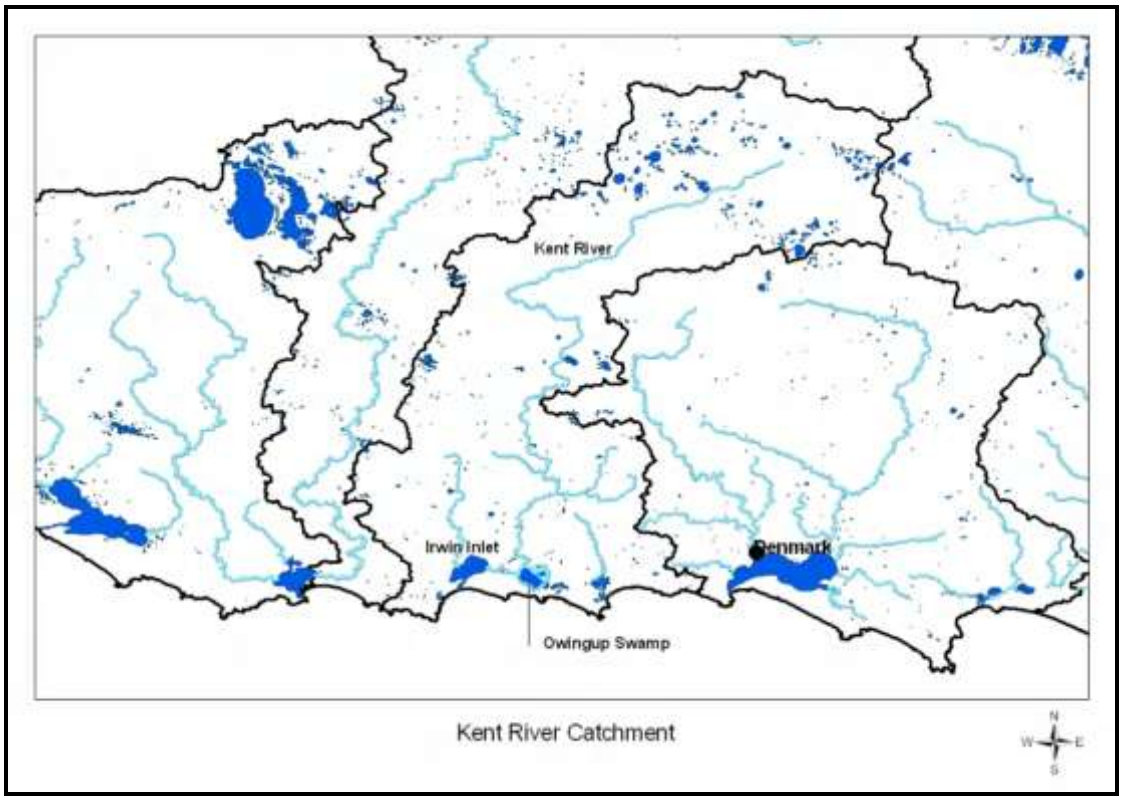

Figure 1. Location map – Owingup Swamp

3.0 History

3.1 Geological History

The Owingup Swamp is situated on the South coast of Western Australia approximately 30 km west of Denmark at the base of the Kent River (Fig 1). In order to understand the Swamp it is important to describe the formation of the landscape in which it resides.

The geology of the Southwest of Western Australia can be traced back to the Archaean over 2,500 million years ago when the granitic bedrock of the Yilgarn plateau was formed. 650 million years ago Australia was part of a super continent known as Gondwana, along with Africa, South America, India, and Antarctica. At this stage rivers in the south-west tended to flow west and north. Around 130 million years ago Gondwana broke up and Australia separated from Antarctica. The break-up resulted in an uplift of the Yilgarn plateau which slowed the flow of these ancient river systems. By the Eocene (56 to 35 million years ago), they had ceased altogether.

The present pattern of southerly draining rivers was initiated in the Tertiary period by a post break-up rebound along the edge of the continent (Smith 1997) and rejuvenated by southward tilting, thought to have occurred during the Oligocene some 30 million years ago. This southerly sloping land adjacent to the Yilgarn Plateau is described as the Ravensthorpe Ramp (Wilde & Walker 1984 in V & C Semeniuk 1998) (Fig. 2 use map from HMBA 1997 page 7).

The Kent River, which feeds Owingup swamp, flows westward over the older Archaean granitic landscape before turning sharply south down the Ravensthorpe ramp to the younger Albany – Fraser Orogen. Which is formed mainly of Proterozoic (2,500 ma to 545 ma), granitic and gneissic bedrock.

Semeniuk 1998 further expanded the Albany-Fraser Orogen and renamed the coastal unit "Albany Headlands and Inlets" to the D'Entrecasteaux-Albany Coastal Zone. They went on to describe this as "a complex of headlands, rocky shores, inlets, deltas, barrier dunes, and local monadnocks".

This bedrock of the D'Entrecasteaux-Albany Coastal Zone is overlain with more recent sediments formed during the Tertiary and quaternary periods. During this time the earth experienced a series of glacial and interglacial phases. The sediments are thus the result of a variety of processes. During glacial periods sea levels were lower and climate drier resulting in deposition of aeolian (wind blown), desertic dune quartz sand. Whilst during interglacial periods onshore winds formed calcareous sand mounds over the more ancient bedrock (V & C Semeniuk 1998). During these interglacial periods the Owingup Swamp basin would have been under the sea. Thus the Quaternary deposits are a mixture of alluvial, estuarine and aeolian deposits of sand, clay and limestone.

