
A BIOLOGICAL SURVEY OF THE MURRAY MOUTH RESERVES SOUTH AUSTRALIA

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Cover Photograph: A view of the southern edge of Myrtle Island in the Mud Island Game Reserve across Tauwitcherie Island to the dunes of the Coorong (*Photo: Tony Robinson NPWSA*).

PREFACE

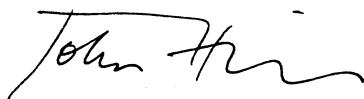
A Biological Survey of the Murray Mouth Reserves, South Australia is a further product of the Biological Survey of South Australia.

The program of systematic biological surveys to cover the whole of South Australia arose out of a realisation that an effort was needed to increase our knowledge of the remaining vascular plants and vertebrate fauna of South Australia and to encourage its conservation.

Over the last 18 years, there has been a strong commitment to the Biological Survey by Government and an impressive dedication from hundreds of volunteer biologists.

It is anticipated that the Biological Survey will achieve complete statewide coverage by 2015.

The Biological Survey of South Australia will be an achievement for which we can be very proud. We will have substantially improved our knowledge of the biodiversity of South Australia to enable biologists in the future to measure the direction of long-term ecological change. This will greatly enhance our ability to adequately manage nature conservation into the future.



JOHN HILL
MINISTER FOR ENVIRONMENT AND CONSERVATION

Biological Survey of the Murray Mouth Reserves

ABSTRACT

The Murray Mouth Reserves incorporate the range of habitats that remain in a natural and semi-natural state at the terminus of the Murray River and the tidal inlet for the Coorong. Three National Parks and Wildlife managed reserves cover approximately half of this area including all of the Coorong and Younghusband Peninsula, a fifth of Hindmarsh Island and a group of smaller islands surrounded by freshwater as Mud Island Game Reserve. The waters of the area are separated between fresh and saline by a series of barrages built in the 1930's to hold fresh water in Lakes Alexandrina and Albert. The terrestrial habitats of the area are primarily a coastal barrier dune that is breached by the outlet to the Murray River but now mostly acts as a tidal inlet for the saline waters of the Coorong and Goolwa Channels. The coastal scrub that dominates these dunes is largely intact having only been slightly modified by stock grazing in most areas. The remaining habitats occur on a number of low islands of which Hindmarsh Island is the biggest. Natural habitat on the islands has been substantially lost or altered for grazing and cropping. Only small areas of saline and wetland habitats remain in natural form. Significant reedland habitat has naturally established on the more reliable freshwater wetlands and island margins following the damming of the Lakes with the barrages.

The Biological Survey of the Murray Mouth Reserves aimed to describe the remaining habitats in the area, to document the flora and fauna, and to map the remnant native vegetation communities of islands of the Murray Mouth at 1:50,000 scale. Methods used to sample the vascular plants, mammals, birds, reptiles and amphibians followed the standard techniques for the Biological Survey of South Australia. The survey incorporated plant data from 53 existing survey sites dating back to 1982, of which twelve also had fauna information. The current survey added plant and fauna information from a further 22 sites.

Two hundred and seventeen plant species were detected at survey sites of which 34% were non-indigenous. The vegetation communities of the area were grouped into 11 associations using cluster analysis based on presence/absence of species at each site (annual species were removed from the analyses). No plants with national or state conservation ratings were recorded at sites. Forty-six species with a regional rating in the Southern Lofty region were recorded at survey sites.

Twelve species of mammals of which four are native to the area were recorded at survey sites and a further three native species were observed opportunistically within the study area. No species with national or state conservation ratings were recorded.

Fifteen reptile and two frog species were recorded at survey sites. No species with conservation significance were recorded though the capture of a Red-bellied Black Snake on the south-eastern end of Hindmarsh Island extended the known distribution of this species. Tiger Snakes were also of interest with both the Eastern Tiger Snake and the Black Tiger Snake co-existing and possibly hybridizing in this area.

Eighty-five bird species were recorded at 22 sites (9% were waders and 27% were waterbirds). The four nationally threatened species that are known to live or occasionally visit the study area were not recorded during the survey. Twenty-one species are considered vulnerable under South Australian legislation. The area provides significant breeding habitat for two of these (Rufous Bristlebird and Lewin's Rail). The area also supports 21 species rated as Rare in South Australia and provides an important breeding area for four of these (Musk Duck, Baillon's Crake, Southern Emu Wren and Golden Headed Cisticola).

This survey differed from most terrestrial surveys by having a significant freshwater fish and aquatic invertebrate component. The freshwater fish survey detected a surprising diversity of species (19 species from ten sites sampled). Of these 16 were native and four were introduced. Two species are considered Nationally Vulnerable (Yarra Pygmy Perch and Small-mouth Hardyhead). The other two have South Australian conservation ratings (Southern Pygmy Perch [Endangered] and Dwarf Flathead Gudgeon [Rare]). The numerous smaller channels characteristic of the Wyndgate Reserve on Hindmarsh Island provide a diversity of habitats with healthy macrophyte communities that may be critical for the survival of these small threatened fish species in this area of the Murray River.

The Reserves and private lands of the Murray Mouth region represent a contrast of relatively intact coastal marine habitats along the major peninsulas and the largely cleared or degraded habitats of the islands. The area appears to be most important for the conservation of aquatic birds and fish: the altered estuarine Coorong system for aquatic birds, and the artificial freshwater system of Lake Alexandrina for fish. Each of the habitat types appears to be important for at least one species of conservation significance, even the cropping land which provides important grazing areas for the large non-breeding population of Cape Barren Geese. Further work targeting frogs and fish across more of the island habitats is required to get a better understanding of the significance of the wetland communities within the recently purchased Wyndgate Reserve on Hindmarsh Island.

Biological Survey of the Murray Mouth Reserves

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Biological Survey of the Murray Mouth Reserves

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INTRODUCTION

R Brandle¹ and R Noye²

**“The Murray, that is probably destined to play no mean part in the future of Australia,
at present runs away in almost pure waste to the ocean.”**

(AJ Perkins, secretary for Agriculture, Journal of Agriculture and Industry 1st March 1903, No. 8, Vol. VI)

This Biological Survey of the Murray Mouth Reserves was undertaken primarily to gather systematic baseline information for a property on the south eastern end of Hindmarsh Island (formerly named Wyndgate Farm), which was recently purchased for the South Australian Reserve System (Fig. 2). The biological survey was expanded to include other areas managed under the National Parks and Wildlife Act partly because of the greatly altered nature and fragmentation of habitats on Wyndgate, and the need to put its remnant biodiversity into a regional context (Fig. 1).

A significant proportion of the Murray Mouth region is now under the management of National Parks and Wildlife SA. This includes; Youngusband Peninsula, all of the waters and islands of the Goolwa and Coorong Channel to the barrages and part way up Mundoo Channel, and Mud Island Game Reserve on the northern freshwater side of the Tauwichee

Barages. Most of the land and waters form part of the Coorong National Park. The Wyndgate Farm addition adds a significant area of freshwater channels, wetlands and the largest remnants of Swamp Paperbark *Melaleuca halmaturorum* to the reserve system. Since November 1985 the whole lower Murray Lakes region has been recognised as a wetland of international importance under the Ramsar Convention. Under the Japan-Australia Migratory Birds Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA) it is recognised as a significant area of habitat for migratory wading birds. The area is subject to a Management Plan published in September 2000 (DEH 2000).

The current study aimed to collect and document biological information from the remnant and altered habitats of the Murray Mouth Reserves, and to establish a baseline dataset for future comparisons.



Figure 1. Aerial photomosaic of the Murray Mouth Reserve survey study area. (Source: *imagemapSA EGI Dept for Environment and Heritage*).

¹ Biodiversity Survey and Monitoring, National Parks and Wildlife SA.

