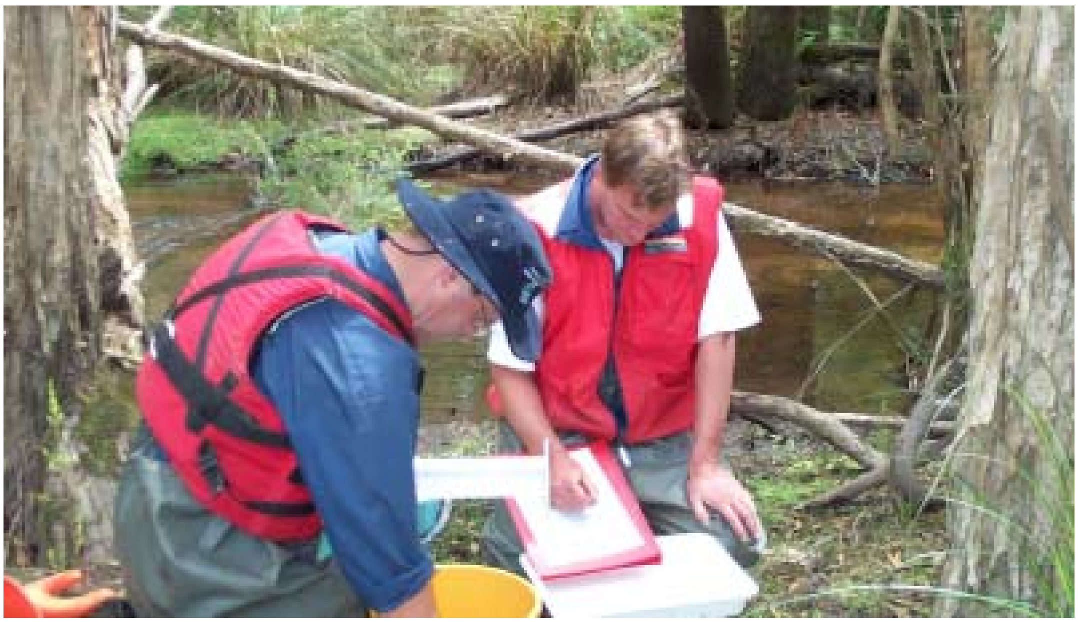
Study to Determine Water Requirements for McKerrows Marsh - Great Forester River



Characterisation of ecology of McKerrows Marsh wetland

Water Assessment and Planning Branch
Water Resources Division, DPIWE

Report Series: WAP 05/01 – Part 2
July, 2005

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DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT

Tasmania

Preferred Citation:

DPIWE (2005) *Study to determine water requirements for McKerrows Marsh – Great Forester River: Characterisation of ecology of Mckerrows Marsh wetland.* Water Assessment and Planning Branch, Department of Primary Industries, Water and Environment, Hobart. Technical Report No. WAP 05/01 – Part 2

ISSN: 1449-5996

Cover Photo: ***Fish sampling in McKerrows Marsh.***

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1. Introduction

The McKerrows Marsh, as defined by the proposed Nature Reserve (Figure 1), encompasses about 386 hectares of dense blackwood-teatree swamp and extensive sedgeland, and is located immediately above the limit of tidal influence on the Great Forester River. The marsh can be spatially divided into two parts; the west arm which includes most of the blackwood swamp forest and through which the Great Forester River flows via a series of meandering channels, and the east arm which is dominated by grassy wetlands and black gum forest. The east arm has been substantially modified by tree removal, the installation of open drainage channels and straightening of the Great Forester River. A low levee (about 2 metres in height) exists on the left-hand bank of the river in this section of the marsh, and as a consequence the land on that side dries out much more and is used for cattle grazing during the summer. The land on the right-hand side retains more wetland characteristics and is used by waterfowl (black swans and native ducks) for nesting and rearing of young.

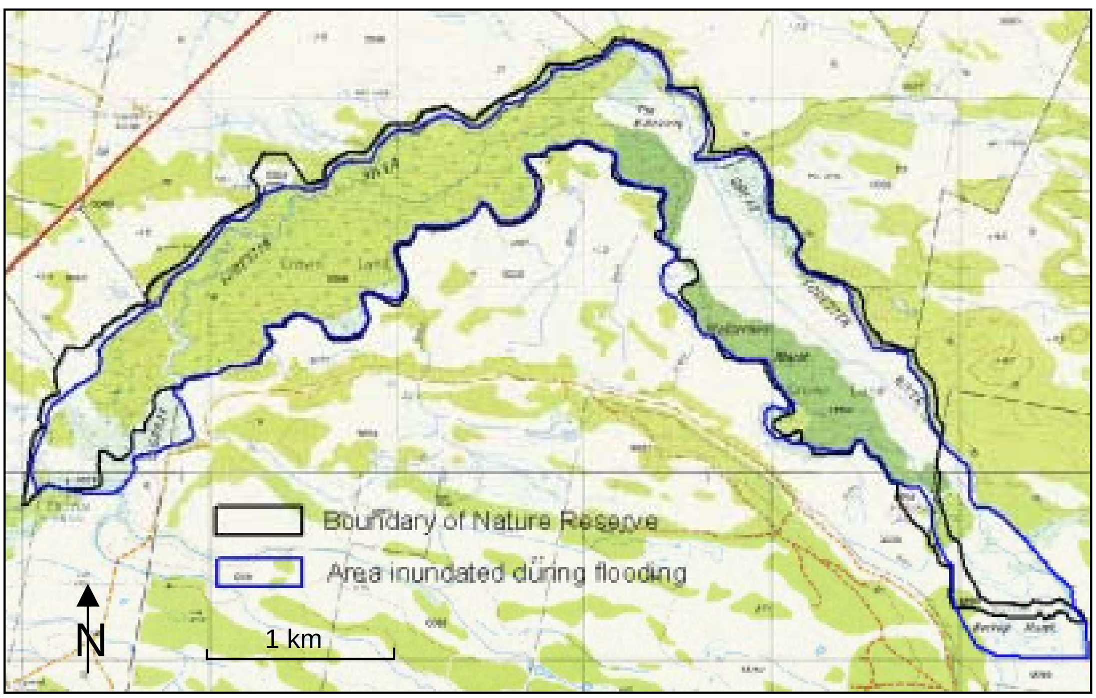

Figure 1: Map showing the boundary of the proposed Nature Reserve at McKerrows Marsh, and the probable area of inundation during larger floods in the Great Forester River.

The aim of this report is to draw together historical and recently acquired information on the flora and fauna inhabiting the Marsh, to determine the ecological health of the ecosystem and assisting with the subsequent development of an ecologically relevant environmental water allocation for the Marsh. It is also envisaged that some of this information will be useful in future management and protection of the wetland under the Natural Resource Management strategy for the region.

While the main focus is on describing the nature of the ecosystem and biota inhabiting the Marsh, the report also includes information about the water and habitat requirements of wetland plant species that has been gained through a brief review of the recent literature. This information will be used later to recommend an ecological water allocation for the Marsh.

2. Flora

Previous surveys

The only significant historical information that is available regarding the swamp environment is contained in Parks & Wildlife Service inter-office memos dated 20 September 1982, and 6 December 1983, in which are reported details of visits by staff (J. Bayly-Stark & S. Harris). It is clear from these documents that the blackwood swamp at that time was essentially undisturbed with the exception of trampling around the edges by foraging cattle, although interviews with the lease-holder of the reserve at the time revealed imminent plans to clear additional sections of the Marsh. Anecdotal evidence from a long-term resident of Bridport also suggested that the blackwood swamp had once extended as far upstream as Wonder Valley (4.5 km above the currently proposed Nature Reserve boundary) and as far downstream as the Waterhouse Road.

From the information contained in these memos, it is clear that the swamp (as it existed in 1983) consisted of a healthy and complex mosaic of *Acacia melanoxylon* (blackwood), *Leptospermum lanigerum* (woolly teatree), *Meleuca squarrosa* and *M. ericifolia* (paperbark), *Eucalyptus ovata* (black gum) and various sedge and health species. *Carex apressa* (tall sedge) was noted as the most common understory plant, and it was also noted that all age classes of blackwood were present.

The memos also make mention of numerous breaks in the otherwise dense canopy by tree-fall, and where this occurred 'dry land' species such as *Coprosma quadrifida* (native currant), *Hypochaeris radicata* and others were found. In such areas numerous blackwood seedlings were also present.

Some 'open-water areas' were also noted on the southern margins of the swamp, and these were stated as containing native and introduced species of emergent aquatic plants (*Myriophyllum* sp., *Hydrocotyle pterocarpa* and *Typha* sp.). Perons Marsh Frog (*Lymnodynastes peronii*) was also heard at these open-water habitats.

In terms of aquatic fauna, trout, blackfish and galaxiids were visually noted in the sections of flowing river, while native ducks and swamp hens were seen at the fringes of the marsh.

The memo concludes with a statement that "the area is probably the largest remaining stand of blackwood in north eastern Tasmania and is of great ecological interest".

Some scant information on the forest community at McKerrows Marsh is also contained in a Forestry Commission report 'Swamp Forests of Tasmania' (Pannell, 1992). In this document the swamp at McKerrows Marsh has been classified as a 'coastal paperbark/sedge swamp forest'. The only other remark in the report relates to the 'mallee' type habit (multi-stemmed form) of some individuals of *Melaleuca ericifolia* and *Leptospermum lanigerum*, with a statement that this may be promoted by recurrent flooding. The report concludes with a suggestion that the area be reserved as a matter of high priority, due to its high regional significance in northeast Tasmania.

January 2005 Vegetation Survey

Much of the following information has been taken from a survey report on the vegetation community currently existing in McKerrows Marsh (full report is contained in Appendix 1 of this document). The survey was carried out in early January 2005, and focussed on developing an inventory of the plant species, mapping plant communities and identifying any threats or management concerns.

As mentioned above, McKerrows Marsh is a mosaic of different vegetation types and these vary in extent and condition. Eight plant communities were mapped (Figure 2) and all but one of these (the coastal black peppermint forest), is dependent on water flow in the Great Forester River to maintain them in their present state. The eight communities that were identified and mapped are as follows:

1. Blackwood swamp forest/paperbark swamp forest
2. Grassy/sedgey wetland
3. Woolly teatree scrub
4. Paperbark swamp scrub/forest
5. Willow
6. Black gum forest
7. Coastal black peppermint forest
8. Wetlands

Ninety-six plant species were recorded (55 dicots, 33 monocots and 8 ferns) and of these two are listed on the *Tasmanian Threatened Species Protection Act 1995*, (purple loosestrife and hemp bush). The Marsh has not escaped weed invasion, and 25 of the species that were identified are exotics that have been introduced to Tasmania. This is particularly evident in the grassy/sedgey wetland, where Harding grass (*Phalaris aquatica*) and willow (*Salix cinerea*) are present in abundance. Harding grass appears to have been introduced from the mainland, where it does occur naturally.