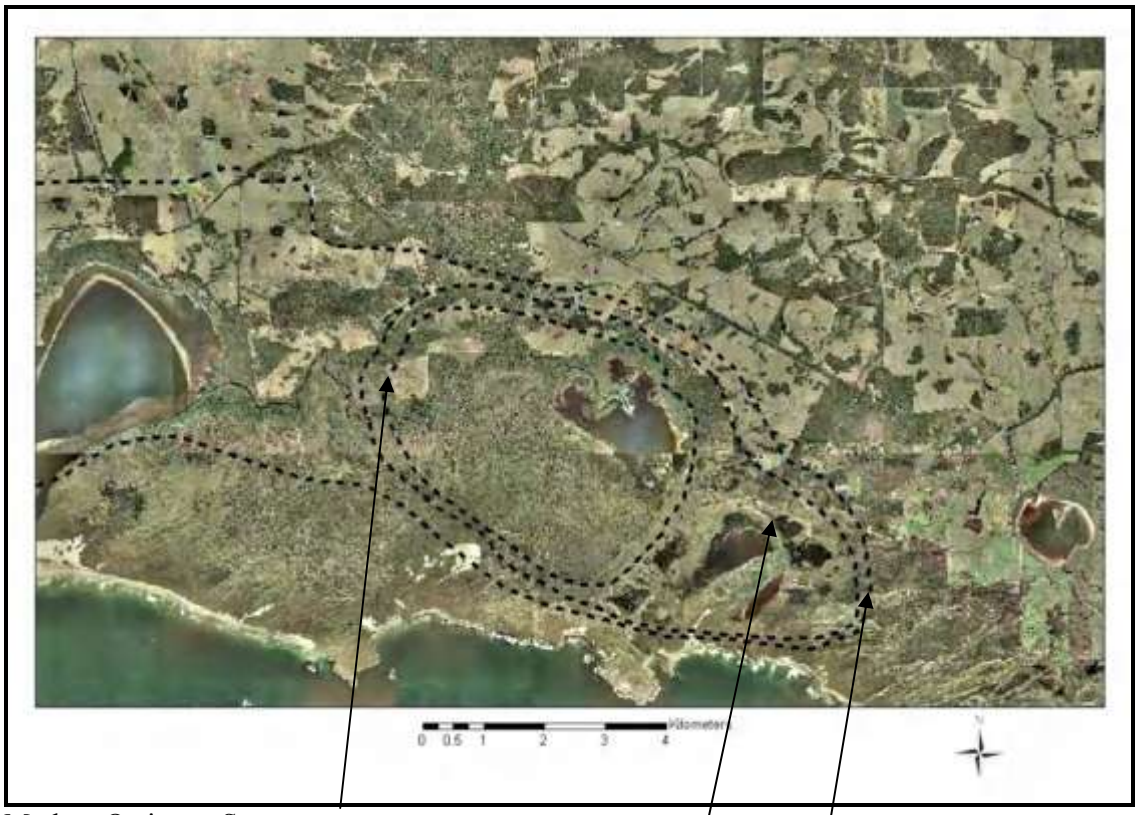

Figure 2. Extent of Owingup Swamp boundaries over the last 2 million years.

The area we know today as the Owingup Swamp was thought to have been part of a larger estuarine system along with Irwin inlet, referred to as the "Kent-Irwin estuarine complex" (Seminiuk 2001). This double estuary was later segmented by deposition from intra-lake deltas along with the encroachment of coastal dunes. Semeniuk goes on to classify 3 natural scales of boundary for Owingup Swamp as follows

- The Pleistocene extent of the system, which includes the area of hinterland that would have been flooded by the Pleistocene high water level.
- The middle Holocene extent of the system, which includes the terrain that would have been flooded by the Holocene high water level.
- The present extent of the system, which is the present rounded boundary of the swamp as mapped by CALM.

Today the wetland is underlain by estuarine fine quartz sand containing shells

3.2 Indigenous Land Use

Indigenous use of the Owingup area may date back tens of thousands of years. During this time The Irwin –Owingup Inlet complex would have expanded and contracted due to sea level fluctuations. More recently over the last few thousand years Owingup slowly separated from Irwin Inlet due to the deposition of sediments at the Kent River delta. Noongar people would thus have observed major changes to the swamp and the life it supports. Little is known of the exact use of the swamp or its place in Noongar religious and cultural customs. However, it is likely that indigenous people living in the area would have made use of the, at times, abundant food resources. Leonard Jack Williams speaks of some of the food sources which may have been seasonally exploited

> …the black swan was a choice food for noongar people too. Then there was the brush wallaby and the tammera. The sign you look for with these animals is the Christmas tree. When that comes out in blossom, you know the tammera and the kourr, are ready to harvest too. Like I said, noongars never used to eat anything out of season. It was a cycle, a chain.

When Owingup was connected to Irwin Inlet it is likely that mullet were hunted during the summer months.

> Now the fish used to get fat when the blossom on the paperbark comes out, then you'd know the mullet fish were fat and ready to catch.
> The blossom on the paperbark was called yaurll in noongar language.
> When the white flower on the paperbark, it is the same colour as the fat on the mullet, blossoms, then it's time. So that white flower used to tell people the mullet were ready for harvesting

Captain Collett Barker refers to other food sources which were thought to be important to Noongar people in the area

> Grass tree or blackboy Xanthorrhoea grew widely in sandy country in the region. Edible beetle larvae and pupae of the cerambycid (cockchafer) beetle *Bardistus cibarius* (called by noongar people bardi) occur in numbers in decaying stems an were an important food source, equivalent to the witchetty grub of the inland. …..property rites over the trees were jealously guarded. P273

Macrozamia palms were utilised by people throughout the south west. Long term local resident Dorothy Brenton (Personal communication 2006) remembers the lower Kent River having zamias as big as boabs during the early 1900's. While Capt Barker (Mulvaney and Green 1992) describes the area as

> This is great country for "quining" the fruit of the low fan leaved palm which after gathering they bury in the earth for about a moon when it becomes fine eating. The country here is very populous and the people fat p302

Obviously from these comments the Noongar people had ample food resources many of which were focused around wetlands. Given the seasonal nature of food and the obvious conduit of the Kent River it is possible that the river was a pathway for people moving from the upper catchment west of the stirlings to the coast. Certainly the wetlands of the upper catchment would have provided much in terms of food. Capt Wakefield in the 1830's records noongars describing it as having an "abundance of grass, the trees very large, great quantities of kangaroos, emus and birds". While Capt Barker in a letter describes one of the upper catchment wetlands as

> a circular basin of pure fresh water about a mile and a half diameter
> literally crowded with black swans, ducks, teal, and other aquatic birds.
> Lake is surrounded by a belt of about fifty yards wide of reeds.
> *Hirudo medicinalis* (leech used for blood letting) was found in great plenty.

Given the geology of the lower catchment it is unlikely that it was a source of stone for tools, although it is unknown what offshore deposits may have been exploited during times of lower sea levels.

4.0 Owingup – Physical characteristics

4.1 Climate

The South coast of Western Australia experiences a Mediterranean-type climate with cool, wet winters and warm to hot, dry summers. Owingup Swamp resides in an area which receives an annual rainfall of approximately 1200mm and has annual evaporation rates of 1000mm. Rainfall decreases as you travel north along the Kent River with the Upper Kent Catchment receiving an average annual rainfall of approximately 600mm. Thus, much of the catchment for Owingup can be described as semi-arid with evaporation rates exceeding rainfall. Wind also plays an important role due to the movement of coastal dunes and deposition of wind blown sand.