² Living with Wildlife, Environmental and Wildlife Consultants, PO Box 707, Blackwood SA 5051

THE STUDY AREA

The Murray Mouth region occurs in the Murray Mallee Province (Province 2) of the Environments of South Australia (Laut *et al.* 1977). The area surveyed is covered by two environmental associations: Lake Alexandrina (2.1.2) and Coorong (2.1.5), in the Murray Lakes Environmental Region (2.1). Laut *et al.* (1977) describes this region as being "...dominated by Lake Alexandrina and Albert which form large depressions in the Murray Plain. The Murray River flows into Lake Alexandrina and its waters discharge into the ocean through a narrow breach in the coastal sand bar-dune system. This has been artificially closed by barriers which prevent the inflow of salt water and also allow the lakes to be flushed when the salinity becomes too high. Small lacustrine plains and swamps with saline cracking clays fringe the lakes and are bordered by undulating calccrete plains covered by extensive sand sheets. Some of the undulations are due to consolidated dune ridges. Unconsolidated dunes with deep sands occur in the east of the region. ..."

The Lake Alexandrina Environmental Association has a mean annual rainfall of 400mm and evaporation potential of 1750mm. Six Environmental Units are described. The dominant unit is 'Lake' and the subdominant is 'Plain' (incorporating Hindmarsh Island) which is dissected with seasonal streams. Soils of the plains are described as poorly drained, black, self-mulching cracking clays. Where present the

dominant native vegetation is samphire Low Shrubland with minor areas of Reedland. Minor Environmental Units include: Undulating calccrete plain supporting bleached sands (cleared for agriculture); Swamp supporting samphire/saltbush Low Shrubland on poorly drained, grey, self-mulching clays; Rises of yellow-grey siliceous sands (cleared for agriculture) and dunes of bleached sands with a yellow-grey colour B horizon (cleared for agriculture).

The Coorong Environmental Association has a mean annual rainfall of 450mm in the northern parts and a mean evaporation potential of 1700mm. Four Environmental Units are described. Co-dominants are: Dunes of yellow-grey calcareous sands supporting *Olearia axillaris* – *Leucopogon parviflorus* open heath and *Acacia longifolia* var. *sophorae* – *L. parviflorus* open heath and the Coorong Lagoon; Subdominant are the beaches comprised of yellow-grey calcareous sands; of minor occurrence are mudflats supporting samphire Low Shrublands on sandy, pedal, mottled-yellow duplex soils.

Information summarising our understanding of the history and biology of the study area prior to this survey follows. It is divided into three areas: Hindmarsh Island, Mud Island Game Reserve and Coorong National Park.

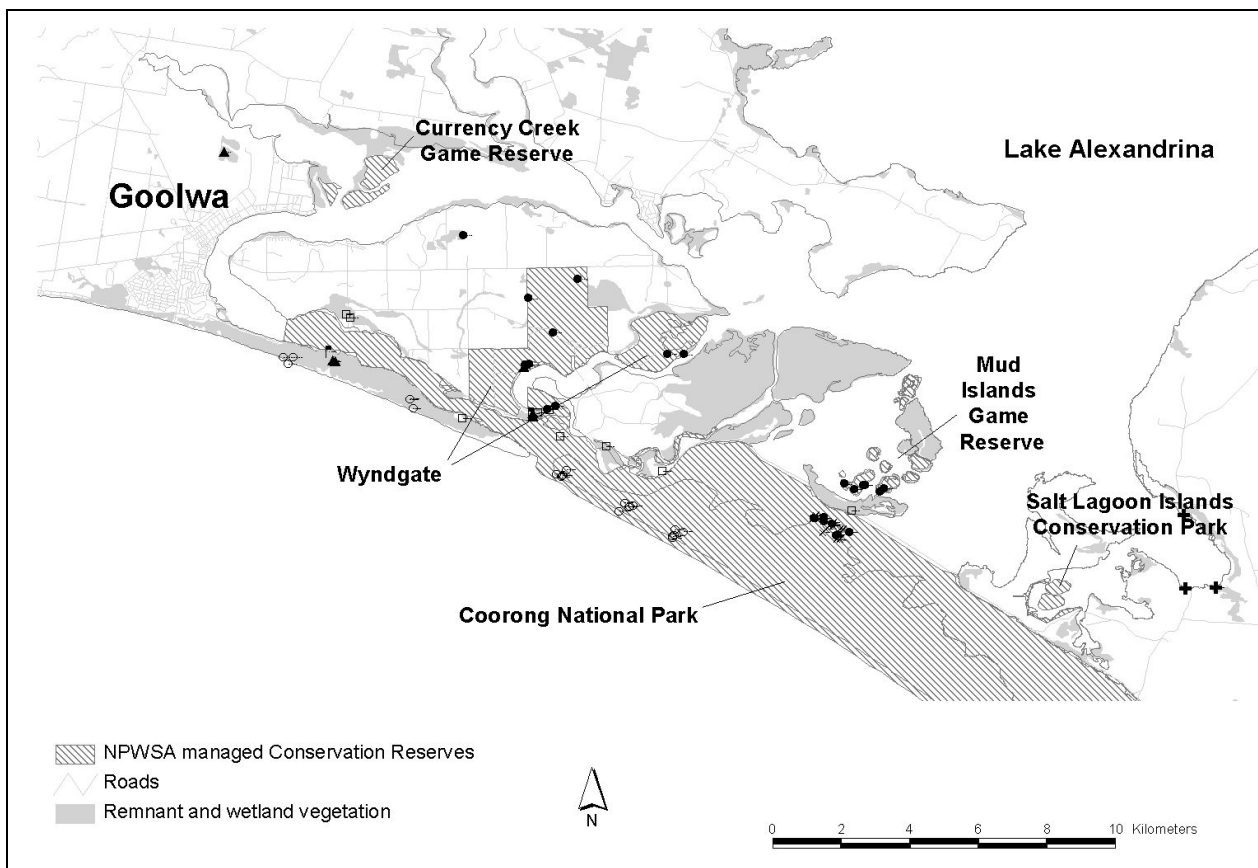


Figure 2. The Murray Mouth Reserve survey study area depicting remnant vegetation, National Parks and Wildlife SA conservation reserves and access roads. The symbols mark survey sites.

HINDMARSH ISLAND

Hindmarsh Island is located approximately 90km south-east of Adelaide near the Mouth of the Murray River in Lake Alexandrina. The Island was the designated territory of a number of Ngarrindjeri Aboriginal clans prior and up to European settlement (Lucas 1990). Since early settlement in 1853, the 4,616ha Island has been used for agriculture, and by the early 1900s, most of the trees had been removed to provide fuel for riverboats and factories (Murfet 1996). In more recent times, many of the farms have been subdivided for hobby farms and residential developments (Renfrey *et al.* 1989).

Over the past decades a considerable amount of ornithological data has been collected in the Murray Mouth region, including Hindmarsh Island (Edyvane *et al.* 1996). Indeed, due primarily to the abundance of bird life in the area, the conservation significance of the region was recognised with the proclamation in 1985, of a Wetland of International Importance under the Ramsar Convention (Department for Environment and Heritage 1999).

Very little is published about the mammals, reptiles and frogs existing or having existed on the Island. The South Australian Museum Database lists only three species of reptile and two species of native mammal collected from the area. There are however comprehensive lists of the vegetation and birds found on Hindmarsh Island that are referred to in detail in later sections of this report.

ABORIGINAL OCCUPATION

Lucas (1990) in his report 'The Anthropology and Aboriginal History of Hindmarsh Island' states "the earliest reference to an Aboriginal group with territory on Hindmarsh Island comes from Moriarty, a police-trooper stationed at Goolwa in the 1870's". Berndt and Berndt's 1951 publication, 'From Black to White in South Australia' provides the most detailed information available concerning the traditional ownership of Hindmarsh Island (Lucas 1990). According to Berndt and Berndt (1951), Hindmarsh Island was the territory of three clans from three different language groups. These groups were the Kangalindjera clan of the Tangani language group who inhabited the western section of the Island, the Melgindjera clan of the Wakend language group who inhabited the north-central section and the Rumerindjera clan of the Yaraldi language group, in the south-eastern section (Berndt and Berndt 1951).

The southern Ngarrindjeri's traditional mortuary practices included mummification of the corpse by smoking and placing the body on a platform in a tree, preferably a Tea-Tree or Sheoak (Lucas 1990). Hodge (1932:134) states "In a grove of ti-tree on Hindmarsh Island, on the River Murray, a number of years ago, there were many relics of these tombs, or Mahomet-like resting places, with numerous bones, scattered about". Lucas (1990) suggests that Hodge was looking

at far more than an isolated burial and cites the observation of a substantial burial site on Hindmarsh Island by Bellchambers (1931).