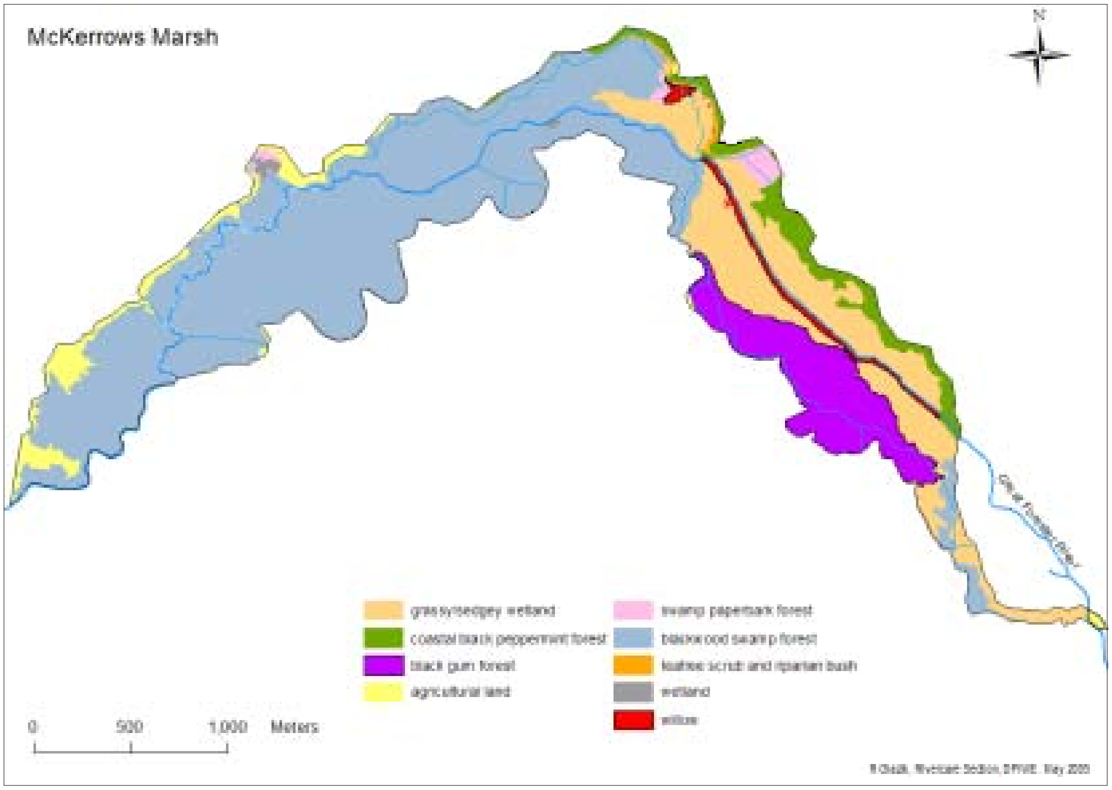

Figure 2: Vegetation types at McKerrows Marsh, at the bottom of the Great Forester catchment.

McKerrows Marsh is spatially dominated by three main plant communities; the blackwood/paperbark swamp forests that cover almost all the western arm of the Marsh (Plate 1), and the grassy/sedgey wetland (Plate 2) and black gum forest that covers most of the eastern arm of the Marsh. In the eastern arm, it is likely that removal of the forest canopy, the installation of drainage and river straightening have dried out the grassy/sedgey wetland sufficiently to allow the introduced Harding grass to gain a competitive advantage over the native sedges, which favour wetter conditions. Coincidentally, these drainage activities may also have contributed to the death of mature trees within the black gum forest (although die-back in other Eucalypt species suggests that this may be a regional phenomenon). All of these plant communities are characteristically found in low-lying, riparian environments, and rely on seasonal inundation caused by river flooding. The degree of this reliance on flood patterns is likely to vary.

One other plant community that occurs within McKerrows Marsh and is very reliant on seasonal inundation is the 'wetland' community. This community is composed of species such as *Myriophyllum* sp., *Eleocharis* sp., *Triglochin* sp., *Lilaeopsis* sp. and others, that are typically regarded as truly 'aquatic' wetland plants. Small patches of these wetland communities are dotted throughout the areas mapped as blackwood swamp and black gum forest. While these contain locally unique plant communities in their own right, they also provide ideal habitat for frog breeding and recruitment, as well as a nursery area for juvenile fish such as southern pygmy perch (see aquatic fauna section below). Therefore, any overall water management regime for the Marsh should also take into consideration the water required to maintain this habitat.

Plate 1: Blackwood swamp forest that covers most of the western arm of McKerrows Marsh.

Plate 2: Grassy/sedgey wetland (The Billabong) that covers part of the eastern arm of McKerrows Marsh. A dense stand of willows can be seen in the background.

The presence of the significant thicket of willows on the northern boundary of 'The Billabong' was thought to be significant during the field assessment of McKerrows Marsh, and further desktop investigations were subsequently carried out. An examination of aerial photographs revealed that at some point between 1984 and 1991 a major event occurred that opened up an erosion 'gash' within the wetland that was then colonised by willows. The streamflow record for the river (Figure 3) shows that in the winter of 1988 a very large flood occurred (94 m^3s^{-1}) and it is very likely that during this event the course of the river changed, leaving its old channel along the northern boundary of the Marsh and travelling through the centre of the swamp forest. As a result of this realignment, a substantial deposit of sand and gravel was deposited alongside the new course of the river, and it seems that the willows were best placed to quickly colonise this area. During the field survey it appeared that many of the willows in this thicket are of the same age, supporting this conclusion.

This thicket poses a significant threat to the long-term condition and integrity of McKerrows Marsh, and small willows are making an attempt to move from the river channel in the eastern arm of the Marsh out into the grassy/sedgey wetland. The presence of the willow thicket also highlights the risk that any future major flood event that results in river realignment is likely to cause more willows to colonise parts of the Marsh.

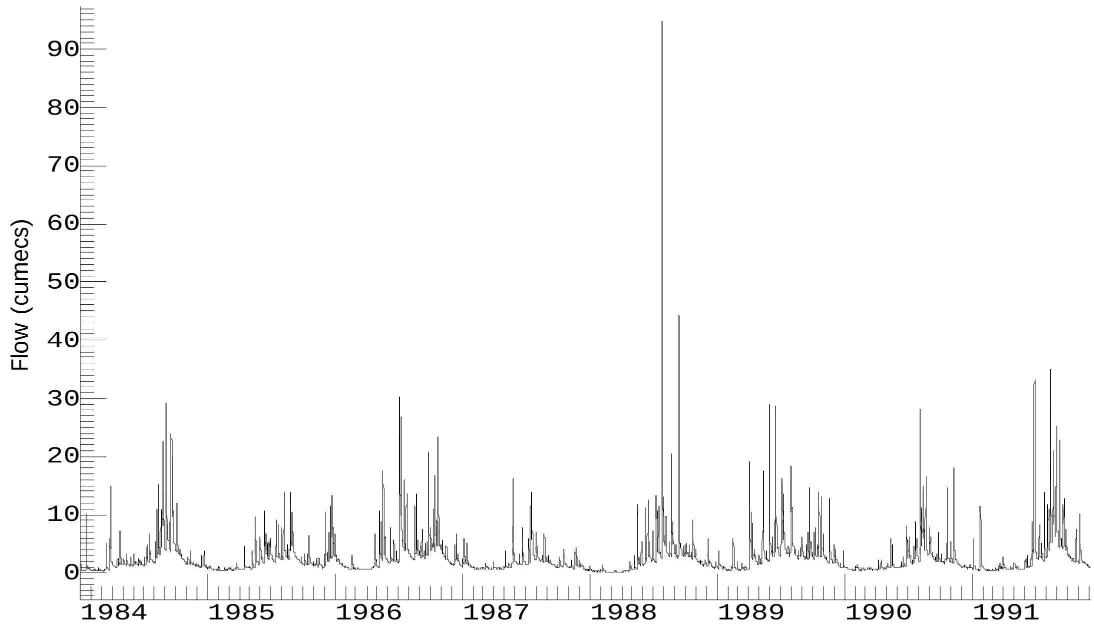

Figure 3: Time series of streamflow for the Great Forester 2 km upstream Waterhouse Road, showing the significant flood event of 94 m^3s^{-1} in winter 1988. The estimated annual return interval (A.R.I.) of this event is about 1:15 years.

Literature on wetland plants

A review of the literature regarding water requirements of wetland plants and riparian floodplain forests was conducted, however very few specific Australian studies have been undertaken that provide information that might justifiably be transferred to plant communities living within the Marsh. The most notable source of information is Davis, *et. al.*, (2001), which reviews Australian experience in determining water regimes for wetlands and presents methodologies for conducting such studies. From this document it is evident that most of the work in Australia has focussed on riverine lakes and floodplain 'wetlands' as opposed to swamp forests. However some specific information regarding water requirements of similar plant species can be extracted from this document and a number of journal articles. These are outlined in brief below.

- Submerged aquatic macrophytes (eg. *Myriophyllum* sp.) require water that is not excessively deep (Balla and Davis, 1993), whilst emergent macrophytes require seasonal drying (Halse, *et. al.*, 1993), but also extended periods (months) of seasonal inundation for flowering and seed production.

- Health and recruitment of juvenile *Melaleuca halmaturorum* is negatively impacted by inundation periods exceeding 6-9 weeks (Denton and Ganf, 1994), but recovers easily from flood inundation periods of 3 weeks or less.

- During studies of an open lake system (Thompsons Lake, WA) it has been recommended that groundwater levels should not fall in the range 0.5 to1.0 metres below lake bed level more than once every 10 years, to maintain the health of fringing sedge vegetation (Townley, *et. al.*, 1993).

- Experimental trials where wetland seed banks were inundated for 8-week periods over a range of seasons (Britten and Brock, 1993) showed that germination could occur during any season, but greatest numbers of individuals and taxa germinated in autumn, and fewest in summer. Temperature appears to play a role as well – high minimum and maximum temperatures may inhibit germination during summer, when seedlings have least chance of survival. The list of taxa examined during this study includes many of those that are present in 'wetland' and 'grassy/sedgey' communities in McKerrows Marsh.