4.2 Hydrology

Hydrological zones for the Kent River catchment have been classified by Ferdowsian 1995 from a combination of geological, soil-landform and borehole data. These zones identify areas with common hydrological problems and solutions. Show map from South Coast Regional Land and Water Care Strategy – The Kent-Frankland sub-region 1996. In summary zones higher in the catchment are at greater risk of salinity whilst the coastal zones surrounding Owingup Swamp are unlikely to suffer from increased salinisation.

4.3 Soils

A survey of the Owingup Swamp was conducted in 1969 by the Department of Agriculture to assess its value as agricultural land (Malcolm, Jones and Fallon, 1969). The findings indicated that around 2000 acres, 800 ha, of the swamp would be suitable for clearing, draining and used for agriculture, although this never happened. Soil samples were taken at varying depths along several transects indicated in Figure ??. The samples were then analysed by the Government Chemical Laboratories for a number of attributes including salinity, pH, moisture retention, and nutritional status. The report concluded that the soil underlying the swamp was

> …an essentially uniform area of soil with a typical soil profile of a thin layer of fibrous organic material overlying 2 to 4 ft of organic clay resting on sand. The clay contains a significant amount of diatomaceous remains and sponge spicules.

4.4 Water salinity

Limited data indicate that all wetlands within the suite are fresh in winter-spring with levels of around 0.17 ppt for Owingup swamp and Boat harbour Lake B around 0.87 ppt. Owingup and Boat Harbour Lake A and B are brackish in summer-autumn with levels of 1.8, 1.1 and 2.11 ppt respectively. (South Coast Rivercare 2005)

Water depth in the main water body is approximately 2.1m in July and approximately 0.7m in April (South coast Rivercare 2005)

4.5 Water pH

The wetlands within the suite are generally slightly alkaline with Owingup swamp measured at 6.1 to 7.4 while the Boat harbour Lakes all fall within the range of 7.4 to 8.1. (South coast Rivercare 2005)

5.0 Biological – Characteristics

5.1 Vegetation

Owingup Swamp lies within the Warren Botanical district. It is a highly diverse species rich environment with 48 species of native plants recorded. Of which 8 are sedges and 7 are aquatic (ANCA 1996 in Semeniuk 1998). There is one population of Declared Rare Flora and 14 populations of priority flora associated with the swamp system (Bain 2006).

The coastal stretch of the system is dominated by Parabolic dunes characterised by podzols over calcareous sands supporting coastal heath dominated by Spyridium and Oleria. Pockets of Bullich/ Yate are located in some of the interdune areas (Bain 2006).

The bulk of the main swamp system is dominated by organic loams and diatomaceous earths supporting *Taxandria juniperina & Melaleuca cuticularis* thickets, *Taxandria parviceps/ linearifolia* and *Lepidosperma sedgelands* and some Bullich/ sheoak woodlands.

A small granite valley enters the system from the northwest and the landforms to the north and northeast consist predominantly of deep sands, Taxandria heath and sedgelands in the lowlands and low hilly terrain dominated by Jarrah-Marri forest with some Karri and Yellow Tingle in the hinterlands (Bain 2006).

Semeniuk 1998 broadly describes the vegetation surrounding the wetland as

> Low closed forest (*Agonis junipera*), low woodland (*M. rhaphiophylla, M. preissiana, Gahnia trifida, Lepidosperma effusum*), closed scrub (*Callistachys lanceolatum*), heath formations (*Beaufortia sparsa, Agonis linearifolia, Melaleuca leptoclada, M. rhaphiophylla, Boronia denticulata, Chaetanthus leptocarpoides, Pericalymma ellipticum and Astartea fasicularis*), and sedgelands (*Baumea articulate, B. vaginalis, B. arthrophylla, B. juncea, Leptocarpus scariosus*.)

Owingup swamp is the largest remaining area of *Agonis juniperina* forest (Robinson 1992 in Semeniuk 1998)

5.2 Exotic species

Weed invasion in the area is generally quite low, with exotic grasses and clover invasion concentrated around the perimeter of the reserve and some minor weed species occurring in the interior. Other weed species such as *Trachyandra divaricata* have the potential to spread quickly into the native vegetation from neighbouring areas(Bain 2006).

5 species of exoctic plants are recorded (South coast Rivercare 2005)…LIST

Boat Harbour Lakes A, B, and C
Totals of 16, 18, and 43 plant species have been recorded in the Lakes A, B, and C respectively (ANCA 1996 in Semeniuk 1998)

5.3 Fauna

Owingup Swamp is an important wetland not only regionally but also nationally and internationally as it provides habitat for a large number of fauna species particularly birds. It is listed as a Wetland of National significance (N.L. McKenzie, J.E. May and S. McKenna 2002). Table ??? shows a list of species reported at Owingup as well as details from fauna studies conducted within the Kent River Catchment, primarily from a Forest Department Survey in the early 1970's and from Western Australian Museum records. The Forest Department Survey focused on three blocks in the upper catchment identified as Frankland, Giants and Soho, while the museum records are predominantly from the Kent River and Rocky Gully. Many of these species are likely to be found at Owingup and in the adjacent bushland, others may be only seasonal visitors while some are restricted to forest types found only in the upper catchment. These surveys found 14 species of native mammal, 85 species of birds, 22 species of reptiles, 11 species of amphibians and 8 species of fish.

Several species of threatened fauna are known to occur or have previously occurred in the area, including the chuditch *Dasyurus geoffroii*, the southern brown bandicoot *Isoodon obesulus*, the Quokka *Setonix brachyurus*, avifauna the red-eared firetail *Emblema oculata, the* Peregrine falcon *Falco peregrinus, the* Short-billed black cockatoo *Calyptorhynchus latirostris, Pezoporus wallicus,* reptile *Morelia spilota imbricata* and a priority 4 mollusc (Bain 2006). These are dealt with in more detail on page 9.

5.4 Birds

Owingup Swamp is an important habitat for waterbirds both in terms of numbers, 1457 waterbirds were recorded in March 1991 (South Coast Rivercare 2005), and for the diversity, supporting at least 39 species. This places it in the top 5% of wetlands in the south west for species richness.

This diversity increases when the Boat Harbour Lakes are included, bringing the total species recorded to 45, nine of which are listed under treaties. The most abundant species are the Eurasian coot and Australian Shelduck.