The Sheoak that these authors refer to is possibly the Drooping Sheoak, (*Allocasuarina verticillata*), and Dryland Tea-Tree, (*Melaleuca lanceolata*) and/or the Swamp Paperbark, (*Melaleuca halmaturorum*). Murfet (1996) recorded these three species in his survey of the vegetation of Hindmarsh Island.

EUROPEAN HISTORY

In his 1829-1830 journey down the River Murray, Charles Sturt followed the Goolwa Channel to the river mouth without realising that its eastern bank was part of a relatively large island (McCourt and Mincham 1987). Following the founding of the colony of South Australia in 1836, an expedition led by Hutchinson and Strangways named Hindmarsh Island when exploring alternate means of reaching the ocean to that of Sturt (McCourt and Mincham 1987).

Although a Dr. Rankine had paid the Government ten pounds a year to use Hindmarsh Island as a 'cattle run', in 1853 (after convincing the Government to survey and sell a portion of the Island) Charles Price was the first person to purchase land (McCourt and Mincham 1987). Charles Price also has the distinction of being the first person to introduce Hereford cattle and Shropshire sheep in South Australia in about 1867 (Tolley 1968; McCourt and Mincham 1987). Price died in April 1886 and in November of the same year his 983-acre freehold property on Hindmarsh Island was sold for £5/3/6 an acre (McCourt and Mincham 1987).

McCourt and Mincham (1987) state "The connection of the Price family with Hindmarsh Island began in September 1853, and ended in 1888, but it may truly be said that the good work they did lived after them". From this statement it could be assumed that the 'good work' would have been the clearance of native vegetation to make way for grazing. Although the Island was surveyed for housing development in those early years, it was predominantly used for grazing up until World War II (McCourt and Mincham 1987).

PREVIOUS BIOLOGICAL SURVEYS

There has never been a complete biological survey of Hindmarsh Island. Paton *et al.* (1989) surveyed the avifauna of the Island and Pedler (1994) surveyed the waterbirds of the Murray Mouth. Renfrey *et al.* (1989) surveyed the aquatic and near aquatic flora of Hindmarsh Island. Murfet (1996) visited the Island eight times and recorded 411 plant species in a vegetation report to the Hindmarsh Island Landcare Group. During November 2001, members of the South Australian Herpetology Group (Matejcic and Milne 2001) conducted a reptile survey of the Island. Although trapping efforts were concentrated at or close

to Tarni Warra Sanctuary and in open mallee woodland on private property in the middle of the Island, some opportunistic searching was undertaken at Wyndgate.

GEOMORPHOLOGY AND GEOLOGY

Geomorphically the lower Murray lakes and Coorong is naturally very dynamic, however, river regulation has had a major impact on those dynamics (Bourman 2000). Aeolian processes, tidal oscillations, storm surges, wave action on lake and ocean shores, wind induced lake level changes and variations in local sea level due to global sea level changes and long-term land subsidence affect the area (Bourman 2000).

The natural estuary system of the River Murray is a Holocene feature occupying Quaternary interdune areas that was formed as a result of drowning by the global sea level rise that accompanied deglaciation from 17,000 years to 7,000 years BP (Bourman 2000). During the last interglacial period, 125,000 years BP, when longshore transport was dominantly from the southeast pushing the course of the River Murray westward, the northern half of Hindmarsh Island was formed (Bourman 2000).

Raised salinity of soils with associated salinisation of depressions and blockage of natural drainage channels has resulted from raised water tables associated with artificially elevated lake levels and regional vegetation clearance (Bourman 2000). Bourman (2000) states “a distributary system of channels formerly discharged river floodwaters across Hindmarsh Island, sometimes forming wetlands where the discharge was blocked by sand dunes on the south side of Hindmarsh Island”. He further states “artificial blockage of these channels has occurred on Hindmarsh Island by roadway causeway construction. Even when there is no flood overflow into the channels, runoff from local rainfall accumulates in the channels. This water cannot flow away, evaporates and increases the salinity of the channels”.

VEGETATION

Of the 411 plant species recorded by Murfet (1996), 239 were indigenous and 172 alien (Appendix 2). This list is also reproduced in ‘A Background Report on the Biological Diversity of the Goolwa to Wellington Local Action Planning Area – Volume 2 – Maps & Catchment Data’ compiled by Marshal and Bradley (1999).

Native trees were initially cleared on Hindmarsh Island as fuel for riverboats and factories. Since then, the major plantings on the Island have been of Aleppo Pine *Pinus halepensis* and Tuart Gum *Eucalyptus gomphocephala* that occur in scattered groups (Murfet 1996). Murfet (1996) suggests that the Native Pine *Callitris preissii*, that still grows naturally near Goolwa and Milang once occurred naturally on the Island. The existing specimens on the island however, are likely to have been planted because of their age and conformity to rows. Plants that Murfet (1996) found of particular

interest during his survey include; Fairy Fanflower (*Scaevola aemula*), collected only once previously from the Southern Lofty region on Hindmarsh Island in 1930, Spinifex (*Triodia compacta*), previously collected in 1935 near Currency Creek and more recently from Newland Head Conservation Park, and Minnie Daisy (*Minuria leptophylla*). This grows more commonly on the coast north of Willunga, with a collection from Cape Jervis. Further, Murfet (1996) raises the question as to whether the plant, Creeping Boobialla (*Myoporum parvifolium*) is indigenous to Hindmarsh Island or has been planted because, as he states “the closest records of *M. parvifolium* are from Sellicks Beach to Hallett Cove”.

A concern that Murfet (1996) raised in his report related to a direct seeding revegetation program by Wyndgate and Mount Lofty Ranges Catchment Program, using Coastal Tea-Tree (*Leptospermum laevigatum*). Murfet (1996) stated: “This is a Victorian species not native to South Australia and is becoming a pest at Parsons Beach where it regenerates prolifically”. Other non-native trees that he suggests have been planted (perhaps inappropriately) throughout the island include *Eucalyptus cornuta*, *Eucalyptus cladocalyx*, *Acacia calamifolia*, *Acacia iteaphylla* and *Acacia retinodes*.

Roadside vegetation on the island was documented by Hyde (1997) as part of his survey of the remnant roadside vegetation on the Fleurieu Peninsula. He recorded Coastal Spear-grass *Stipa stipoides* as being a significant species at the end of Mundoo Channel Road and a dominant species at two other roadside segments. The Mundoo Channel Road lies within the proposed Wyndgate reserve.

A survey of the aquatic and near aquatic vegetation at 40 sites on Hindmarsh Island was conducted in 1989 (Renfrey *et al.* 1989). They described the aquatic plant associations of Hindmarsh Island as not being outstanding examples of native aquatic flora, of the 85 species recorded, eight were considered to be uncommon, rare, vulnerable or endangered at that time. Renfrey *et al.* (1989) found that two sites between the Mundoo and Scab Channels were the most pristine, and in general, the less saline an environment the more weeds were present. However, they also found the inland lakes to be repeatedly invaded by weed species of annual grasses as they dry out. Four very strong plant associations were defined as *Hydrocotyle – Crassula – Juncus*; *Typha – Phragmites*; *Triglochin – Polygonum* and *Sarcocornia – Distichlis*. Table 3 from Renfrey *et al.* (1989) listing the plants within these associations is reproduced in Appendix 3.

Although the source of the information is not clearly identified, the National Parks and Wildlife South Australia Natural Heritage Trust Application to purchase and establish Ramsar additions to the Coorong National Park, identifies four vegetation associations on the Wyndgate property. These are described in the vegetation chapter.