- Ladiges, *et. al.*, (1981) studied waterlogging tolerance of *Melaleuca ericifolia* in Victoria and found that seed germination is delayed by submergence in water (seeds may be adapted to cope with anaerobic conditions), but this does not affect the final percentage of seeds that germinate. These authors also suggested that seedling growth may be increased by waterlogging (compared to freely draining), that inundation stimulates root growth (new roots are thick and aerenchymatous), and that roots run horizontally rather than vertically to better cope with anoxia. This suggests that the periods of 'dry' present a greater risk to seedlings than lengths of inundation.

- Although species of *Eucalyptus* have adapted to widely varying climatic and edaphic conditions, no species appears to be able to grow in permanently waterlogged conditions (probably mainly due to anoxic effects). Experiments by Ladiges and Kelso (1977) showed that juvenile *E. ovata* were more tolerant of waterlogging than those of *E. viminalis*, but the reasons for this may be many, including root morphology (aerenchyma), lower metabolic processing and lower nutrient demands.

- There is very little in the literature regarding the water needs of blackwoods (*Acacia melanoxylon*). Although it is clear that the species can grow in a diversity of situations, it appears to favour fertile, freely draining valley basin soils and blackwood forests are usually located on organic-rich alluvial flats that are frequently inundated by floods.

Some more general environmental information that relates to species that have been found in McKerrows Marsh is summarised below. This information has been taken from more general texts on water plants (Sainty and Jacobs, 1988; Romanowski, 1998) and wetland plant communities (Brock, *et. al*., 1994).

- *Lythrum salicaria* (purple loosestrife) is a native perennial, emergent open wetland plant that flowers in summer and dies back in winter. It is found in a wide variety of wet to shallowly flooded swamps and riverbank areas. It can tolerate short periods of flooding during growing season, but no other specific water requirements have been identified.
- *Triglochin procera* (water ribbon) is a native perennial emergent macrophyte that produces a seed-spike in summer. Seeds germinate readily in autumn in shallow water and small plants can survive winter if not de-watered. Established plants are hardy and can handle extended dry periods as they have underground rhizomes. Plants put up leaves readily after rainfall, but will not flower until flooded.
- *Phragmites australis* (common reed) is a very hardy native perennial with an extensive rhizome system. Spread is mainly vegetative, and is found in stationary or slow-moving water bodies, stream margins and swamps, and areas where a high water table is maintained or is seasonally inundated.
- *Juncus* spp. (common rushes) are perennial emergent sedgey/grassland species that prefer damp/saturated soils alongside rivers and in wetland margins that are usually only periodically inundated by shallow water.
- *Eleocharis sphacelata* (tall spikesedge) is a native perennial with a robust rhizome system that mainly inhabits areas where there is permanent standing water (shallow up to 2 metres deep), or consistently saturated soil. Spread is mainly vegetative, but can be through seed germination.
- *Rorippa dictyosperma* (forest watercress) is a native, emergent wetland plant that is most commonly found along the edges of muddy river-banks and slow-flowing streams. It flowers in summer, with seeds released in late summer – autumn, but also spreads readily through vegetative means.
- Members of the Apiaceae (*Hydrocotyle* spp. and *Lilaeopsis polyantha* were found in McKerrows Marsh) can handle extended periods of inundation.
- Members of the Asteraceae inhabit fringes of wetlands, and generally cannot handle waterlogging for long, though some species appear to favour areas that are seasonally flooded.

- Cyperaceae (sedges): Members of the genus *Lepidosperma* (and *Schoenus*) are generally terrestrial, but *L. longitudinale* forms extensive stands in shallow, ephemeral wetlands and around the flooded fringes of deeper areas. It is replaced by other, more aquatic sedges (*Eleocharis* spp.) where water regularly stands for more than a few months per year. *Cyperus lucidus* also prefers wetter conditions.
- Poaceae (grasses): These are grasses, and as such really prefer drier, more sunlit conditions, where flooding is intermittent and drainage is better. *Phragmites australis* is the major exception, preferring saturated conditions.

The information presented above highlights the diverse range of environmental requirements of plants living in 'wetland' or 'marsh' habitats. It is clear that these areas contain a range of plant species with differing levels of preference or tolerance to inundation, and tolerance levels can vary depending on a whole suite of factors. These include, but are not limited to; the depth of inundation, the age of the plant, the duration of inundation, the nature of the substrate in which the plant grows and the season during which inundation usually occurs.

Denton and Ganf (1993) suggest that any overall recommendation regarding water regimes for wetlands should encompass three main principles: Firstly, the timing and depth of water will differentially influence the germination, recruitment and establishment of species and thus influence the floristic diversity of a wetland. Secondly, the duration and depth of floods will affect hydrophytes and flood-tolerant and flood-intolerant species in different ways, depending upon whether they are prone to anoxia or post-anoxia injuries. Thirdly, the spatial pattern of wetland vegetation will be a product of these factors within the limits set by inter-annual variations.

Given that the Great Forester River is unregulated and already has a natural flow regime that appears to be maintaining a healthy and diverse vegetation community, the challenge in developing an 'environmental water allocation' for McKerrows Marsh is to try and quantify the risk posed by altering the existing flow regime. How much additional water can reasonably be extracted from the system before un-natural changes to the ecosystem begin to occur? From what part of the hydrograph can water safely be taken? How much water can safely be extracted from the groundwater before there are impacts on the marsh? These are the questions that will be dealt with during later stages of this project.

3. Aquatic Fauna

Although McKerrows Marsh is used by a host of avian and terrestrial animals (various species of water fowl, black cockatoos, owls, possums, wallabies and wombats), the main focus of this section is to identify those animals whose life-histories are likely to be closely linked to the water regime of the wetland. Therefore, the discussion will be restricted to fish, aquatic invertebrates and amphibians, although since breeding by waterfowl is known to occur within the Marsh some acknowledgment will be made of the needs of these species.

Fish

Information on the composition of the fish community inhabiting McKerrows Marsh was collected during electrofishing surveys of the river system carried out in December 2004. Electrofishing surveys were conducted at 5 locations within the Marsh (Table 1), most of which were within the river channel, and comprised 20 minutes of active searching.

Table 1: Location of sites within McKerrows Marsh where electrofishing surveys were undertaken.

Location Name	Location Code	Easting (AGD 66)	Northing (AGD 66)
Great Forester River at 'Forester Lodge' pump-pond	GFOR53	545650	5461505
Great Forester River at 'Lovers Reach'	GFOR57	546725	5462025
Great Forester River at the 'Boat Hole'	GFOR54	544850	5460475
McKerrows Marsh cut-off channel 49	GFOR56	547100	5461725
Grassy wetland upstream of 'The Billabong'	GFOR58	547650	5461625

From these surveys, a total of eight species of fish were found to inhabit the river within McKerrows Marsh. There were (in order of overall abundance);

- *Nannoperca australis* (southern pygmy perch)
- *Galaxias maculatus* (common jollytail)
- *Pseudaphritis urvillii* (sandy, or freshwater flathead)
- *Anguilla australis* (short-finned eel)
- *Mordacia mordax* (short-headed lamprey)
- *Galaxias truttaceus* (spotted galaxias)
- *Gadopsis marmoratus* (blackfish)
- *Salmo trutta* (brown trout)

The most common species were the native southern pygmy perch and the common jollytail. These were collected in nearly equal numbers and were present at all locations that were surveyed. Blackfish and brown trout were rare, however it is very likely that because of the dark staining of the water, and the difficulty in sampling deeper holes within the wetland, blackfish are actually present in greater numbers than were found using this technique. Discussions with the land-holder suggest that this is indeed the case.

Although pygmy perch and jollytails were collected throughout the wetland, the habitat in which they were most abundant was different. Southern pygmy perch were most abundant in ‘slack water’ habitats, where there was prolific and dense cover of aquatic plants such as *Myriophyllum* spp. (watermilfoil) and *Rorippa* spp. (watercress). The grassy wetlands within ‘The Billabong’ and upstream (Plate 3) is an example of habitat that is preferred by this species, although ‘herb-fields’ located along the edge of the main river provided good habitat as well. Most of the fish that were caught during the electrofishing survey were young to mature adults (30 to 55 mm in length).

Additional evidence that the smaller ‘open-water’ wetlands within McKerrows Marsh (Plate 4) are important habitats for this fish species, particularly during the early part of their life-history, was gathered during kick-net sampling of a small ‘open-water’ wetland in October 2004. During opportunistic sampling for macroinvertebrates, large numbers of very young pygmy perch (5 to 10 mm) were captured in the sampling net. This suggests that these small wetlands provide ideal nursery areas for newly hatched larval fish, as they do not experience high water velocities and are too shallow for larger fish that might prey on them.

Together, this information supports conclusions by Davies and Humphries (1995) that pygmy perch have an “almost complete reliance on riparian wetland macrophyte beds” for all stages of their life history.

Plate 3: Small grassy wetland on the right-hand side of the Great Forester River upstream of 'The Billabong'.

Plate 4: An example of the small 'open-water' wetlands that are dotted around McKerrows Marsh and may be important nursery areas for southern pygmy perch.

The other abundant species in the marsh, the common jollytail (*Galaxias maculatus*), was found to prefer river channel habitat, where there was flowing water. In these environments it forms small schools that usually travel along the river's edge. This species is migratory, and along with spotted galaxias (*Galaxias truttaceus*) forms a substantial part of the annual 'whitebait' run in rivers along the north coast each spring (Fulton, 1990). It is unlikely to have any particular requirements in terms of water regime as it relates to McKerrows Marsh, other than the occurrence of spring floods to trigger migration from the estuaries into the river system.

The spotted galaxias (*Galaxias truttaceus*) was much less abundant in McKerrows Marsh, and was found at only a single location, in a slow-flowing cut-off channel where the bed of the channel was dominated by gravel, fallen logs and leaf litter. Little is known about the spawning habitat of these fish, but it is appears that eggs are laid in freshwater in autumn and the larvae are swept downstream, to return to the river during the spring 'whitebait run' (Fulton, 1990).

Freshwater flathead (*Pseudaphritis urvillii*) are native to lowland rivers and streams throughout Tasmania (Fulton, 1990) and although it has not been confirmed, it appears that they spawn and hatch in estuarine or marine environments, with juveniles moving into freshwater in late spring. During the survey of McKerrows Marsh this species was found at all sample sites, although it preferred to inhabit the bottom of slow-flowing sections of river around fallen woody debris and amongst leaf litter rather than very shallow ponded, or muddy backwater habitats.