The wetland suite is an important site for the Australasian Bittern, *Botaurus poiciloptilus*, being only one of five known habitats for the species in Western Australia (South coast Rivercare 2005). This is a secretive species with the highest number recorded for the state at any one location being eight. In January 1992 5 individuals were recorded at Owingup. While at Boat Harbour Lake A 3 individuals were sited in November 1984. (Semeniuk 1998)

Ten species have been identified as breeding within the wetland suite, mostly at Owingup. The species include the Spotless Crake and the Blue-billed Duck. While the Darter, and the Little Black Cormorant are reported to nest along the Kent River. (South Coast Rivercare 2005)

Seven species are listed on both the Japan/Australia and China/Australia Migratory Bird Agreements (Semeniuk 1998) although only the Red-necked Stint appears in appreciable numbers with 200 recorded at Boat Harbour Lake A (South coast Rivercare 2005)

There is also a possibility that the Noisey Scrub Bird *Atrichornis clamosus*, is present within the reserve as several individuals were released in 1989. However, although four males were heard singing in the release area shortly after, none have been recorded since this time. (Danks, A.A. Burbidge, A.H. Burbidge and Smith 1996)

5.5 Fish

Nine species of fish are recorded within the system

5.6 Reptiles

There is one threatened reptile listed for the area the carpet python *Morelia aspilota imbricata*. (Bain 2006).

5.7 Amphibians

5.8 Macroinvertebrates

5.9 Other

In the northeast of Owingup Swamp an unusual formation thought to be related to stromatilites, known as “algal biscuits” is present, (South coast Rivercare 2005). While, at Boat Harbour Lakes A and B an organic gelatinous suspension over 1 metre thick has been described. This suspension comprises diatoms, blue-green algae, and invertebrates and their faecal pellets, held together by a mucopolysaccharide gel excreted by the unicellular algae (South coast Rivercare 2005)

5.10 Threatened Fauna

The information in this section comes mainly from the CALM Naturebase website with other specific information referenced as usual.

5.10.1 Chuditch *Dasyurus geoffroii*

The chuditch is the largest marsupial carnivore in Western Australia. The name chuditch is a noongar term. (S.R. Morton, C.R. Dickman & T.P. Fletcher in D.W.Walton & B.J.Richardson (eds) (1989)

The chuditch is generally nocturnal and occupies a wide range of habitats from woodlands, riparian vegetation beaches and deserts. Once widespread across the continent the chuditch survives now in the jarrah and karri forests of the southwest with small numbers in the wheatbelt.

Chuditch are opportunistic feeders whose principal diet is large macroinvertebrates such as scorpians, spiders, and crickets although they have been reported to eat mammals including the endangered Southern Brown Bandicoot, numbats, woylies, brushtailed possums and rodents, along with birds, small reptiles and eggs, as well as flowers and fruits including the red pulp from the seeds of the Macrozamia palm. In the eastern states quolls have been reported to supplement their insectivorous diet with grasses and herbs (S.R. Morton, C.R. Dickman & T.P. Fletcher in D.W.Walton & B.J.Richardson (eds) (1989)

Chuditch require reasonably large areas of bush. In the jarrah forest, females may have ranges of 2 to 3 square kilometres while males may range over 15 square kilometres. Generally dens are hollow logs or burrows with entrances of at least 30cm. An adult female may utilise as many as 60 or more logs and over 100 burrows within her territory.

Chuditch breed during autumn and winter with mating taking place between April and July. The two to six young remain in the pouch for around 60 days before being left in the den. Young are weaned by four to five months and begin to disperse in December. Males and females reach sexual maturity within the first year and may breed. Chuditch are thought to have a life span of around 2 years.

5.10.2 Quenda or Southern Brown Bandicoot *Isoodon obesulus*

The Quenda prefers a habitat of dense scrubby, often swampy, vegetation with dense cover up to one metre high, although they often feed in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses.

Nests consist of a heap of ground litter over a shallow depression usually concealed next to or under logs, shrubs or piles of debris. Quenda are generally nocturnal but can be active during the day. A large adult male has a home range of two to seven hectares compared with one to three hectares for females. The size of the home range depends upon the density of individuals in an area, and the locality. Individuals are usually solitary though overlap in home ranges has been recorded for some individuals. When searching for underground foods, quendas dig into the soil with their strong fore-claws to produce a characteristic conical hole and, with their eyes shut, use their nose as a probe.

The quenda is omnivorous. The diet includes invertebrates (including earthworms, adult beetles and their larvae), underground fungi, subterranean plant material, and very occasionally, small vertebrates.

Quenda breed throughout the year with a peak in Spring. The young are weaned when about 60 or 70 days old.

5.10.3 Quokka

Fossil evidence suggests that the Quokka has always been restricted to the south-west of Western Australia and was common at the time of first contact. Mainland populations declined rapidly until the 1960's when Quokkas were known only from a few isolated populations south of Perth. Today the Quokka exists in at least 25 locations on the mainland as well as Rottnest and Bald islands. In the south-west it inhabits densely vegetated swamps and tea-tree thickets on sandy soils along creeklines and some dense heaths.

Little is known about the behaviour of mainland Quokkas with most of the study done on Rottnest Island populations. Island Quokkas form groups of between 25 to 150 adults which occupy territories. On the mainland Quokkas hide in runs in thick vegetation during the day and forage at night. Their principal diet in northern forests is peppermint *Agonis flexuosa* and Thomasia species.

On the mainland, the quokka can breed throughout the year. Most females carry a quiescent blastocyst resulting from a mating shortly after the first birth of the year but few blastocysts resume development after that young has left the pouch.

5.10.4 Peregrine Falcon *(Falco peregrinus)*

Found throughout the world, the Peregrine Falcon occurs in all parts of Australia. The Peregrine Falcon, like other birds of prey, is relatively long lived, with low reproductive rates and low population density. These factors combined with the fact that they are at the top of the food chain and limited by their prey makes them particularly vulnerable to human impact.

Today populations in Australia are now generally higher than elsewhere in the world. There are no natural predators here and unlike other endangered species it is not confined to a specific habitat. Found everywhere from woodlands to open grasslands and coastal cliffs - though less frequently in desert regions - it feeds almost entirely on other birds. It also eats rabbits and other moderate sized mammals, bats and reptiles. Since 1971 all Australian raptors have been protected by legislation.

5.10.5 Carnaby's black-cockatoo

Carnaby's black-cockatoo or Ngoolark in the Noongar tongue is a large, black-cockatoo with a white patch on its cheek, white bands on its tail, and a strong curved bill. It is endemic to the south west of Western Australia. Carnaby's black-cockatoo occurs in uncleared or remnant areas of eucalypt woodland, principally salmon gum or wandoo, and shrubland or kwongan heath dominated by *Hakea, Dryandra* and *Banksia* species. Following breeding, large flocks of up to 5,000 birds move to the higher rainfall coastal areas with *Banksia* woodland and/or pine plantations, accessible water, and trees surrounding watercourses. Carnaby's black-cockatoo nests in the hollows of live or dead eucalypts, primarily the Salmon Gum and Wandoo. The cockatoos feed on the seeds of a variety of native and introduced plants (*Banksia, Dryandra, Hakea, Grevillea, Allocasuarina, Eucalyptus, Pinus*), nectar from flowers of *Dryandra, Lambertia, Callistemon, Banksia* and *Eucalyptus*, and insect larvae.