BIRDS

Prior to the construction of the five barrages that separate salt and fresh water close to the River Murray Mouth, the Coorong and Lakes Albert and Alexandrina formed a large fluctuating estuarine system (DEH 2000). The construction of these regulatory devices is likely to have increased the value of the Coorong and Lower Lakes as an important waterbird refuge during times of widespread severe drought (DEH 1999, 2000). Approximately 85 species of waterbird including waders and waterfowl whose presence or absence is dictated by seasonal and other factors have been recorded in this region (DEH 1999). A number of these species are listed in the Ramsar Convention (Wetlands of International Importance particularly as Waterfowl Habitat) and the Migratory Bird Agreements with Japan (JAMBA) and the People's Republic of China (CAMBA) (Kahrimanis *et al.* 2001).

During the summer of 1988-1989 Paton *et al.* (1989) conducted a systematic search for birds over the entire Hindmarsh Island and immediate surrounding areas. This involved dividing the Island into a series of 1 minute x 1 minute grid squares, recording the habitats present in each and recording all the species of birds and the numbers of each seen during three, one hour searches of a grid area. The researchers recognised six main habitats, semi-urban, agricultural, exotic and native woodland, freshwater wetlands, estuarine mudflats and samphire areas for birds on and around Hindmarsh Island (Paton *et al.* 1989). A description of these habitats is reproduced in Appendix 4.

The researchers found that, although these habitats support different ranges of bird species, the freshwater swamps and estuarine mudflats supported the greatest diversity of species in comparison with agricultural and semi-urban habitats where many were introduced species or species found in similar farmland areas in the district (Paton *et al.* 1989).

A total of 114 species of birds were recorded during this survey with waterbirds and waders dominating the species list. However, the South Australian Ornithological Association have recorded an additional 23 species on Hindmarsh Island in previous years (Paton *et al.* 1989). Paton *et al.* (1989) state "several observers who have visited the area regularly during the last twenty years have noted a substantial decline in the numbers of birds as well as species of birds using the freshwater swamps and reedy areas along the shoreline from Goolwa to the Goolwa Barrages and on the estuarine mudflats east of the barrages".

Although bird surveys have been conducted throughout the Coorong and the Murray Mouth region, Paton *et al.* (1989) appears to be the only survey conducted on Hindmarsh Island.

MAMMALS

The South Australian Museum Database holds three species of native mammal collected from Hindmarsh Island. These are the Water Rat (*Hydromys chrysogaster*), the Swamp Rat (*Rattus lutreolus*) and the Echidna (*Tachyglossus aculeatus*). The exact location where these specimens were collected is not known. Littlely (1998) during a biological survey of the swamps of the Fleurieu Peninsula observed several large populations of Swamp Rats in habitat similar to that found on Hindmarsh Island. These animals could therefore be expected to still exist on Hindmarsh Island. Further, Eckert (Strathalbyn Field Naturalists Club 2000), writing about the mammals of the Strathalbyn and Goolwa Districts, states "this species is abundant in reedy areas all around the margins of Lake Alexandrina". However, Strahan (1983) points out that the Swamp Rat requires dense cover, and is vulnerable to fire, clearing and grazing. He states: "Several years of regrowth after disturbance are required before the habitat can again support a breeding population". The Water Rat, although pressured by swamp drainage and flood mitigation practices, can be found in some irrigated areas (Strahan 1983). Hunting for fur was thought to have significantly reduced the populations of Water Rats in the Lower Murray Lakes from pre-European levels (Strathalbyn Field Naturalists Club 2000).

During the South Australian Herpetology Group November 2001 survey of Hindmarsh Island, kangaroo faeces, most likely from the Western Grey Kangaroo (*Macropus fuliginosus*), and Echidna scratchings were observed (Milne and Matejcic 2001).

Distribution maps in 'A Guide to the Bats of South Australia' (Reardon and Flavel 1987) indicate that five species of bat inhabit areas adjacent to Hindmarsh Island. These species, King River Bat (*Vespadelus regulus*), Chocolate Wattle Bat (*Chalinolobus morio*), Gould's Wattle Bat (*Chalinolobus gouldii*), Lesser Long-Eared Bat (*Nyctophilus geoffroyi*) and White-Striped Mastiff Bat (*Tadarida australis*) traditionally roost in tree hollows (Reardon and Flavel 1987) and may possibly find suitable roosting in the Drooping Sheoaks recorded by Murfet (1996). They will also roost in buildings (Reardon and Flavel 1987).

An indication of the mammals that may have existed on Hindmarsh Island can be found in 'Natural History of Strathalbyn and Goolwa' (The Strathalbyn Field Naturalist Club 2000) which summarises data recorded over forty years of observation in the Strathalbyn - Goolwa area.

REPTILES AND FROGS

The South Australian Museum Database holds only three species of reptile collected from the vicinity of Hindmarsh Island: Tiger Snake (*Notechus ater*), Eastern Brown Snake (*Pseudonaja textilis*), and Thick-tailed Gecko (*Nephrurus milii*). The exact location of these records is unclear.

The South Australian Herpetology Group conducted a three-day survey in November 2001. Much of the survey concentrated on Tarni Warra Sanctuary and other private property however, opportunistic searches were conducted along the island shore at Wyndgate. Pitfall and Elliott trap lines were established on flat sandy grassland near the water's edge southwest of the Sanctuary main house and Elliott traps and cages near the tidal swamp by the entrance to the Sanctuary (Milne and Matejcic 2001). Further pitfall and Elliott trap lines were placed in a coastal dune site on private property east of Tarni Warra and in an open mallee woodland with spear grass and wallaby grass understorey in the middle of the island (Milne and Matejcic 2001). A total of ten species of reptile and one species of frog were captured and one species of frog was identified from its call (Milne and Matejcic 2001). The species captured during this survey are listed in Appendix 5.

FISH

The estuarine fish and habitats of the Murray Mouth region were the subject of the 'Biological Assessment of the Murray Mouth Estuary' (Edyvane *et al.* 1996). This study found the estuarine areas had low faunal and floral species diversity. However the high abundance of some species groups were considered important for the growth of juvenile estuarine fish.

No similar work has been done in the freshwater sections of the Murray Mouth region and only general information for the area exists (Hammer 2002).

INVERTEBRATES

The Biological Assessment of the Murray Mouth Estuary (Edyvane *et al.* 1996) provided information on the estuarine invertebrates. However, as with the mammals, reptiles and frogs existing on Hindmarsh Island, little is recorded about the terrestrial invertebrates. The 'Natural History of Strathalbyn & Goolwa Districts' (Strathalbyn Field Naturalists Club 2000) lists the invertebrates in the region and may give some indication of what exists on the island.

MUD ISLAND GAME RESERVE

Mud Island Game Reserve incorporates 10 individual islands (125.6 ha) including Myrtle, Snake and Mud Islands, but exclude the two largest islands: Reedy and Tauwichterie. The game reserve was proclaimed in 1968. Very little has been written about these islands since Sutton's "A trip to the Islands Near the River Murray Mouth" (Sutton 1929). Sutton described some of the vegetation on Reedy Island No.2: "This part of the island, as well as the other portion, is low-lying, being about three to four feet above the level of the Lake. It is covered with samphire, much Lignum, and some nitre bushes, with reeds along the shore in many

places. Off the southern end there was a very large sandy plain, which was dry at the time of our visit, but at high tide or a flooded river is probably covered with water." On another part of Reedy Island No.2 "The vegetation on this part was similar to the other, but the land was more open, and on walking along a slight ridge covered in long dry grass and samphire...". These observations were made before the barrages were built permanently raising and freshening the surrounding water. This is likely to have increased the area of reeds and decreased the area of tidal and floodplain vegetation.

COORONG NATIONAL PARK

Coorong National Park incorporates the Coorong, the Murray Mouth, the estuarine portion of Goolwa Channel, and Younghusband Peninsula. The islands supporting waterbird breeding colonies in the central Coorong first received protection in 1914. Since 1972 there have been more than 12 additions to the park, the waters and islands of the Murray Mouth and Goolwa Channel being the most recent in 2001. The whole of the Coorong received formal legislated protection under the National Parks and Wildlife Act in 1986.