The short-finned eel was also fairly common in the Marsh and was found in similar habitats to freshwater flathead, although some individuals were captured in backwater habitats. The short-finned eel is very common and widely distributed throughout most of Tasmania, and is considered a very hardy species inhabiting a broad range of instream habitats.

A number of lamprey ammocetes and one adult (*Mordacia mordax*) were caught during the surveys. The ammocetes (juvenile lampreys) were caught in depositional areas like the bed of cut-off channels and in the mud of backwaters within the grassy wetland. The single adult, which was probably migrating inland from the sea to spawn, was captured in the main river. Adult lampreys are known to migrate upstream to headwater areas between November and March. Actual spawning occurs between July and September, and newly hatched ammocete larvae live in soft mud in the bed of rivers for about three to four years (Koehn, 1990) before migrating downstream to the sea. Within McKerrows Marsh, the soft mud of the river bottom and the muddy area within the grassy/sedgey wetland around 'The Billabong' are the two main habitats favoured by the juveniles of this species.

Although few blackfish (*Gadopsis marmoratus*) were collected during the electrofishing survey, discussions with landholders indicate that the species is commonly caught throughout the riverine habitat in McKerrows Marsh. This is consistent with Fulton (1990), who states that this species favours slow-flowing sections of rivers on the north coast of Tasmania, particularly where instream woody debris is abundant. Blackfish spawn in spring and early summer, each female depositing 20-500 eggs in a patch on the bottom surface of a log or rocks. These hatch after about three weeks, and this is followed by an embryonic stage that lasts another month. In developing a water regime for McKerrows Marsh that will preserve blackfish populations (and the populations of several other fish species), it appears that the maintenance of snag habitat within the river channel is the priority, as this is provides both adult habitat and a surface for egg deposition.

From the results of this survey it is clear that trout do not find suitable habitat within McKerrows Marsh. Within the western arm of the Marsh, the odd adult fish was seen in open pools (eg. The Boat Hole), but environmental conditions (particularly stream flows and dissolved oxygen levels within the blackwood/paperbark swamp) are not likely to favour this species. The only other section where fish were found was in the straightened river section upstream of ‘The Billabong’, where the river itself is more open and flow velocity is greater. Maintenance of environmental conditions for this species within McKerrows Marsh is not seen as a priority.

Finally, in reviewing the distribution data for native fish in Tasmania it was identified that McKerrows Marsh falls within the range of the dwarf galaxias (*Galaxiella pusilla*), which is listed as ‘rare’ in Tasmania. This species was not found during this survey, but records from DIPWE databases show that dwarf galaxias have been collected from drainage ditches to the north of the Marsh, one of which flows southwards into the Marsh. Although this species may occur in the Marsh, information on locations where this species has been found indicate that it prefers slow-flowing, shallow, open drains and lagoons, and it is likely that McKerrows Marsh may not provide much suitable habitat.

Aquatic Macroinvertebrates

Samples of the macroinvertebrate community in McKerrows Marsh were collected in October and December of 2004, and April of 2005 using the AUSRIVAS sampling method. Samples were collected from edgewaters along the main river and side-channels within the Marsh, where there was flowing water. These samples were 'live-picked' in the field and the subsequent samples taken back to the laboratory for identification down to family level. The taxonomic list from this identification is presented in Appendix 3, and the resulting data was then used as input to the spring AUSRIVAS 'edgewater' model for Tasmania, to give some indication of the health of the macroinvertebrate community within the Marsh. It must be pointed out that although these samples were collected using the AUSRIVAS sampling technique, live picking was not carried out strictly following the standard methods for this technique. As a result, the outputs should be regarded as indicative only.

A total of 46 families of aquatic macroinvertebrates were collected in the edgewater kicknet samples. The variation in taxa diversity between sites was moderate, with most taxa (25) being recorded in the river where it flows through the 'sedgey/grassland' habitat, and where there was greatest 'trailing' bankside vegetation. Fewest taxa (17) were collected from the river within the heart of the 'blackwood/paperbark forest', where the river contains most mud and silt, and has least trailing vegetation that could provide good edgewater habitat for aquatic biota. Using relative abundance of individuals in samples and the their frequency of occurrence between sites, the aquatic invertebrate fauna within the Marsh is dominated by; water mites (Hydracarina), side swimmers (Parameletidae), diving beetles (Dytiscidae), various families of non-biting midges (Chironomidae), leptophlebiid and oniscigastrid mayflies, corixid and veliid bugs, gripopterygid stoneflies, and several families of caddisflies. Many of these taxa are either cosmopolitan in the range of habitats they inhabit, or are more typical of slow-flowing waterways with substantial supplies of decaying plant material.

The following table presents the assessment of 'riverine health' within the McKerrows Marsh wetland. It should be mentioned that in developing the predictive models for AUSRIVAS in Tasmania, very few 'reference' sites could be found more than 50 km downstream from the river source. As McKerrows Marsh is located slightly more than 50 km below the source of the Great Forester River, this means that all of the test sites are on the very edge of the predictive capability of the AUSRIVAS models. Nevertheless, the outputs from the spring/edgewater model are given below in Table 2, and are useful in demonstrating that the 'health' of the aquatic macroinvertebrate community inhabiting the Great Forester River within McKerrows Marsh is generally good. Results which have resulted in an 'A' classification are essentially healthy, whilst those falling within the B band are slightly impaired. Lower OE50 results were obtained for two locations within the blackwood\paperbark forest, where it has already been mentioned that conditions do not naturally provide suitable 'edgewater' habitat for macroinvertebrates, and the results reflect this rather than any degradation in river condition.

Table 2: River health assessment outputs from the AUSRIVAS spring/edgewater model for Tasmania.

Site Name	OE50 Taxa	OE50 SIGNAL	OE0SIGNAL	Band
McKerrows at Forester Lodge - i	1.09	0.95	0.97	A
McKerrows at Forester Lodge - ii	0.65	0.96	1.01	B
McKerrows at Boat Hole	1.09	0.89	0.97	A
McKerrows at small wetland	0.86	0.93	0.94	A
McKerrows at Cut-off Channel	0.86	1.21	1.23	A
McKerrows at Lovers Reach	0.75	1.03	1.15	B
McKerrows u/s Billabong	1.18	0.93	0.98	A

Crayfish

There are 15 species of small burrowing freshwater crayfish (*Engaeus* spp.) in Tasmania, many of which are distributed across the northern half of the State, have overlapping distributions and can be found in similar habitats (Bryant & Jackson, 1998). All of the *Engaeus* species are distinguished by their ability to burrow, often to depths in excess of 2 m, and are very rarely seen above ground. These burrows can be connected directly to streams and rivers, to local groundwater tables, or they can be associated with areas of runoff.

Burrowing crayfish feed on plant material, detritus and other ground dwelling invertebrates. The breeding season (as indicated by the prevalence of 'berried' females) is generally between July and December.

The northeast of Tasmania is noted for its exceptionally diverse crayfish fauna (Doran & Richards, 1996), and during the course of other field-based work for this study *Engaeus* spp. burrows were found scattered throughout the western arm of McKerrows Marsh, where blackwood and paperbark swamp forest communities dominate. In some areas, the density of burrow entrances was locally very heavy, and often occurred in pasture outside the boundary of the marsh. Relatively fewer burrows were noticed within the grassy/sedgey plant communities that dominate the eastern arm of the Marsh, however this may be a reflection of the lack of visibility due to the density of ground-covering plants rather than a true lack of burrows.

Because of resource constraints, and the substantial effort that is required to obtain crayfish specimens in the field, surveys to identify the species responsible for these burrows were not carried out. In lieu of this, a review of notable literature on the distribution of burrowing crayfish in Tasmania (Horwitz, 1990; Doran & Richards, 1996) reveals that the species that may be responsible for these burrows are *Engaeus mairener*, *Engaeus tayatea* and possibly *Engaeus spinicaudatus* (the Scottsdale burrowing crayfish). The latter species is listed as 'endangered' under both the *Tasmanian Threatened Species Protection Act* 1995 and the Commonwealth *Environment Protection and Biodiversity Protection Act* 1999, and has only been found in the Surveyors Creek and smaller tributaries of the lower Great Forester River north of Scottsdale (Gaffney & Horwitz, 1992). It is described as mainly occurring in "floodplains and riparian areas of streams (often with scrubby tea-tree or paperbark vegetation), seepages and wet pasture or buttongrass or wet heathy plains" and appears to prefer "organic, permanently saturated surface soils" (Bryant & Jackson, 1999).

Important issues that have been identified for the management of all burrowing crayfish (and in particular for the Scottsdale burrowing crayfish) are;

- maintaining water availability (especially in seepages);
- the retention of healthy native riparian vegetation communities (particularly swamp habitat);
- prevention of water contamination, particularly by pesticides;
- the exclusion of stock that can result in soil compaction and damage to burrows; and
- activities that might impact on soil water retention and water table levels.

The Giant Freshwater Crayfish (*Astacopsis gouldi*) is endemic to the Great Forester River drainage system, and adults of the species have been found in the main river down as far as Wonder Valley (some 6 km above McKerrows Marsh). However, no specimens were spotted during surveys conducted during this study, and it is unlikely that the Marsh provides particularly good habitat for the crayfish, which prefers deep pools, cool water temperatures and well-oxygenated water.

Frogs

Interrogation of databases available within DPIWE shows that a number of frog species have been noted as inhabiting the area to the north and west of McKerrows Marsh, and therefore may occur within the wetland. These are:

- the eastern banjo frog (*Limnodynastes dumerili*)
- the spotted marsh frog (*Limnodynastes tasmaniensis*)
- the brown tree frog (*Litoria ewingi*)
- the green and gold frog (*Litoria raniformis*)
- the common brown froglet (*Crinia signifera*)

In addition to these species, the report from a field visit to the Marsh by Bayly-Stark and Harris in the mid-1980s indicates that the more uncommon *Limnodynastes peronii* (striped marsh frog) was also present (calls noted). During field work for the present study, calls of *Geocrinia laevis* (smooth froglet) and *Litoria ewingi* have also been identified. It is therefore clear that the Marsh is likely to provide habitat for up to seven species of frog, two of which are listed under the *Tasmanian Threatened Species Act* (1995) as 'rare' or 'vulnerable'.

The complex life-cycle of frogs means that the habitat they require varies with age as well as by species. Egg masses are generally attached to emergent vegetation in shallow water, and this habitat also provides cover and a rich feeding ground for young tadpoles (Littlejohn, 2003). This land – water interface is also important for adults during the breeding season and can provide a refuge from predators during the daylight hours. Fringing woodlands and forests are also important environments for feeding by adults and also provide habitat for refuge and hibernation. For some species (such as *Limnodynastes dumerili*), periods of water scarcity may be dealt with by burrowing, whilst for other species fallen logs in damp conditions may provide suitable refuge during dry periods (*Litoria ewingi*). Some species (eg. *Limnodynastes peronii*) may be more reliant on the existence of permanent water.