Breeding takes place from July to September with females laying one or two eggs, although it is rare for parents to successfully raise more than one chick. Survival of the fledgling is thought to be dependent upon the availability of sufficient, suitable native vegetation adjacent to nest sites.

5.10.6 Carpet Python *Morelia spilota* (Lacépède, 1804)

The subspecies Moralia spilota imbricata occurs in the south west of Western Australia in semi-arid coastal and inland habitats, Banksia and eucalyptus woodlands, and grasslands. The carpet python is most active in summer although may be seen throughout the year. It shelters in burrows, hollow branches, or rock crevices. Carpet Pythons feed on a variety of mammals, birds and reptiles. Females generally lay between 14 and 35 eggs which they wrap themselves around for up to 60 days. The young are independent at birth.

5.11 Introduced species

There are at least 7 introduced species of fauna present within the Kent Catchment which may or may not be present at Owingup and Boat harbour lakes. The mouse *Mus musculus*, brown rat *Rattus norvegicus*, blackrat *Rattus rattus*, rabbit *Oryctolagus cuniculus*, fox *Vulpes vulpes*, cat *Felis catus*, horse *Equus caballus*, and the pig *Sus scrofa*. Certainly there is evidence of foxes and rabbits and it is likely that mice, rats and cats are all present. Wild Horses are known to be present within the Frankland catchment to the west of the Kent River and are likely to visit the western part of the Kent River Catchment. The horses are thought to have originated from domestic stock (Kelly 1995). Domestic horses occasionally visit the wetland but at this stage are not considered to be an issue in low numbers. Pigs are reported from higher in the catchment (Owingup Waterways 2002), however, there is no evidence of pigs at either Owingup or the Boat Harbour lakes.

6.0 Kent River Catchment

6.1 Upper Catchment

6.2 Kent River

The Lower Kent River is in excellent condition with a thick buffer of native riparian vegetation. Trees overhanging the river provide shade keeping water cooler and restricting the growth of algal blooms. This is particularly important where water bodies may hold high nutrient levels due to runoff from agricultural land. Plants in the riparian zone act as a buffer to nutrients by slowing the movement of water and lowering its energy which permits particulate matter to settle. Nutrients present in this material may then be taken up by riparian plants. There is still a movement of these nutrients into the water body through the death of older plants and leaves or branches which fall into the river. Many of these carry high levels of tannins which leach into the water body or are released during the breakdown of the plant material. The deep amber, colour characteristic of tannin rich waters, further helps to restrict the amount of sunlight penetrating the river.

Riparian vegetation also provides habitat for many species of animals. Some may live out their entire life cycle within this zone other utilise it temporarily. Continuous stretches of riparian vegetation may provide corridors for the movement of animals which avoid crossing open ground.

Another important role of riparian vegetation is the stabilisation of stream banks by their roots. Penn 1999 in reference to the skeleton of intermeshed roots within the stream embankment states

> Human ingenuity could not build a better structural support system for the river valley, and this natural system maintains itself indefinitely, at no cost to the human community.

The Lower Kent River is a series of deep pools behind rock barriers and fallen trees. These act to oxygenate water flowing over their surface during winter months. In summer when flow slows or ceases altogether these pools will gradually become deoxygenated due to increases in water temperature, with warm water holding less oxygen than colder water (Penn 1999) and the consumption of organic matter by aerobic microbes. The snags are also important as habitat for a variety of wildlife. Larger organisms such as cormorants need such places where they may perch and spread their wings to dry (Penn 1999), while tortoises require places where they can pull themselves out of the water. Smaller organisms find either shelter or may consume the woody material directly or feed upon algae which grow upon its surface. Another important feature of such pools is that they provide permanent fresh water for native animals during the summer months.

In 2002 Green Skills carried out an assessment of the stream foreshore condition for the lower Kent River, Styx River, Little River and Owingup Creek. Over 388 km of foreshore were assessed and graded based on a system developed by Luke Penn (detailed in Water & Rivers Commission Report No RR 3 1999). In general terms the system grades the river foreshore condition through 4 major categories A, B, C, D with each of these being further divided into 3. Thus there is a scale with 12 stages from A1 pristine to D3 – Drain. It was found that of the 53 km of the lower Kent River that 80% was considered to be A grade while the remaining 20% was considered to be B grade, that is displaying varying degrees of weed infestation but not yet prone to erosion. 146 km of tributaries for the Kent River were assessed with the result that 34% were A grade, 23% B grade and the rest C grade or worse. Of the 45 km of Owingup creek foreshore 12% was A grade and 32% B grade. While for the Styx and Little Rivers 61% of the 144km assessed were considered to be A grade and 16% B grade.

It can be seen from these figures that in general terms the foreshores of the rivers systems feeding Owingup are in reasonable condition with approximately 75% considered to be B grade or better. (Owingup Waterways 2002)

7.0 Threats

7.1 Salinity

Today Owingup Swamp is considered a freshwater system with brackish conditions during summer. A dramatic increase to salinity levels within the swamp system could lead to large scale losses of freshwater riparian species such as Baumea. The extensive reed beds of the Kent River Delta (see Figure 4) provide habitat for a large number of birds and aquatic organisms many of which would die or move elsewhere should salinity levels rise significantly. Thus there would be both a loss of habitat and the organisms which drive nutrient cycling processes within the swamp until such time as a new salt tolerant fringing vegetation established itself. Most of the salt water entering Owingup comes from the Upper catchment which is characterised by highly saline rising groundwater tables. It should be noted that Owingup was once part of an estuarine system and is continually in the process of evolving. New land is being formed at the Kent River Delta and if the process continues the delta may well split the existing water body into two. The eastern of which would be likely to dry our and become seasonally inundated damplands.

7.2 Weeds

There are a number of weed species present in the Lower Kent Catchment which have the potential to infest disturbed areas of the riparian zone and to potentially enter the swamp system. (Owingup Waterways 2002) report the main threats as Blackberry *Rubus fruticosus*, Blue gums *Eucalyptus globulus*, watsonia *Watsonia spp* Bulrush *Typha orientalis*, Taylorina *Psoralea pinnata*, Arum lily *Zantedeschia aethiopica*, Sydney Golden Wattle *Acacia longifolia* and Victorian Tea Tree *Leptospermum laevigatum*. In addition species such as kikuyu, dock *Rumex spp* and *Juncus microcephalus* are present on a drain which runs directly into the swamp from the east.