The waters and intertidal areas of the Murray Mouth and upper Coorong have been the subject of a number of biological studies since the 1980's. Systematic counts of wading bird species (Charadriiformes) were first undertaken within the study area in the summer of 1980/81 and have been repeated in 1981/82, 1985/86, 1993, 2000/01 and 2001/02 (Gosbell *et al.* 2002). Paton (1982) undertook and completed a study on the Biota

of the Coorong for the Cardwell Buckingham Committee. This project highlighted the deficiencies in existing data and began some avenues of research and monitoring to help identify the critical components of the major food chains in the Coorong ecosystem. Pedler (1994) mapped the use of the various parts of the Murray Mouth region by wading bird species and highlighted the importance of the mud flats opposite Tauwichterie and Ewe Islands and the Murray Mouth area. This was followed up later by Paton *et al.* (2000a) with a study that assessed the physical characteristics of the mudflats and how this affected the density of potential wader food items (mostly invertebrates) in the sediments. This was then related to observed abundances of various waders. In a separate study Paton *et al.* (2000b), investigated the distribution of recreational activity in the Murray Mouth region and the impact of these activities on waterbird and wader behavior. The Murray Mouth

estuarine areas were the subject of a biological resource assessment (Edyvane *et al.* 1996) which collated existing information as well as undertaking studies of: supratidal, tidal and subtidal habitats and plant communities; benthic macro-invertebrates; plankton and fish fauna.

Studies of the terrestrial flora and vertebrate fauna are few in the upper part of the Coorong National Park and far from comprehensive. Best sampled is the flora. Several studies have contributed to the Biological Survey of South Australia database. The first was the South East Coastal Survey, which contributed limited flora information for sites with 10m x 10m quadrats and also conducted systematic sampling for reptiles and small mammals (NPWSA unpublished data). The Coastal Dune and Clifftop survey contributed further information along the Younghusband Peninsula using

30m x 30m quadrats (Oppermann 1999). No significant sampling of the terrestrial birds in the study area appears to have been published. A list of 189 species was compiled for an area below Salt Creek on the southern Coorong for the Nature Conservation Society of SA (Gilbertson and Foale 1977). As only 50 species were recorded in “wet and windy” conditions during the survey, the source of the observations for the greater list and the suggested status of these birds in the area was not referenced. More recently as part of the biodiversity assessment for the Ramsar management plan a number of monitoring sites have been established which include birds surveys and pitfall trapping for small mammals and reptiles. One of these sites falls within the study area near Godfreys Landing on northern Younghusband Peninsula (NPWSA unpublished report 2002).



Figure 3. Reedland habitat on Mud Island Game Reserve looking south west across Tauwitcherie Island and Coorong National Park. Photo: AC Robinson NPWSA.



Figure 4. *Leucopogon parviflorus* / *Olearia axillaris* coastal scrub on Younghusband Peninsula in Coorong National Park. Photo: AC Robinson NPWSA.



Figure 5. Sedge and herblands on Lucern Island. Site WYN00201 which was not sampled in March 2002. Note Swamp Paperbark trees in background. Photo: R Brandle NPWSA.



Figure 6. Samphire flats on Hindmarsh Island Wyndgate site WY01101. Photo: R Brandle NPWSA.

METHODS

R Brandle¹

This survey forms part of the Biological Survey of South Australia. The methods are therefore consistent with the methodology first developed for the Biological Survey of the Nullarbor and Yellabinna Region (Copley and Kemper 1992) with some minor alterations. A set of two manuals, detailing these methods is available from the Department for Environment and Heritage Information Centre. Vegetation survey methods are detailed in Heard and Channon (1997) and vertebrate methods in Owens (2000).

SITE SELECTION

There were existing vegetation sites in the study area (bounded by latitude 35°37' to 35°29' and longitude 138°47' to 139°1') from four surveys that had sites within the Murray Mouth Reserves study area (Table 1). These data and additional data from sites by private collectors (D Murfett and M Hyde) were used to help determine the location of potential sites for the vertebrate survey sites. The published data and vegetation mapping in Renfrey *et al.* (1983) and Edyvane *et al.* (1996) was also used in conjunction with aerial photography and onsite inspection to select sites. The need to survey the remnant habitats of Wyndgate Farm and accessibility for regular checking of traps also influenced site selection.

Twelve sites were selected on Hindmarsh Island WYN00101 – WYN01201. WYN00101-003 were not sampled in March 2002 because of access difficulties

so an extra site WYN01301 was sampled. Six sites were sampled on the Coorong opposite Tauwitherie Island (WYN00101 - WYN00601) and six sites were sampled on two islands of the Mud Island Game Reserve (WYN00701 - WYN01201). All sites were marked with two white plastic star droppers set 10m apart as photopoint posts and labeled with an aluminum site tag wired to the camera position post.

SAMPLING

Quadrats were sampled for vegetation over a 30m x 30m area, vertebrate fauna (birds, reptiles, frogs and non-marine mammals) and terrestrial macro-invertebrates were sampled within the habitat type sampled for vegetation and within 500m of the photopoint (Owens 2000). Bats were sampled where conditions were suitable using bat traps and an Anabat call detector. Non-estuarine aquatic sites were sampled for fish and selected invertebrates. The field survey was conducted by two teams working in separate areas for a minimum of four nights from the 18-22 March 2002.

Each survey team was independent and consisted of a minimum of six people: a botanist and assistant; a herpetologist; a mammalogist; an ornithologist; and a technical assistant. Fish and aquatic invertebrate researchers joined the WYN team for part of the survey week and undertook extra sampling post-survey (refer to relevant chapters for details of methods).



Figure 7. Pelicans on mud flats in the Coorong looking towards MUD00401 on Youngusband Peninsula from Tauwitherie Island. Photo: AC Robinson NPWSA.

¹ Biodiversity Survey and Monitoring, National Parks and Wildlife SA.

RESULTS

VEGETATION

R Brandle¹

BACKGROUND INFORMATION

The Murray Mouth Reserves cover approximately half of the land supporting some form of native vegetation across the study area. The most intact and diverse habitats occur along the Younghusband Peninsula of Coorong National Park. These range from grassy foredunes and coastal dune scrub to estuarine wetlands supporting samphires, sedges and dense Lignum stands. Non-vegetated habitats included the surf zone, sandy beaches and the estuarine waters of The Coorong with its associated mud flats. A significant area of similar, though more heavily impacted, weedy habitat occurs along the Sir Richard Peninsula, currently administered by the South Australian Government under the Minister for Infrastructure. Wyndgate Reserve and adjacent government land incorporates some of the best examples of estuarine wetlands on the islands of the Murray Mouth, annual pastures and crops, some remnant chenopod shrublands, small areas of Swamp Paperbark and extensive reed beds. The Mud Island Game Reserves are dominated by reed-beds with minor areas of introduced Salt Couch grassland and samphire dominated depressions. The small remnant lunettes have been generally grazed and trampled into bare areas that may support some large old remnant Boobialla trees. Mundoo and associated islands support the most extensive areas of a similar range of habitats, in particular reed-beds, samphire and sedge communities. All of the vegetation communities on the islands are impacted by cattle grazing both on and off reserves.

The remnant vegetation communities of the region have been described by a number of researchers. Specht (1972) in the “*Vegetation of South Australia*” mapped the area at a broad regional level into three classes: the northern section of Hindmarsh Island and the surrounding mainland was a Drooping Sheoak (*Allocasuarina verticillata*) Woodland to Open-forest (with herbaceous understorey); the southern low lying areas of Hindmarsh Island and Narrung Peninsula supported a Low Shrubland of Marsh Saltbush (*Atriplex paludosa*) – *Salicornia* (*Sarcocornia*) – *Arthrocnemum* (*Halosarcia*) Samphires; and Coastal Dune Vegetation. Specht describes this as *Spinifex hirsutus* and *Scirpus nodosus* Tussock Grassland formations on the foredunes and *Olearia axillaris* – *Leucopogon parviflorus* and *Acacia longifolia* var. *sophorae* – *Leucopogon parviflorus* Open-heath formations on the more established dunes and swales. More recent studies have taken a more detailed but less comprehensive approach. Davies (1982) listed eight vegetation associations for the Coastal Dune Complex and Wetlands that occur at the northwestern end of The Coorong. The former uses the groups established by

Specht (1972). Under Wetlands, a small area was described as *Melaleuca halmaturorum* Open-scrub, whilst Low-Shrublands were divided into; *Sarcocornia* sp., *Halosarcia halocnemoides* and *Atriplex paludosa* – *Threlkeldia diffusa*. A minor occurrence of *Distichlis distichophylla* Closed-grassland was also reported. The only recent study to describe vegetation communities in the area was conducted for the Department of Environment and Planning (Renfrey *et al.* 1989). This was a detailed survey of the aquatic and near aquatic habitats surrounding Hindmarsh Island and they used a cluster analysis program to analyse presence/ absence species data from 40 sites. They found three freshwater (*Hydrocotyle* – *Crassula* – *Juncus*; *Typha* – *Phragmites*; *Triglochin* – *Polygonum*) and one saltwater (*Sarcocornia* – *Distichlis*) association.