Spring, summer and autumn appear to be the most commonly used seasons for breeding, although some species are opportunists and may breed at any time of year (*Crinia signifera* and *Litoria ewingi*). There is a wide range in the amount of time spent in the larval (tadpole) stage, and therefore the time during which standing water is a prerequisite for survival. In some species, metamorphosis from the tadpole stage can occur within as little as 6 to 12 weeks (*Crinia signifera*) whilst for species such as *Litoria raniformis* and *Limnodynastes dumerili* the tadpole stage can last as long as 15 months.

The information presented above clearly shows that the presence of standing water habitat within McKerrows Marsh is critical to the survival and recruitment of frogs. It is likely that the ‘wetland’ and ‘grassy/sedgey’ plant communities that occur throughout the marsh are important habitats for breeding, egg-laying and tadpole development.

4. Important issues for water management

1. General Remarks

It is clear from the information that has been collected during this phase of the study that there are a number of important biological values that need to be considered when developing a water regime to maintain the condition of McKerrows Marsh into the future. Because of the interconnectedness of many of these values, it may not be necessary to develop a water regime that will cater for the needs of each and every value that has been identified. The most logical approach will be to develop a water regime that aims to support the critical values that must be protected if the marsh ecosystem is to survive in the long-term.

Possibly the most important value within McKerrows Marsh relates to the blackwood/paperbark forest community. This vegetation community is highly significant in a regional context, as only approximately 374 ha is left in northeast Tasmania, 215 ha of which is held within the marsh. As well as containing a highly diverse ecosystem, it provides habitat for a number of unique and endangered plant and animal species. Implementing water management measures to maintain this habitat will ensure the protection of these other unique species.

The following sections present some of the other important ecological and conservation values that have identified in each of the main vegetation community types, and briefly mention important issues or threats to these values now or into the future. The order in which they are presented in no way implies their relative importance.

2. Open wetland habitats:

- These areas contain unique aquatic plant species that the marsh is not necessarily recognised for, but have some conservation significance. In developing rules to preserve components of the existing flow regime for the Marsh, some consideration should be given to the water regime that will sustain this habitat – particularly with regard for seed germination and plant recruitment.

- From the results of aquatic fauna sampling, it is clear that the connection of these areas to permanent water during winter and early spring provides for the successful breeding and recruitment of juvenile pygmy perch to the local population. This plant community is also likely to function as an important area for breeding and recruitment of frogs, in particular for those species that are more reliant on ponded water. To facilitate breeding and maintenance of frog populations within the area generally, inundation of these habitats is likely to be most important during spring and late in autumn.

- Other risks to the preservation of this habitat within McKerrows Marsh include physical damage to open wetlands by cattle and exposure of fauna (most particularly frogs and burrowing crayfish), to pesticides and herbicides entering through surface or groundwater pathways.

3. Blackwood/paperbark forest community:

- Given the lack of available surface water for agricultural production, future groundwater extraction is likely to increase. This has the potential to cause significant decline in the water table below the marsh, and negatively impact on this plant community, and the population of burrowing crayfish that inhabit the area, as both may struggle to reach water if the level is substantially lowered. Both paperbarks and blackwoods have shallow roots, and cannot maintain contact with groundwater if it is too deep.

- Long-term declines in groundwater may also result in excessive loss of surface water to groundwater (mostly during intermediate and low flows), meaning that the vadose zone becomes drier, negatively impacting the swamp forest community.

- The inter-flood period is probably the most critical feature of the surface hydrology that needs to be considered, as excessively long intervals between flooding are likely to stress adult tress and negatively impact on the survival of seedlings. It seems likely that the inter-flood interval is already going to increase as a result of climate change, as the record shows that flows in the Great Forester River have declined somewhat over the last 30 years.

- Flood durations (ie. duration of inundation) may also be important to the long-term maintenance of this plant community. If large dams upstream are allowed to harvest flood water, questions regarding how much water can ‘safely’ be harvested need to be answered – particularly from more frequent moderate-sized floods. It may not be possible to provide a definitive answer to this question, but in determining ‘harvesting rules’ the issue of impact on flood duration must be considered.

4. Grassy/sedgey wetland community:

- Because of the predominance of grasses within this community, and in particular the dominance of the introduced Harding grass, this habitat probably has the lowest priority in terms of the provision of environmental water regimes. While many of the plants within this community are adapted to periods of saturation, most appear to be quite hardy and can handle dry conditions to some degree. Indeed, drainage activities in this area may have favoured the introduced Harding grass, and resulted in the dominance of this species in this community.

- Although this plant community contains the ‘vulnerable’ plant Purple Loosestrife, the most significant factor in considering any potential water needs for this area is likely to be its use for breeding and rearing of young by waterfowl. Several species of wild duck, black swans (with cygnets) and other native waterfowl were seen during the course of other field-work for this study, particularly during spring when much of this wetland community on the right-hand side was covered by standing water. Major threats to the current use of this area by waterfowl are future drainage of the wetland on the right-hand side of the river, and infestation by introduced willow, which would dramatically alter the nature of this habitat.

5. Black gum forest community:

- During the visual inspection of this community, which occurs as a discrete patch on the eastern arm of McKerrows Marsh, it was clear that many mature trees had died, particularly in the northwestern sector. The black gum forest community lies within the part of the Marsh where extensive drainage has been carried out (several deep drains occur in and around this forest). Therefore it seems logical that these drains may have contributed to the loss of these trees by lowering both the residence time of flood-waters and the level of the local groundwater table. Future management activities aimed at preserving McKerrows Marsh might consider restoring inundation patterns in this part of the Marsh through reducing the effectiveness of these drains (eg. plugging). This should not be undertaken without first conducting a thorough hydraulic analysis to determine its possible impacts on other parts of the Marsh and the surrounding agricultural land.

6. Willows:

The presence of this species within the marsh is a threat to the long-term integrity and condition of the Marsh. Although the spread of willow under normal circumstances (ie. normal hydrological conditions) is likely to be minimised by the presence of other, well established plant species, another significant flood event that causes erosion or realignment of the river channel is likely to result in the further spread of willow. This is a particularly significant threat within the grassy/sedgey wetland area, where light conditions are more favourable and there are few larger plant species.

Although it is not the aim of this document to recommend general management issues for the Marsh, in this case willows present a long-term threat that is best dealt with sooner rather than later. It is therefore recommended that activities to remove willows from within McKerrows Marsh be undertaken as a matter of high priority. No recommendation about how this should be done is made here, but advice on this matter can be obtained from the Rivercare section of DPIWE.

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Appendix 1: Report on a vegetation survey of McKerrows Marsh

Location:	McKerrows Marsh on ‘Barnbougle’, Great Forester River
Grid Reference:	E546450 N5461650
Elevation:	<10 metres
Bioregion:	Northern
NRM region:	North
1:25 000 Tasmap:	Oxberry 5446
Recorders:	Rae Glazik, Chris Bobbi.
Date:	January 2005

An inspection of McKerrows Marsh was undertaken to determine the natural values, and for this information to be used — with other scientific data — to determine water requirements for the area. The survey was carried out in January 2005 focussing on the flora values which included an inventory of the plant species, mapping of the plant communities and identification of any threats or management concerns.

McKerrows Marsh is a mosaic of different vegetation types and these vary in spatial extent and condition. The grassy/sedgey wetlands are a combination of native and exotic species often dominated by exotic species, and the blackwood swamp forests, while having exotic species within them are not ecologically altered by these. Eight plant communities were mapped and all but one of these (coastal black peppermint forest) are dependent on water flow from the Great Forester River to maintain them in their current state. The area has been fenced off from stock and management issues include fence maintenance, weed control and water management.

There are willows in the area and removal is recommended. However, prior to any works being undertaken an inspection by a fluvial geomorphologist is recommended. The removal of the willows is seen as essential to maintain the blackwood swamp forests in the long term.

Ninety-six plant species were recorded (55 dicots, 33 monocots and 8 ferns) and of these two are listed on the *Tasmanian Threatened Species Protection Act 1995*, (purple loosestrife and hemp bush), and twenty-five are introduced to Tasmania.

Methods

Methods used included desktop research, interrogation of existing GIS databases and undertaking field survey work. Research undertaken to find existing data on McKerrows Marsh resulted in a survey undertaken by Bayley-Stark and Harris in 1983. This related only to the western end of the reserve, the blackwood swamp forest, and included a start on determining the previous extent of blackwood swamp forest in the immediate area.

The Threatened Species Database (managed by the Threatened Species Unit, Nature Conservation Branch, DPIWE) was interrogated for possible locations of threatened species in the area, and likely candidates. Only one threatened species on the Threatened Species Database was recorded from the general area and was not located on site during the brief survey work.

Survey work consisted of visiting selected areas of the Crown Land and recording any plant species and the plant community and noting any management issues.

Plant community information

During a survey of the natural values of McKerrows Marsh in January 2005, nine plant communities were recorded. These are

1. Blackwood swamp forest/paperbark swamp forest
2. Grassy/sedgey wetland
3. Woolly teatree scrub
4. Paperbark swamp scrub/forest
5. Willow
6. Black gum forest
7. Coastal black peppermint forest
8. Wetlands
9. Pasture

The area has not escaped weed invasion, and this is particularly evident in the grassy/sedgey wetland. The river has been straightened through this plant community, and this channel is now lined with willows. Another willow infestation has developed downstream from the channel on what appears to be a large sediment slump. This willow infestation is of a single age range. Willows are also spreading out from the channel into the grassy/sedgey wetland to the west of the straightened river channel.