Weeds are thought to threaten the health or habitat value of wetlands and river systems through a variety of mechanisms. Typically weed infested areas are dominated by a few species in comparison to native vegetation and so do not provide the full range of habitats, food sources and nesting or dwelling sites. Risk of fire may be heightened particularly in the case of annual and perennial grasses. Weeds may inhibit the generation of native seedlings and affect nutrient cycling (Hopkinson 2005). It should be noted that weeds are frequently species which are colonisers of bare or disturbed ground. In natural succession it is often grasses which are the first to appear after disturbance. Slowly, over time shrubs and finally tree species will take over. Only after very long periods of time do we once again find the full compliment of native species. Weeds are rarely the cause of the loss of habitat. In managing for weeds great care needs to be taken to avoid or minimise activities which lead to the baring of soil or disturbance of the soil profile. Further more weeds may play an important role on some sites where they are the only plants holding soil together and thus minimising erosion and the subsequent problems further down the catchment.

A roadside weed survey was conducted in April 2006 with infestations recorded and plotted on a GIS system (see appendix ??)

7.3 Blue Gums

In recent times there has been a shift from the traditional agriculture of the catchment towards a greater percentage of tree crops, particularly Blue gums. For example, between 1995 and 2002 the area of the upper catchment under timber plantations increased from 3 000 ha to over 18, 000 ha (Bradshaw 2006). There are a number of concerns with this change; Blue gums have the potential to become weeds and replace native western Australian trees in the landscape. This has occurred at a few places within the catchment and the continued spread of blue gums needs to be monitored carefully. Plantations are also reported to be refuges for some feral animals including pigs (Owingup Waterways (2002). Large scale plantings may lead to changes in the water balance of the catchment . This should be positive as bluegums are being planted on pasture which was once forest. The most sever threat to the health of Owingup and the Lower Kent River may come from current management practices for the plantations namely the use of biological poisons and fertilisers. Biological poisons, most commonly, insecticides are known to be extremely toxic to many aquatic organisms (Hopkinson, 2003) not least of which are the macro invertebrates which play a vital role in nutrient cycling within rivers, lakes and estuaries.

7.4 Phytophthora cinnamomi

Phytophthora dieback ia disease caused by the soil-borne microscopic water mould Phytophthora cinnamomi. Thought to have originated in Asia it may have been introduced to some 200 hundred years ago. Phytophthora cinnamomi attacks the roots of many native plants severely reducing their ability to transport water and nutrients (Carter 2004). There are many susceptible species present within the Owingup Swamp Reserve such as Banksias, Xanthorrhoea spp, and Macrozamias. Generally these occur along the sandy ridge lines of the old swamp system. Loss of susceptible species in these areas would severely impact on the wildlife due to loss of food sources, habitat and nesting sites.

7.5 Nutrients

Nutrients from predominantly from agricultural land pose a threat to aquatic systems by changing the nutritional status of the waterbodies and sediments. Native species adapted to low levels of nutrients or their influx in organic form may be poorly adapted to live in the new regime. Imbalances of nitrogen and phosphorus may lead to algal blooms or favour introduced aquatic species. The two major nutrients leaching from agricultural lands are likely to be Phosphorus and nitrogen. Phosphorus may be carried into the river on organic particles to which it attaches, adsorbs. It may also move within the water body as phosphorus ions. Nitrogen may enter as ammonium ions but be quickly converted by bacteria into nitrates and nitrites in which form it is most readily taken up by plants.

7.6 Habitat loss

Habitat loss is one of the major threatening processes affecting native animals in the South west of Western Australia. Kitchner (1982, cited in Bradshaw 2006) noted that of all animal groups studied, mammals have shown the greatest departure from their original richness since the fragmentation of the landscape of South-Western Australia. Fragmentation of landscape and loss of habitat are listed as threatening processes for both the Quenda and the Quokka by CALM. Many catchments have only very small areas of native vegetation remaining and these are fragmented and degraded. Weeds encroach easily on disturbed areas and although they may provide some valuable habitat and food it is unlikely that they provide the same diverse suite of beneficial attributes as intact native vegetation. Fragmentation of ecological communities may lead to species loss where individuals are unable to move between key food supplies. The loss of key species within ecosystems results in a decline of the whole system. For instance loss of a pollinator may result in a decline in recruitment of new seedlings with an eventual loss of flora from this area of the landscape. All other species dependent upon it would then be at risk. Habitat loss is not confined to the loss of flora species, frequent burning or removal of old logs may result in a lack of den sites for species such as the Chuditch. While loss of dead trees with hollows may impact on species such as Carnaby's Cockatoo.

7.7 Feral Animals

Feral animals are considered a threat to native species due to competition for resources such as food and nesting and breeding sites. They may also impact directly consuming native animals or plants. In some cases they may carry transmissible disease or through their foraging behaviour disturb or destroy fragile habitats. There are few, if any, areas in the south west which have not felt the impact of these introduced species. At least 7 species of feral animal are thought to be present within the lower Kent Catchment and so pose some level of threat to the Owingup swamp. It should be noted that for many areas native species which may have been present 200 years ago are no longer there and that little or no scientific study has been carried out on the possible ecologically beneficial role that introduced predators may be having.

Pigs were first brought to Australia as a food source however escapees quickly established feral populations. Today Australia may have as many as 23 million feral pigs. Feral pigs are

considered to be an agricultural and environmental menace. Their behaviour of wallowing and rooting around water courses and swamps is described as being responsible for destroying fringing vegetation, nesting sites and the habitat of several eastern states frogs such as the white-bellied frog, orange-bellied frog and the corroboree frog (http://www.deh.gov.au/biodiversity/invasive/publications/pig/pubs/pig.pdf).

Rabbits are considered to be a problem primarily as they compete for food with native species. In large numbers they may also interfere with an areas ability to rejuvenate after fire as they feed on young seedlings. Warrens may also lead to erosion of sandy soils particularly around the fringes of the swamp basin. Rabbits in Meditteraen climates reach sexual maturity earlier than those of the arid regions becoming sexually mature at around 7 months of age. In these environments females may produce upwards of 28 young per year with populations reaching their maximum during spring. D.W.Walton & B.J.Richardson (eds) (1989). So under suitable conditions rabbits populations are able to increase dramatically

The fox was brought to Australia in 1855 for hunting, within 100 years it had spread across the continent. The fox is thought to have played a major role in the decline of many populations of native animals. Foxes generally prey on small mammals but will eat birds, reptiles, insects and fruit if their preferred food is scarce Both males and females are sexually mature at the age of one year. Litters, averaging four cubs, are born during August and September, and emerge from the den in late spring. Foxes are considered to be a severe impediment to small mammals re-establishing colonies. For example Quendas have become abundant again at Lake Magenta after fox control programmes were initiated.