Paton *et al.* (1989) also described the habitats on Hindmarsh Island but from the perspective of ornithologists. They mapped out the habitats as; Agricultural Areas, two Woodland Habitats (*Pinus halepensis* and *Allocasuarina verticillata*), Freshwater Habitats (reedbeds with minor areas of sedges, samphire, *Melaleuca halmaturorum* and shallow open waters), Estuarine Mudflats, Samphire Depressions and Semi-urban Areas.

The National Parks and Wildlife South Australia Natural Heritage Trust Application to purchase and establish Ramsar additions to the Coorong National Park, identifies four vegetation associations on the Wyndgate property as follows:

Tea-tree – *Melaleuca halmaturorum* ssp. *halmaturorum* open scrub

Species in this association include: Tea-tree Mistletoe (*Amyema melaleucae*) +/- Sea Club-rush (*Bolboschoenus caldwellii*), Sea Rush (*Juncus kraussii*), Beaded Samphire (*Sarcocornia quinqueflora*), Austral Seablite (*Suaeda australis*).

Samphire - *Sclerostegia arbuscula* - *Halosarcia pergranulata* ssp. *pergranulata* Low Shrubland on saline flats

Species in this association include: Round-leaf Pigface (*Disphyma crassifolium* ssp. *clavellatum*), Emu-grass (*Distichlis distichophylla*); Ruby Saltbush (*Enchylaena tomentosa* var. *tomentosa*), Southern Sea-heath (*Frankenia pauciflora*), Samphire (*Halosarcia pergranulata* ssp. *pergranulata*), Trailing Hemichroa (*Hemichroa pentandra*), Sea Rush (*Juncus kraussii*), Australian Saltmarsh Grass (*Puccinellia stricta* var. *stricta*); Creeping Brookweed (*Samolus repens*), Beaded Samphire (*Sarcocornia quinqueflora*), Annual Groundsel (*Senecio glossanthus*), Austral Seablite (*Suaeda australis*), Narrow-leaf Wilsonia (*Wilsonia backhousei*).

Wetland - freshwater herbland / sedgeland *Schoenoplectus validus* - *Eleocharis acuta* sedgeland

Species in this association include: Berry Saltbush (*Atriplex semibaccata*), Pacific Azolla (*Azolla filiculoides*), Emu-grass (*Distichlis distichophylla*), Common Spike-rush (*Eleocharis acuta*), Milfoil (*Myriophyllum* sp.), Common Reed (*Phragmites australis*), *Puccinellia stricta* var. *stricta*, Creeping Brookweed (*Samolus repens*), Sharp-leaf Club-rush (*Schoenoplectus pungens*), Prickly Arrowgrass (*Triglochin mucronatum*), Streaked Arrowgrass (*Triglochin striatum*).

Wetland - saltwater herbland / sedgeland - *Phragmites australis* - *Typha domingensis* grassland in areas flooded by River Murray water, in seasonal freshwater wetland

Species in this association include: Common Reed (*Phragmites australis*), Narrow-leaf Bulrush (*Typha*

domingensis), Salt Couch (*Sporobolus virginicus*); Australian Saltmarsh Grass (*Puccinellia stricta* var. *stricta*), Sea Club-rush (*Bolboschoenus caldwellii*).

This chapter compiles the data from seven surveys that have sampled sites within the region (depicted in Figure 8) that have contributed data to the Biological Survey of South Australia Database. A vegetation map of the Islands of the Murray Mouth region has also been produced and complements the existing mapping of the surrounding peninsulas and mainland that have been produced for the Mt Lofty Region and Western Murray Flats by the Environmental Analysis and Research Unit of the Department for Environment and Heritage.

VEGETATION SURVEY COVERAGE

The contribution to the dataset from each site is summarised in Table 1. The current survey effort (Survey 136) concentrated on NPWSA reserve land to provide information for reserve management, particularly the new Wyndgate reserve and Mud Island Game Reserve for which there was no vegetation or general fauna data. An area of the Coorong which was sampled in 1982 was resampled because of the proximity to Mud Island Game Reserve which was unsuitable for establishing a base camp for the survey team. No sites were sampled on Mundoo Island because of access difficulties. The physical attributes

of the sites are summarised in Figures 9-11. These figures show the levels of sampling different physical attributes in the landscape and reflect the relative extent of those attributes across the study area. Figure 9 indicates that over 30% of sites are associated with sand dunes and this is reflected in figure 10 where 35% of sites have sandy soils. This is also the substrate for the bulk of the shrubland associations (Figure 11) and occurs almost exclusively along the coastal peninsulas. The other main habitat types are more complex in the relationships between soils, land unit and vegetation and will be described in detail in the results section.

Table 1. Surveys and the number of sites sampled contributing to this report.

Survey Number	Survey Name and year of sampling	Number of sites sampled in study area
4	South East Coast 1982	12
42	Mt Lofty - Private Collectors (Murfett) 1987	6
45	Western Murray Flats 1992	3
78	Tidal and Saltmarsh Communities 1995	9
82	Coastal Dune and Clifftop 1996-7	21
93	Fleurieu Roadsides (M Hyde) 1993	2
136	Murray Mouth Reserves 2002	22
	Total	75