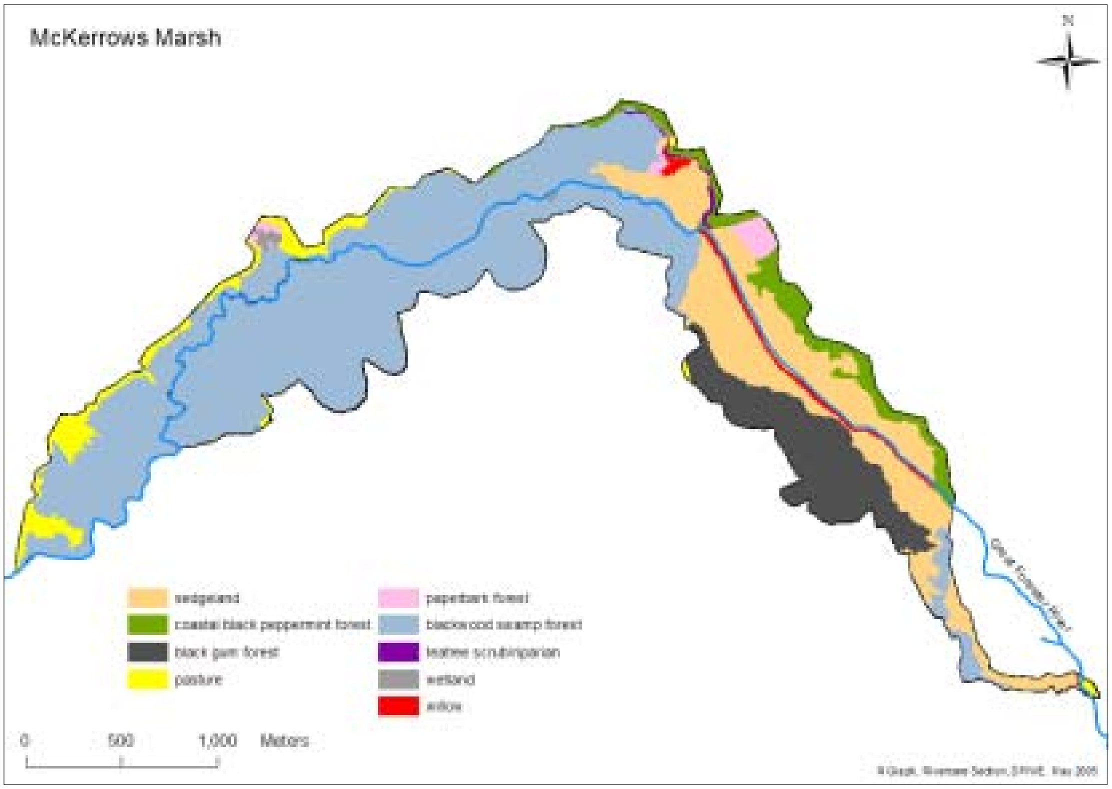
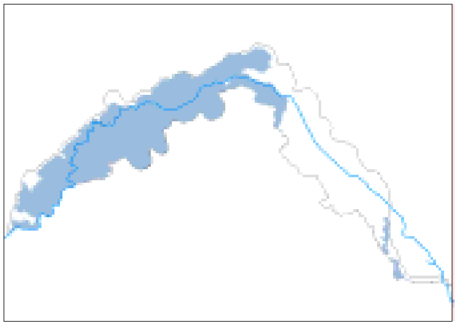


Figure 1: Vegetation types of McKerrows Marsh.

1. Blackwood swamp forest/paperbark swamp forest.



Canopy: blackwood

Shrub layer: paperbark, native current, dogwood

Ground cover: leaf litter and bare ground 60–90%, ferns, annual and perennial herbs

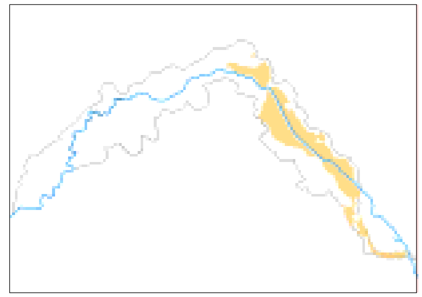
This community is rare in the north-east today, due to past clearance for production. Blackwoods tower up to 20 metres in parts of this swamp forest, and in other are 10–12 metres high. There is a series of age ranges of blackwoods. Interspersed with the blackwood swamp forest are discreet areas of paperbark swamp forest. The paperbark (*Melaleuca ericifolia*) appears to follow disused channels within the swamp forest, perhaps out-competing the blackwoods in wetter areas, and often dominates along the edges of the swamp.

There is ample regeneration of the tree species occurring throughout the blackwood swamp forest. There are also a series of introduced plants within the plant community, forming part of the ecosystem. The most prolific at the time of recording is Harding grass (*Phalaris aquatica*). This plant has spread to flourish where there are canopy gaps and established to the point where removal or even control are likely to be unsuccessful. Harding grass is well established in the sedgeland upstream of the blackwood swamp forest.

Other introduced species are annual weeds, which includes grasses such as foxtail fescue and herbs such as chickweed. These plants proliferate in some years and are barely there in other years. Management options are limited with possibly no benefits to the ecosystem.

Management issues for this plant community would be to ensure adequate water runs through the swamp to maintain the trees and regeneration, to provide an intact and functioning ecosystem that can sustain itself over time. Threats to this plant community are from stock, upstream willows, irrigation and climate change.

2. Grassy/sedgey wetland



Sedges: tall sedge, leafy flatsedge, pithy swordsedge

Grasses: Harding grass, fog grass, tussock grass

***Ground cover*:** leaf litter and bare ground 10–15%, slender birdsfoot-trefoil.

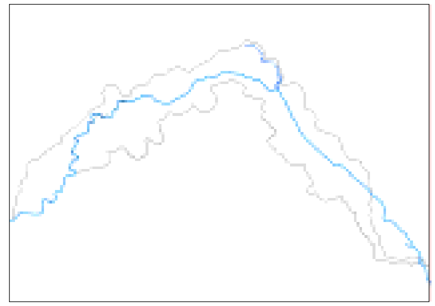
This area occurs in the eastern part of the Crown Land. The Great Forester River has been straightened in this area and now runs through the wetland effectively dividing it into two areas. The channel is lined with crack willow, with a scanty amount of natural vegetation (mainly silver wattle). The willows are starting to spread out into the wetlands, which could present ideal conditions for the development of a willow swamp. The hydrology of this area is altered due to past drainage activities.

The vegetation in the wetland is dominated by several different plant species and forms a mosaic across the landscape. Harding grass, which is introduced to Tasmania, occurs throughout and frequently dominates. The ground is uneven to walk over, quite tussocky, with the vegetation growing upward of 1.5 metres. Other dominants include tall sedge and leafy flatsedge. The relative abundance of all three dominant species will no doubt vary seasonally, but in January 2005, Harding grass appeared to be the most abundant. Other species that occur are tussock grass, pithy swordsedge, fog grass, and in the inter-tussock spaces are smaller grasses such as creeping bent grass, slender birdsfoot-trefoil. The cover of exotic species is high in this plant community, up to 60% in areas. This area looks to be seasonally inundated, perhaps being wet for several months during the year.

Threats to this plant community are from the invading willows, which are spreading from the channel. Knowing the costs and complexities involved in removing willow swamps, experience would suggest that control measures be taken sooner rather than later. The presence and abundance of the Harding grass is a potential threat. It is possible that reduced water levels favour the Harding grass over the native species, such as pithy swordsedge, leafy flatsedge and tall sedge.

Stock entering the area will have an effect on water quality, but in low enough numbers the vegetation will survive. When the area is wet, cattle and sheep can cause major pugging of the soil.

3. Woolly teatree scrub



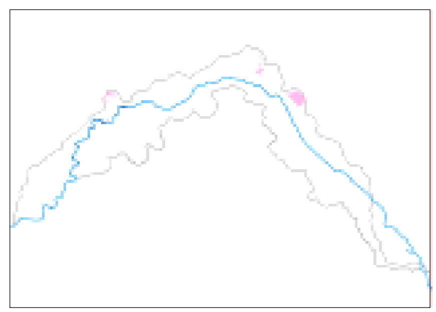
Shrub layer: woolly teatree, dogwood, paperbark

***Ground cover*:** leaf litter and bare ground 60–90%, ferns, annuals and perennial herbs

Occurs fringing the sedgelands and likely to be present along the river in the blackwood swamp forest area. The teatree scrub consists of a narrow band of teatree along the edge of the river channel. Teatree dominates at 2–4 metres in height, with others species such as dogwood and paperbark occasional. The ground is generally leaf litter and bare soil, interspersed with clumps of native and exotic grasses or ferns.

Threats to this plant community are from the invading willows and reduced water flow

4. Paperbark swamp scrub/forest

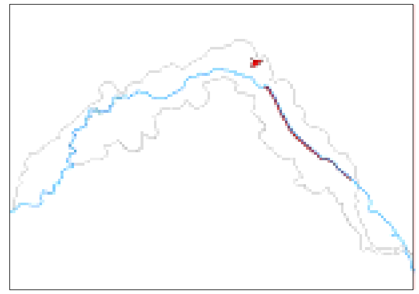


Canopy: paperbark, teatree

***Ground cover*:** leaf litter and bare ground 60–90%, ferns, annuals and perennial herbs

Paperbark swamp has been mapped separately for the eastern areas; however it co-occurs with blackwoods in the blackwood swamp area, appearing to favour old drainage lines. Paperbarks are some 6–10 metres high and dominant. Other species that occur in the canopy include dogwood, native currant, woolly teatree and blackwood. Ground is litter and bare soil with ground covers including matted pratia and chickweed, and some areas where ferns flourish. Threats to this plant community include inadequate water flow.

5. Willow



Canopy: willow, dogwood, teatree

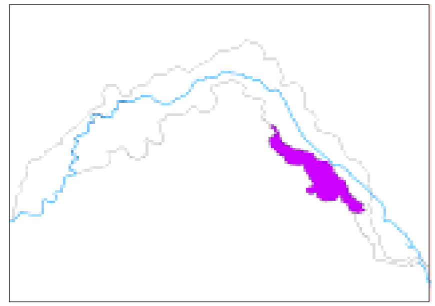
Shrub layer: teatree, dogwood

Ground cover: leaf litter and bare ground 70–100%

Willows occur along the drain on the eastern side of the reserve, and in one clump as indicated on the map. This clump appears to be the result of a single event, such as a large scour cause by a single major flood event, with all the willows being a single age range. Examination of aerial photographs and the flow record for the river suggest that a massive flood event in1988 may have been responsible for creating an exposed bed of gravel which willows could colonise. Willows dominate the canopy at 8–10 metres Underneath this canopy are scattered woolly teatree and dogwood. The ground is mostly bare and sandy/gravelly. Currently the willows have not spread beyond the sediment slug; however, there is a chance that in the next flood event they will spread further into the blackwood swamp area. Once there, they will have every opportunity to then spread into areas of slow flowing water.

Adjacent to the drain the willows are now spreading into the sedgeland, which appears to present an ideal environment for willow colonisation. This community is a threat to the entire ecosystem of the marsh.