Feral cats are found throughout much of mainland Australia and are known to predate a large range of native animals from brush-tailed possums and bandicoots, through to the smaller marsupials such as dunnarts as well as birds, reptiles and macro-invertebrates. However, there appears to be no documented evidence of cats leading to the local extinction of any native species on the mainland Nattrass 1993, and D.W.Walton & B.J.Richardson (eds) (1989)

E. Jones in D.W.Walton & B.J.Richardson (eds) (1989) cites several studies where the full extent of native species one would expect to find in a particular habitat are present even where feral cats are prevalent. Nattrass 1993 also points out that in many areas the native predators such as quolls, *Dasyurus* spp, are no longer present and indicates that the feral cat may be playing the role of these predators in a sustainable manner. Both authors indicate that the role of the cat needs to be considered along with large scale ecological changes such as habitat loss and fragmentation. In some studies the major food source for feral cats appear to have been another introduced species the rabbit, which further complicates the dynamics between introduced and native fauna.

7.8 Stock

Stock impact on wetlands and riparian zones through a number of mechanisms. Firstly they may trample plants and if using a site regularly denude it of any vegetation which then leads to erosion of stream banks and an increase in sediment loads and nutrients. They may also increase the nutrient load in the waterbody through their droppings. Stock can also help to spread weed seeds either through seeds being present in manure or carried on the animal. Management of stock in riparian zones if therefore critical to the health of the river and wetland system

7.9 Acid Sulphate Soils

Acid sulphate soils is the term given to soils which contain iron sulphides. In Western Australia the acid sulphate soils of greatest concern are those which formed after the last major sea level rise. Sammut and Lines-Kelly 1995 describe the formation of acid sulphate soils as being due to

> Bacteria in organically rich waterlogged sediments converted sulfate
> from tidal waters and iron from sediments to iron disulfide (iron pyrite).
> When exposed to air, iron sulfides oxidise and produce sulfuric acid.

Acid sulphate soils are typically categorised as either "Potential" or "Actual" acid sulphate soil. Potential acid sulphate soils are those containing iron sulphides that are contained in an anaerobic environment such as being waterlogged. Actual acid sulphate soils on the other hand are those that have been exposed to the air and oxidation of the iron sulphides is producing sulphuric acid.

The exposure and subsequent oxidation of acid sulphate soils leads to many adverse environmental impacts both for agricultural land and natural ecosystems. Acid leaching from the soil profile may directly impact on aquatic life which typically requires a minimum pH of 6 to survive (Sammut and Lines-Kelly 1995). Fish exposed to highly acidic water are likely to suffer damage to gills and skin making them more prone to fungal infections and ulcerous diseases such as red spot. More subtle effects are reduced hatching and decline in growth rates (Sammut and Lines-Kelly 1995).

7.10 Biological poisons

The use of biological poisons impacts on all levels of the ecosystem. These chemicals persist in the environment accumulating in species at the top of the food chain. Peregrine falcons, as a top predator for example, are known to have experienced symptoms such as thin egg shells which may severely reduce their chances of successful breeding. Hopkinson (2003) states that the commonly used Dimethoate is known to be extremely toxic to aquatic fauna particularly macroinvertebrates such as gilgies and marron. Changes in landuse within the catchment that result in an increase in the use of of biological poisons have the potential to impact upon the health of the Kent River and Owingup Swamp.

7.11 Fire

Fire poses a serious threat to the flora and fauna of the Owingup wetland system. In general terms fire may lead to the loss of fire sensitive plant species and fauna species that require vegetative communities which arise after long periods without fire. Loss of habitat appears to be the most limiting factor for quenda because they have not persisted in areas where adequate dense cover is provided and fox/cat control measures are not undertaken (Bradshaw, 2006). (Morris et al. 2000, Paull 1999/1) has also shown that in an area where foxes and cats are likely to be present the most critical factor for quenda survival is availability of protection from predators through dense understorey. Paull (1999/1, p.5) stated that in the south-east of South Australia, emerging patterns between fire age and quenda abundance indicated that four to six years after burning, quendas made little use of habitats, and that dense regrowth of the ground layer is first necessary, which occurs at different rates in different communities. Habitat may be optimal for approx one decade after the ground layer regenerates, but some sites are used five decades after fire.

Large scale intense fires may kill fauna populations within the reserve. Recruitment from other areas may be difficult or impossible given the fragmented state of remnant vegetation within the lower catchment. Loss of habitat, including suitable cover from predators and short

term loss of nesting or breeding sites, may impose further stress on already threatened populations. With the added threat imposed by acid sulphate soils intense fire may pose a threat to areas and plant communities normally free from its impact such as reed beds and aquatic organisms through oxidation of iron sulphates and the subsequent production of highly acidic material. The combined effect of massive loss of habitat both in the water body and within the surrounding riparian community could be disastrous for local populations of already threatened species such as quenda, Chuditch and Quokkas. Other species which are thought to be present within the reserve such as the Western Ground Parrot, and those for which efforts have been made to relocate, such as the Noisey Scrub Bird both require vegetation with long periods between fires.

7.12 Global Warming

Owingup Swamp, today a freshwater wetland, was once part of a larger estuarine complex refered to by semeniuk as the Owingup Irwin Estuarine Complex. Over time sedimentation and land formation at the Kent River Delta has led to the upper part of the estuary becoming separated and the formation of Owingup Swamp. Water still moves from the Kent River to Irwin inlet subsurface. Water also flows across the surface between Irwin and Owingup at times of high flood. With sea levels expected to rise over the next few decades it is possible that Owingup Swamp will once more become joined to Irwin Inlet and return to its former saline estuarine life. Over time, 100's to 1 000's of years there will be a transition from freshwater to salt tolerant species and from species which prefer static or seasonal water level fluctuations to those which are able to tolerate daily tidal fluctuations. Although a diverse native riparian community may arise it will be different to the freshwater system currently in place.

Figure 4. Lower Kent River Catchment, Kent River delta & Owingup wetlands. Note the extensive Baumea spp reed beds surrounding the delta, the fragmented nature of remnant vegetation and the bush corridor along South Coast Highway.

8.0 Management Recommendations

Owingup swamp is a refuge for many species of wildlife whose populations are in decline. Fragmentation of bushland and degradation of habitat across much of the south-west have made these animals more vulnerable to other pressures such as fire and predation from introduced predators.