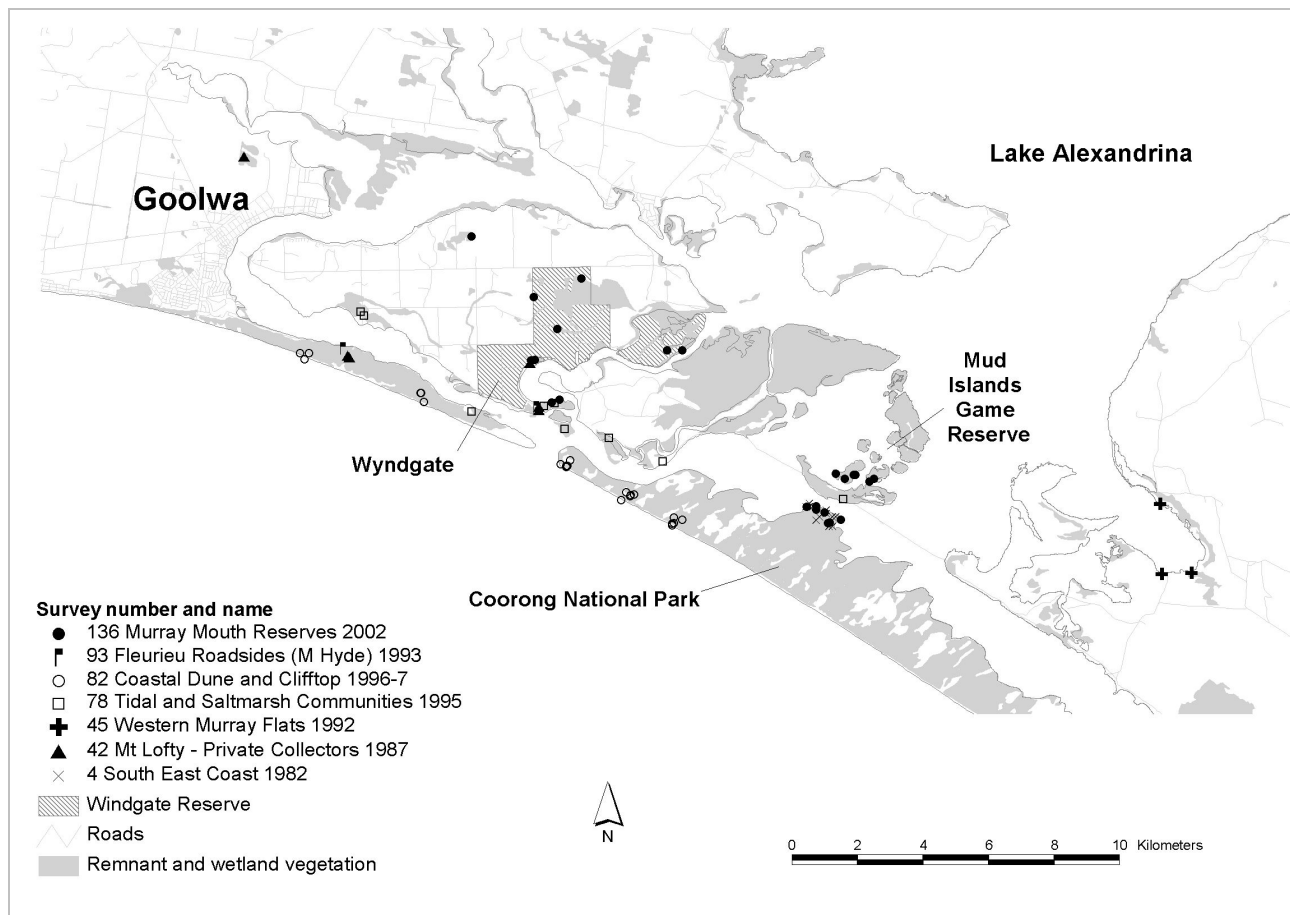


Figure 8. Map of study area showing native vegetation, wetland vegetation and survey sites.

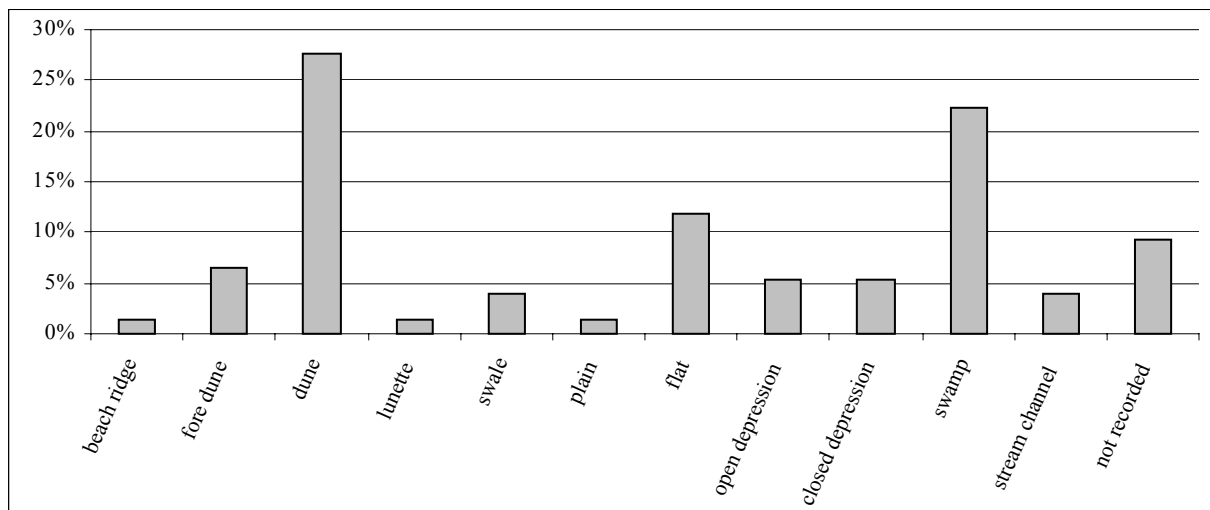


Figure 9. The proportion of the 75 sites sampled in each land unit within the survey area.

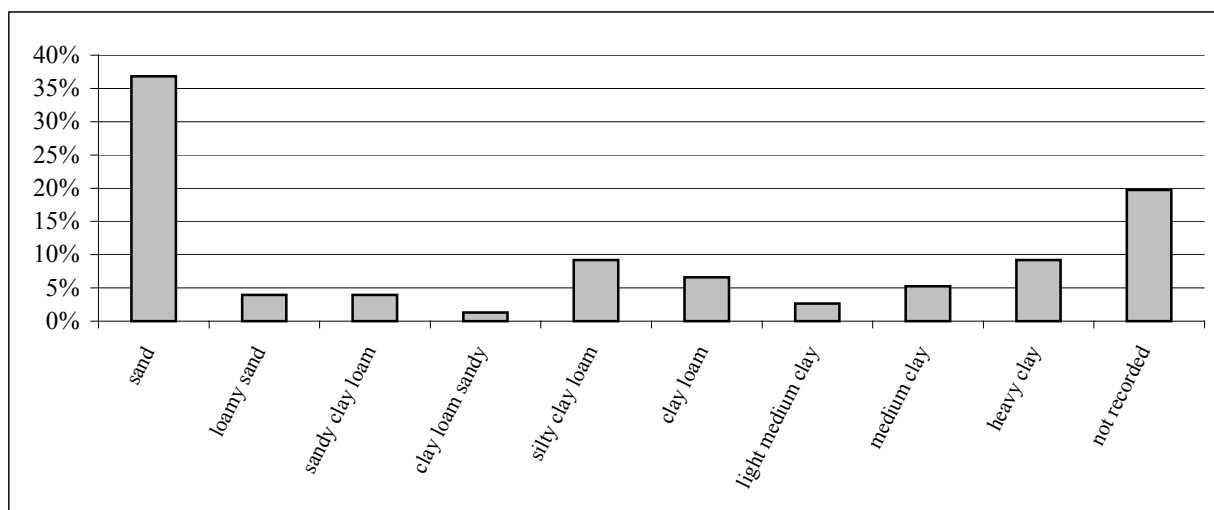


Figure 10. The proportion of the 75 sites sampling each surface soil texture class within the survey area.

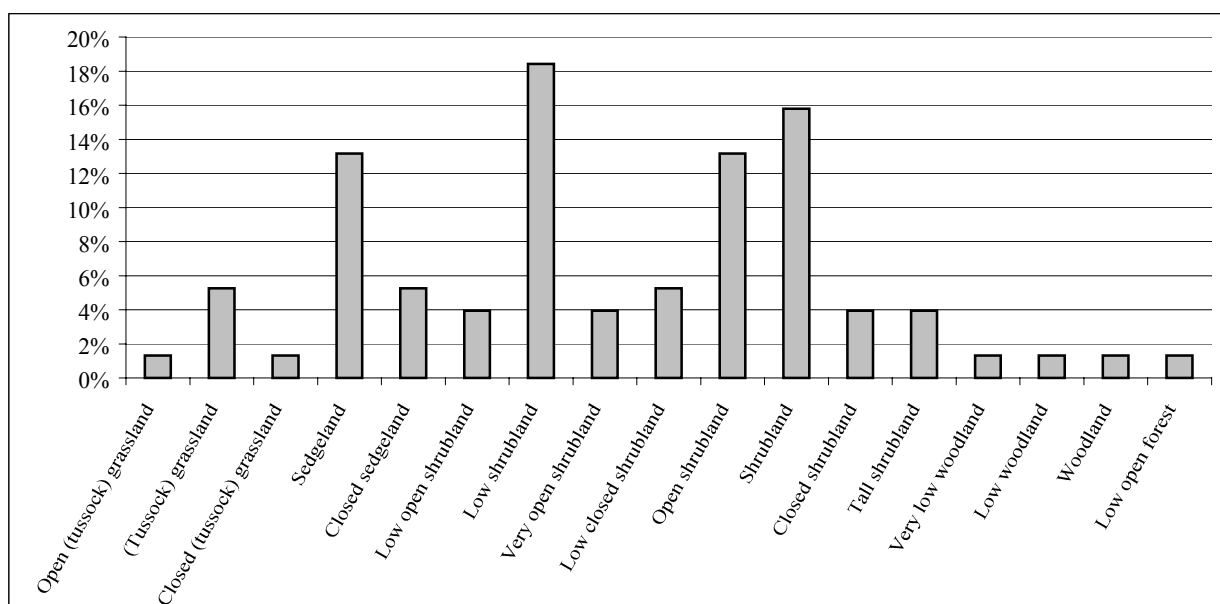


Figure 11. The proportion of the 75 sites sampling each structural vegetation category within the survey area.