6. Black gum forest



Sedges: black gum, white gum

Shrub layer: prickly box, silver banksias, native currant, prickly mimosa

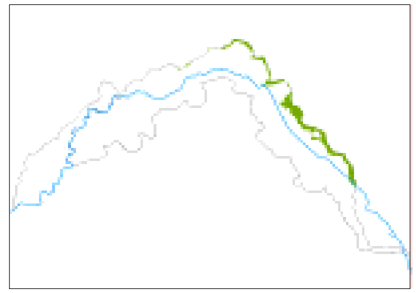
Grasses and sedges: pasture grasses, swordsedge, tall sedge, tussock grass

Ground cover: leaf litter and bare ground 10%

Black gum forest occurs in one large patch, however black gums are also present in the blackwood swamp forest. The black gum forest consists of trees up to 20 metres high with an understorey being a mosaic of exotic grasses through to layers of shrubs. On the edges, pasture grass has spread into the forest but there are still good numbers of native shrubs such as native currant, prickly box, silver banksia and prickly mimosa, and now that stock are excluded these will all be able to flourish. The ground is well covered with pasture grasses, swordsedges, tall sedge and tussock grass. This combination stabilizes the ground reducing erosion and is excellent habitat for small birds in the area. There is significant dieback in the black gum forest and while dieback is apparent regionally through out a range of plant communities it is possible that the altered drainage of the Great Forester River has contributed to the degree of dieback in this plant community.

Threats to this plant community include grazing.

7. Coastal black peppermint forest



Canopy: black peppermint, cabbage gum, white gum

Shrub layer: silver banksias, prickly box

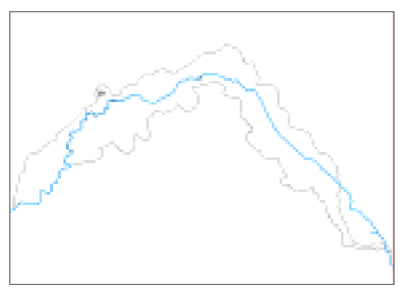
Shrubs < 1 metre: common flat pea, beard heath

Ground cover: leaf litter and bare ground 60–90%, ferns, annuals and perennial herbs

Occurring on the higher banks this bush type is relatively rich in species, with a low incidence of exotics. While black peppermint dominates there are also white gums and cabbage gums in this bush, all up to 25 metres high. The understorey consists of a range of native plants such as silver banksias and prickly box 3–6 metres high and shrubs less than one metre such as common flatpea and coast beardheath. The ground layer consists of leaf litter ranging from 20–60%, bare ground 10–30%, grasses, and both native and exotic herbs. These areas are worthy of further investigation to determine any management issues and complete the species lists.

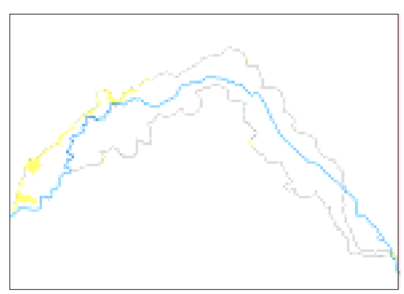
Threats to this plant community include grazing and invasion of woody weeds from surrounding areas.

8. Wetlands



Wetlands too small to map are scattered throughout the blackwood swamp and black gum areas. One wetland was looked at in detail on the northern edge. This wetland consists of a mosaic of sedgelands, herbfields and aquatic plants dormant until the next flush of water passes through. While having some introduced species, it is an excellent example of a wetland in the area. Threats include grazing, inadequate water flows and weed invasions.

Pasture



Some agricultural land falls within the boundary of the proposed reserve, and contains introduced pasture grasses.

Discussion

Blackwood swamp forest has been extensively cleared in the Northern NRM region. This patch, at 215 hectares, is the largest patch of the 430 hectares mapped (Tasmanian Vegetation Mapping Program). During this survey 56 hectares of the ‘mapped’ blackwood swamp forest was found to be incorrectly identified. From this we can deduce that at the very most there is only 374 hectares of blackwood swamp forest left in the northern NRM region of Tasmania. This plant community is therefore highly significant in terms of conservation value.

Water requirements for the area should be considered within a catchment context. Lack of research of the water requirements for maintenance of blackwood swamp forest hinders the determination of environmental water allocations, and some targeted research may be required to fill this knowledge gap. Monitoring of the current water flows along with monitoring of the health of the vegetation may add to our knowledge of the effects of altered water regimes on vegetation community health. The objective of any mandated water management regime for this section of the Great Forester River should focus of maintaining the current ecological character of the Marsh. This concept will incorporate a degree of deviance from the pre-European state which now forms part of the Marsh and needs to be accepted as part of its present ecological function. Any future water management regime should focus on maintenance rather than restoration.

Some monitoring of different plant communities could lead to some interesting results. The grassy/sedgey wetland in particular has a high percentage of exotic grass (Harding grass). This grass can tolerate wet soil conditions, and due to it deep root system can also tolerate dry conditions (http://ucce.ucdavis.edu/datastore/detailreport.cfm). Monitoring this area would give an indication as to whether or not Harding grass is spreading, has reached its peak, or is declining in extent. In addition research into the black gum forest requirements may be enlightening as to the cause of the dieback in this plant community.

Willows are a threat to the vegetation and control measures should be considered. The willow has been mapped in detail and a combination of control techniques would yield optimum results. Removal should be considered over a number of years. Prior to any control being undertaken an inspection by a fluvial geomorphologist is recommended to determine possible negative implications. Access to the willow is difficult, being surrounded by grassy/sedgey wetland — access by foot only. Control techniques to consider should include helicopter spraying, drill and fill, cut and paste application and foliar spraying for secondary work. If any willows are up-stream of the area, they will be a source of re-invasion.

Complete plant list for 'McKerrows Marsh' arranged by scientific name

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Nomenclature follows Buchanan 2003

i = introduced and naturalised in Tasmania

e = endemic in Tasmania

t = within Australia it is only found in Tasmania

No symbol indicates that the species is native to Tasmania and the Australian mainland

The letters indicate the plant is listed on the Tasmanian Threatened Species Protection Act (1995), EN = endangered, V= vulnerable and R = rare

DICOTS

APIACEAE		
	Hydrocotyle sp.	
	Lilaeopsis polyantha	jointed swampstalks
ASTERACEAE		
i	*Carduus tenuiflorus*	winged thistle
i	*Cirsium vulgare*	spear thistle
i	*Hypochoeris glabra*	smooth catsear
i	*Hypochoeris radicata*	rough catsear
i	*Leontodon taraxacoides*	hairy hawkbit
	Senecio minimus	shrubby fireweed
BORAGINACEAE		
i	*Myosotis laxa* subsp. *caespitosa*	lesser forget-me-not
BRASSICACEAE		
	Rorippa dictyosperma	forest bittercress
CALLITRICHACEAE		
i	*Callitriche stagnalis*	mud waterstarwort
CAMPANULACEAE		

	Pratia pedunculata	matted pratia
CARYOPHYLLACEAE		
i	*Cerastium glomeratum*	clustered mouse-ear
CHENOPODIACEAE		
i	*Chenopodium murale*	nettleleaf goosefoot
EPACRIDACEAE		
	Epacris lanuginosa	woolly-style heath
	Leucopogon parviflorus	coast beardheath
FABACEAE		
i#	*Lotus angustissimus*	slender birdsfoot-trefoil
	Platylobium obtusangulum	common flatpea
i	*Trifolium dubium*	yellow suckling-clover
i	*Vicia sativa* subsp. *nigra*	narrowleaf vetch
GOODENIACEAE		
	Goodenia elongata	lanky native-primrose
	Selliera radicans	shiny swampmat
HALORAGACEAE		
	Myriophyllum sp.	milfoil
LAMIACEAE		
i	*Prunella vulgaris*	selfheal
LYTHRACEAE		
V	*Lythrum salicaria*	purple loosestrife
MALVACEAE		
R	*Gynatrix pulchella*	hemp bush
MIMOSACEAE		
	Acacia melanoxylon	blackwood
	Acacia verticillata subsp. *verticillata*	prickly mimosa
MYRTACEAE		
	Eucalyptus ovata	swamp gum
	Eucalyptus pauciflora subsp. *pauciflora*	cabbage gum
	Eucalyptus viminalis subsp. *viminalis*	white gum
	Leptospermum lanigerum	woolly teatree
	Melaleuca ericifolia	swamp paperbark
	Melaleuca squamea	swamp honey-myrtle
	Melaleuca squarrosa	scented paperbark
ONAGRACEAE		
	Epilobium pallidiflorum	showy willowherb
PITTOSPORACEAE		
	Bursaria spinosa	prickly box
POLYGONACEAE		
i	*Acetosella vulgaris*	sheep sorrel
	Persicaria decipiens	slender knotweed
PRIMULACEAE		
i	*Anagallis arvensis* var. *arvensis*	scarlet pimpernel
	Samolus repens	creeping brookweed

PROTEACEAE		
	Banksia marginata	silver banksia
RANUNCULACEAE		
	Clematis aristata	southern clematis
	Rananculus sp.	buttercup
RHAMNACEAE		
	Pomaderris apetala subsp. *apetala*	rough dogwood
ROSACEAE		
	Acaena novae-zelandiae	buzzy
i	*Rubus fruticosus*	blackberry
	Rubus parvifolius	native raspberry
RUBIACEAE		
	Coprosma quadrifida	native currant
SALICACEAE		
i	*Salix cinerea*	grey willow
SCROPHULARIACEAE		
	Gratiola peruviana	southern brooklime
i	*Verbascum blattaria*	moth mullein
STYLIDIACEAE		
	Stylidium graminifolium	grass triggerplant
URTICACEAE		
	Urtica incisa	scrub nettle
VIOLACEAE		
	Viola hederacea subsp. *hederacea*	ivyleaf violet
WINTERACEAE		
	Tasmannia lanceolata	native pepper

MONOCOTS

CYPERACEAE		
t	*Carex appressa* var. *virgata*	tall sedge
	Cyperus lucidus	leafy flatsedge
	Eleocharis sphacelata	tall spikesedge
	Gahnia sieberiana	redfruit cutting-grass
	Lepidosperma concavum	sand swordsedge
	Lepidosperma elatius	tall swordsedge
	Lepidosperma laterale	variable swordsedge
	Lepidosperma longitudinale	pithy swordsedge
	Schoenus apogon	common bogsedge
IRIDACEAE		
	Diplarrena moraea	white flag-iris
JUNCACEAE		
	Juncus australis	southern rush
	Juncus pallidus	pale rush
JUNCAGINACEAE		
	Triglochin procerum	water-ribbons