The health of the Owingup swamp is largely dependent upon two things the quality of the water entering the wetland and the health of the riparian vegetation and surrounding bushland, the two being closely linked. The quality of water entering the system is mainly dependent upon that flowing from the Kent River. As discussed earlier (see page ?/) riparian vegetation plays an important role in buffering the river from nutrients. This ability diminishes as the riparian flora becomes degraded through inappropriate stock access or clearing. To prevent further degradation of the riparian zone 260 km of stream line fencing was recommended throughout the Kent River Catchment south of the State forest. (Owingup waterways 2002). Protection of foreshores and the subsequent regeneration of riparian communities will also provide a greater degree of connectivity between large areas of remnant vegetation and between seasonal food sources or habitats. This is particularly important for small vertebrates such as frogs, lizards and small mammals who face a much greater risk of predation if they

have to cross open ground with little cover. Where possible existing corridors such as the old railway line between Denmark and Walpole should be fenced to exclude stock and revegetated where necessary to provide a wildlife link. Linkages should attempt to join ecologically dissimilar communities such as jarrah, marri woodlands on ridge tops with karri and heath communities of the lower landscape so as to provide diverse seasonal habitats. The benefit of native corridors is much diminished by the incursion of weeds and efforts should be made to control the movement of weeds within such systems. Where possible weeds should be removed and replaced with suitable local native species. Where impracticable care should be taken to minimise disturbance to surrounding bushland in terms of clearing, stock access, and fire to slow further encroachment of introduced plant species. Information should be passed onto landholders regarding weed and pest control methods such as steam, grazing management, planting density, hand removal, cover cropping and soil nutritional status which minimise the use of biological poisons in weed control.

Fire as a management tool should be used with care throughout the lower catchment. Although some native species are fire dependent and fire may be used to stimulate the regeneration of some areas of remnant vegetation, fire always leads to a reduction in the complexity and nutritional status of an area. Nutrients are lost to the system through smoke and particulate matter, soil humus may be entirely lost if fires are intense. In a fragmented landscape re-colonisation by small vertebrates may not be possible so local populations can be lost through a broad scale intense fire regime. Particular caution needs to be adopted for areas close to the Owingup Reserve so as to minimise the chance of a large scale peat fire which could result in the oxidation of acid sulphate soils and all the subsequent acidification and mobilisation of heavy element issues. Fire within the reserve should be kept to a minimum and, where utilised, low intensity mosaic regimes implemented. Animals such as the southern Brown bandicoot have been shown to require bush which has had many years to regenerate post fire and thus provide suitable shelter for survival. This is even more important in areas such as Owingup where foxes and cats are present.

Access to the reserve is mainly only possible through Boat Harbour Road which turns into a 4WD only track at Boat Harbour Lakes. Signage should be in place to advise drivers to keep to designated tracks and so minimise further erosion issues within the coastal dune system. Access to Owingup Swamp is via a track off Boat Harbour Road. This track, built around 40 years ago by local landholders, is the only access by vehicle to the main water body and so is a valuable entry for those wishing to monitor or utilise the swamp. It is however, also a potential access point for feral animals, weeds and disease. Signage at the entrance to the track displaying appropriate usage of the wetland environment would serve to educate users and minimise accidental disturbance or damage. Phytophthora cinnamomi could cause considerable damage to the bushland within the reserve particularly to the plant communities of the ancient ridge systems which have many susceptible species such as Banksias Xanthorrhea spp and Macrozamias. A wash down bay for vehicles at the track entrance could help to minimise this threat.

Management Recommendations Table

Site/Issue	Threat	Recommendations
Kent River		
Tributaries to Kent River	**Stock access, weed incursion, loss of riparian flora**	**All creeklines be fenced to exclude stock access. Revegetation with native species of bare or degraded foreshores.**
Drain east of Owingup	**Weed incursion**	**Removal of weeds from creek – revegetation with local species.**
Bush corridors	**Connectivity**	**That all remaining remnant vegetation be protected from stock access by fencing. That where practicable key areas of remnant vegetation are linked by new bush corridors of local species.**
Track into Owingup	**Access, vechiles, horses**	**Signage indicating appropriate use of wetland area.** **'Dieback' wash down facility installed and maintained.**
Lower Catchment Acid Sulphate Soils	**Oxidation resulting in acidification of wetland**	**Information circulated to all landholders in the lower catchment advising them of the presence of Acid Sulphate Soils & management recommendations for mitigating the threat. That soils in the lower catchment within the Pleistocene boundary of the Owingup swamp remain covered and undrained. That only small scale low intensity fires used in this area.**
Fire	**Loss of flora & fauna, oxidation of ASS**	**Impact of fire reduced to a minimum – low intensity patchwork of fire that would be more appropriate for threatened fauna species.**
Weeds - roadside	**Loss of habitat & native species**	**To act upon recommendation from Roadside weed survey – removal of weeds from priority sites.** **On going removal and monitoring of infestations.**
Access tracks boat Harbour	**Transmission of disease, weeds, vehicles, horses, feral animals**	**Signage at track entrance advising of dieback threat, need to keep to track and appropriate care of wetland area.**
Feral animals	**Competition with & predation of native fauna**	**Fox baiting program in lower catchment, trapping of pigs and cats be carried out in lower catchment**
Nutrients	**Eutrification of water body, algal blooms**	**Landholders assisted to adopt sustainable nutrient management and minimise use of water soluble fertilisers**
Salinity	**Loss of freshwater species and riparian community**	**Protection of remnant vegetation and integration of deep rooted perennials in Upper catchment farming systems**
Biological poisons	**Loss of native species**	**Advise to landholders on alternative methods of biological control**
Phytophthora cinnamomi	**Dieback, loss of native species**	**Dieback survey of lower catchment to map present infected & protectable areas, signage & wash down station at entrance to Owingup**

9.0 Conclusion

Owingup Swamp is a permanent wetland at the bottom of the Kent River. Once joined with the Irwin Inlet it is now separated by sediments laid down by the Kent River delta. Owingup Swamp is an area of significance for its habitat values for many waterbirds, aquatic fauna, and threatened species. The major threats to the system are;

- acidification due to the oxidation of acid sulphate soils,
- the introduction of soil borne root pathogens such as Phytophthora cinnamomi,
- inappropriate fire regimes,
- invasion of introduced weed species, and
- eutrification of the waterbody.

It is recommended that the weed infestation sites prioritised by the Denmark Weed Action Group be removed, that fencing and rehabilitation of streamlines within the lower catchment be continued in accordance with the Green Skills Owingup Waterways report, that information is provided to landholders regarding the threat of acid sulphate soils, and that where possible wildlife corridors are established to link areas of remnant vegetation. Further, minimisation in the use of biological poisons and appropriate fertilisation regimes by landholders within the lower catchment will ensure that Owingup Swamp continues to be a beautiful and diverse sanctuary for many native flora and fauna species.

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