LILIACEAE		
	Arthropodium milleflorum	pale vanilla-lily
	Dianella tasmanica	tasman flaxlily
POACEAE		
i	*Agrostis stolonifera*	creeping bent
i	*Aira caryophyllea*	silvery hairgrass
	Amphibromus recurvatus	dark swampgrass
i	*Anthoxanthum odoratum*	sweet vernalgrass
	Austrodanthonia setacea	bristly wallby-grass
	Ehrharta stipoides	weeping grass
i	*Festuca arundinacea*	tall fescue
	Hemarthria uncinata	hooked matgrass
i	*Holcus lanatus*	yorkshire fog
i	*Hordeum marinum* subsp. *marinum*	sea barleygrass
	Lachnagrostis filiformis	common blowngrass
	Phalaris aquatica	Harding grass
	Phragmites australis	southern reed
	Poa labillardierei var. *labillardierei*	silver tussockgrass
	Themeda triandra	kangaroo grass
i	*Vulpia myuros* f. *megalura*	foxtail fescue
XANTHORRHOEACEAE		
	Lomandra longifolia	sagg
XYRIDACEAE		
	Xyris operculata	tall yelloweye

FERNS

BLECHNACEAE		
	Blechnum nudum	fishbone waterfern
DENNSTAEDTIACEAE		
	Hypolepis rugosula	ruddy groundfern
	Pteridium esculentum	bracken
DICKSONIACEAE		
	Dicksonia antarctica	soft treefern
DRYOPTERIDACEAE		
	Polystichum proliferum	mother shieldfern
GLEICHENIACEAE		
	Gleichenia dicarpa	pouched coralfern
OSMUNDACEAE		
	Todea barbara	austral kingfern
POLYPODIACEAE		
	Microsorum pustulatum subsp. *pustulatum*	kangaroo fern

Appendix 2: Fish community data - McKerrows Marsh

Site name	Site Code	Date sampled	S. trutta	A. australis	N. australis	P. urvilii	G. maculatus	G. truttaceus	M. mordax
Great Forester Rv d/s Prosperity Rd	GFOR12	22/12/2004	20	4	0	0	0	0	4
Great Forester Rv u/s Waterhouse Rd	GFOR04	21/12/2004	0	2	0	4	2	0	10
Great Forester Rv at wetland u/s Billabong	GFOR58	21/12/2004	1	1	22	2	9	0	2
McKerrows Marsh cut-off channel 49	GFOR56	21/12/2004	0	4	3	6	25	4	2
Great Forester Rv at Lovers Reach (Headlams Blackfish Hole)	GFOR57	20/12/2004	0	2	3	11	3	0	1
Great Forester Rv at Headlams Pond	GFOR53	20/12/2004	0	5	22	2	5	0	0
Great Forester Rv at Boat Hole	GFOR54	21/12/2004	0	5	2	6	9	0	0
McKerrows Marsh wetland	GFOR55	21/12/2004	0	0	0	0	0	0	0
		Total No. Fish	1	17	52	27	51	4	5

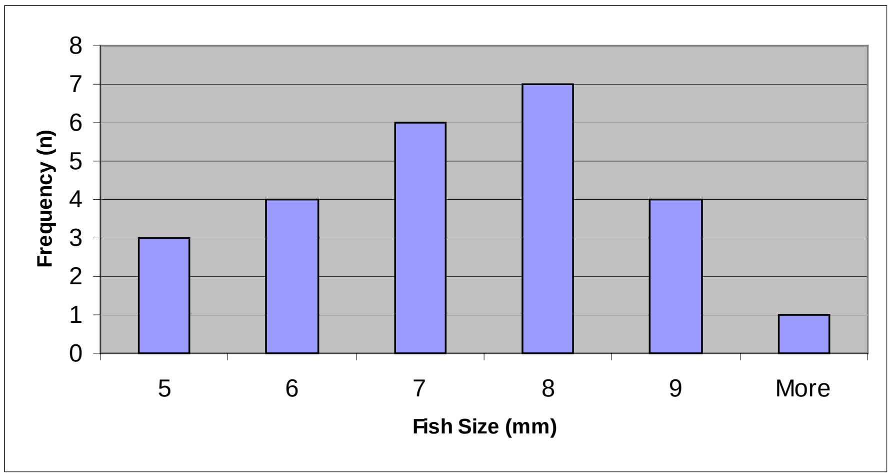

FIG: Length frequency of *N. australis* collected in macroinvertebrate kick-net October, 2004.

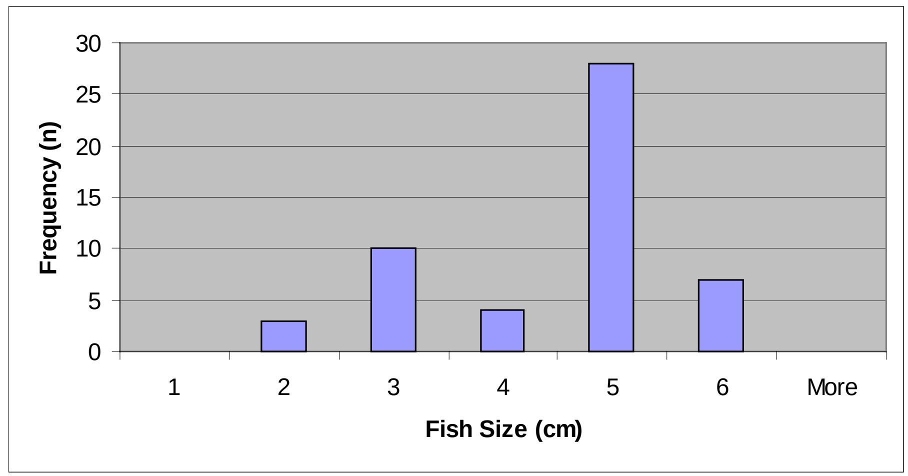

FIG: Length frequency of *N. australis* collected during electrofishing Survey, December, 2004.

Appendix 3: Macroinvertebrate community data - McKerrows Marsh

Samples collected using AUSRIVAS methodology.

		Boat Hole wetland	Cut-off channel	Forester Lodge gauge 1	Forester Lodge gauge 2	GFOR at Boat Hole	GFORat Billabong narrows	GFOR at Lovers Reach	Forester Lodge gauge
Order	**Family**	**Oct-04**	**Dec-04**	**Dec-04**	**Dec-04**	**Dec-04**	**Dec-04**	**Dec-04**	**Apr-05**
Platyhelminthes	Turbellaria								
Nematomorpha	Gordiidae								
Oligochaeta				1		1	4		12
Hirudinea					1		1		
Hydracarina		26	1	6		4	2		1
Mollusca	Sphaeriidae		7	10				4	1
	Ancylidae				14			1	
	Hydrobiidae					1	2	2	
	Lymnaeidae								
	Physidae								
	Planorbidae	3			2	1			
Amphipoda	Ceinidae								
	Corophidae		14				30	8	3
	Eusiridae								
	Paracalliopidae								
	Paramelitidae	2	10	8			1	22	8
	Talitridae								
Decapoda	Atyidae				4		8		5
	Hymenosomatidae		3					1	
	Parastacidae								
Syncarida	Anaspididae								
Isopoda	Janiridae								
	Oniscidae								
	Phreatoicidae								
Coleoptera	Chrysomelidae Adults								
	Chrysomelidae Larvae								
	Dytiscidae Adults	5			2	1	6	1	
	Dytiscidae Larvae	7							
	Elmidae Adults	1							
	Elmidae Larvae				1	1			
	Gyrinidae Adults								
	Gyrinidae Larvae								
	Heteroceridae								
	Hydraenidae	10							
	Hydrophilidae	19			1				
	Noteridae								
	Psephenidae								
	Curculionidae								
	Scirtidae	3					1		
	Staphylinidae								
	Carabidae								
Diptera	Athericidae								
	Blephariceridae								
	Ceratopogonidae	1		3		1	7		1
	Chaoboridae								
Chironomidae:	ch Orthocladiinae	6	2		1	4	3	5	2
	ch Chironominae	23	6	20	1	19	5	8	11
	ch Podonominae								
	ch Diamesinae								
	ch Tanypodinae		10	7		10	11	6	4
	Culicidae								
	Dixidae								
	Empididae				1			1	
	Ephydridae								
	Psychodidae							1	
	Simuliidae		1				2		11
	Stratiomyidae								
	Thaumaleidae								
	Tipulidae			1				2	
	Unid. Pupae								
Ephemeroptera	Baetidae								
	Caenidae			3					
	Leptophlebiidae		32	17	2	9	9	19	2
	Oniscigastridae	2	2		3	4		2	
	Siphlonuridae								

table continued.

Order	Family	Boat Hole wetland Oct-04	Cut-off channel Dec-04	Forester Lodge gauge 1 Dec-04	Forester Lodge gauge 2 Dec-04	GFOR at Boat Hole Dec-04	GFORat Billabong narrows Dec-04	GFOR at Lovers Reach Dec-04	Forester Lodge gauge Apr-05
Hemiptera	Corixidae	1		1	6	3	8		
	Gelastocoridae								
	Gerridae			6					
	Naucoridae								
	Notonectidae								
	Saldidae				1				
	Veliidae			3	4	1	11		
Lepidoptera	Pyralidae								
Mecoptera	Nannochoristidae		6					5	
Neuroptera	Osmylidae								
	Sisyridae								
Odonata	Aeshnidae								
	Gomphidae								
	Hemicorduliidae								
	Synthemistidae								
	Telephlebiidae						2		
	Coenagrionidae								
	Lestidae	6							
Plectoptera	Austroperlidae								
	Eustheniidae								
	Gripopterygidae	4	25	6	16	4	35	4	4
	Notonemouridae								
Trichoptera	Atriplectididae		15				9	12	2
	Calamoceratidae		2	2	1	4		3	9
	Calocidae						2		
	Conoesucidae				2		15		
	Ecnomidae					1			
	Glossosomatidae								
	Helicophidae								
	Helicopsychidae								
	Hydrobiosidae		2	1		3	1	4	
	Hydropsychidae								
	Hydroptilidae		1		1	3	1		
	Leptoceridae	3	35	6	15	27	27	29	25
	Limnephilidae								
	Odontoceridae								
	Oeconesidae								
	Philopotamidae								
	Philorheithridae		4						
	Plectrotarsidae								
	Polycentropodidae								
	Tasimiidae								
	Unid. Pupae								
Unid									
Other Taxa:									
Total number of taxa		17	19	17	20	20	25	21	17
Total number of individuals		122	178	101	79	102	203	140	102