SURVEY RESULTS

Compilation of data from all Surveys detected 217 plant species from 55 families. The best represented families were the Gramineae (grasses) with 18% of species and the Compositae (daisies) with 11% (Table 2). In the Flinders Ranges daisies then grasses were dominant and in the stony deserts further north the Chenopodiaceae then grasses were dominant (Brandle 1998 and 2000). Seventy-three (34%) species were

exotic of which half were grasses (34%) and daisies (16%).

Table 3 indicates the number of species that were recorded for each survey effort in the study area and the number that were indigenous or exotic. A full species list is in Appendices II, III, VI. No species of state or national conservation significance were recorded at survey sites.

Table 2. Numbers of species recorded from plant families within the study area.

FAMILYNAME	Species per family	FAMILYNAME	Species per family	FAMILYNAME	Species per family
GRAMINEAE	38	SCROPHULARIACEAE	3	CASUARINACEAE	1
COMPOSITAE	24	SOLANACEAE	3	CENTROLEPIDACEAE	1
CHENOPODIACEAE	16	CRUCIFERAE	2	EPACRIDACEAE	1
LEGUMINOSAE	13	DROSERACEAE	2	FRANKENIACEAE	1
CYPERACEAE	11	EUPHORBIACEAE	2	LOGANIACEAE	1
LILIACEAE	8	JUNCAGINACEAE	2	MYOPORACEAE	1
UMBELLIFERAE	8	LAURACEAE	2	ONAGRACEAE	1
MYRTACEAE	6	LIMONIACEAE	2	OXALIDACEAE	1
POLYGONACEAE	6	LORANTHACEAE	2	POLYGALACEAE	1
CARYOPHYLLACEAE	4	MALVACEAE	2	PROTEACEAE	1
CONVOLVULACEAE	4	PLANTAGINACEAE	2	RANUNCULACEAE	1
CRASSULACEAE	4	PRIMULACEAE	2	RUBIACEAE	1
JUNCACEAE	4	SAPINDACEAE	2	SANTALACEAE	1
ORCHIDACEAE	4	THYMELAEACEAE	2	STACKHOUSIACEAE	1
AIZOACEAE	3	AMARANTHACEAE	1	STYLIDIACEAE	1
GERANIACEAE	3	APOCYNACEAE	1	TYPHACEAE	1
HALORAGACEAE	3	ASCLEPIADACEAE	1	URTICACEAE	1
LABIATAE	3	AZOLLACEAE	1	TOTAL = 55	217
PITTOSPORACEAE	3	CAMPANULACEAE	1		

Table 3. Numbers of native and exotic species recorded at sites for seven survey efforts.

Survey number	SE Coast	Murfett & Taplin	Western Murray Flats	Tidal & Saltmarsh	Coastal Dune & Cliftop	Fleurieu Roadsides Hyde	Murray Mouth Reserves	Total
Number of indigenous species	23	51	10	24	38	22	90	143
Number of exotic species	1	12	10	9	31	5	36	73
Total number of species	24	63	20	33	69	27	126	216

COMMONLY DETECTED SPECIES

No species was common to even half of the sites sampled. This reflects the diversity of habitat types and the distribution of sites across that diversity gradient, particularly between the 40 sandy sites of the barrier dunes and the 33 clay/loam sites of the flats and

swamps. Table 4 shows the most widely distributed species by this major landform/soil type division. None of the species present at more than 25% of sites in either category are common to both. There is also little overlap at the higher taxonomic level of family.

COMPARISONS WITH THE KNOWN FLORA OF THE REGION

As indicated in the literature review, the vegetation of Hindmarsh Island has been mostly cleared and the majority of remnants have been severely modified or impacted by changes to water regimes and stock grazing. Despite this, Murfett has been able to find 239 indigenous as well as 172 introduced plant species on Hindmarsh Island (Murfett 1996). The Murray Mouth

Reserves Survey recorded 104 of these on the island at the 18 biological survey sites sampled. Seven species were new records for the island of which five were indigenous and had not been recorded by Murfett (1995) or Renfrey *et al.* (1989). These are marked with a hash “#” in the species list (Appendix VI).

Table 4. Species detected at more than 25% of sites in decreasing order. Percentages for sand dune species from 40 sites and 33 sites for flats and swamp species.

Family	Species	Common Name	# of sites	
Sand Dune Species				
COMPOSITAE	<i>Olearia axillaris</i>	Coast Daisy-bush	27	64%
THYMELAEACEAE	<i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i>	Thyme riceflower	27	64%
AIZOACEAE	<i>Carpobrotus rossii</i>	Native pigface	26	62%
CHENOPODIACEAE	<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry saltbush	25	60%
CYPERACEAE	<i>Isolepis nodosa</i>	Knobby Club-rush	22	52%
AIZOACEAE	<i>Tetragonia implexicoma</i>	Bower Spinach	21	50%
LEGUMINOSAE	<i>Acacia longifolia</i> var. <i>sophorae</i>	Coastal Wattle	21	50%
POLYGONACEAE	<i>Muehlenbeckia gunnii</i>	Coastal Climbing Lignum	18	43%
LILIACEAE	<i>Dianella brevicaulis</i>	Short-stem Flax-lily	17	40%
COMPOSITAE	<i>Sonchus oleraceus</i>	Common Sow-thistle*	16	38%
EPACRIDACEAE	<i>Leucopogon parviflorus</i>	Coast Beard-heath	16	38%
SANTALACEAE	<i>Exocarpos syrticola</i>	Coast Cherry	16	38%
MYOPORACEAE	<i>Myoporum insulare</i>	Common Boobialla	15	36%
UMBELLIFERAE	<i>Daucus glochidiatus</i>	Native Carrot	14	33%
GRAMINEAE	<i>Spinifex sericeus</i>	Rolling Spinifex	13	31%
PITTOSPORACEAE	<i>Billardiera cymosa</i>	Sweet Apple-berry	13	31%
CARYOPHYLLACEAE	<i>Sagina maritima</i>	Sea Pearlwort*	11	26%
Flat and Swamp Species				
PRIMULACEAE	<i>Samolus repens</i>	Creeping Brookweed	21	64%
CHENOPODIACEAE	<i>Sarcocornia quinqueflora</i>	Beaded Samphire	16	48%
CHENOPODIACEAE	<i>Suaeda australis</i>	Austral Seablite	15	45%
PLANTAGINACEAE	<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain*	14	42%
GRAMINEAE	<i>Phragmites australis</i>	Common Reed	13	39%
GRAMINEAE	<i>Distichlis distichophylla</i>	Emu-grass	12	36%
JUNCACEAE	<i>Juncus kraussii</i>	Sea Rush	11	33%
POLYGONACEAE	<i>Muehlenbeckia florulenta</i>	Lignum	11	33%
FRANKENIACEAE	<i>Frankenia pauciflora</i> var.	Southern Sea-heath	10	30%
GRAMINEAE	<i>Paspalum vaginatum</i>	Salt-water Couch*	10	30%
CHENOPODIACEAE	<i>Atriplex paludosa</i> ssp.	Marsh Saltbush	9	27%
CHENOPODIACEAE	<i>Sarcocornia blackiana</i>	Thick-head Samphire	9	27%
CYPERACEAE	<i>Bolboschoenus caldwellii</i>	Salt Club-rush	9	27%
LIMONIACEAE	<i>Limonium binervosum</i>	dwarf sea-lavender*	9	27%

SPECIES PATTERNS

The 75 sites sampled for vegetation by seven survey efforts since 1982 were analysed for floristic similarity and used to define floristic groups and assist with understanding the vegetation communities present in the area. Of the 217 distinct plant taxa recorded at sites, 70 were retained for the analysis whilst the remaining annuals and species that were recorded at less than four sites were excluded. A complete list of species by floristic group is presented in Appendix VII.

The exploratory analysis program PATN (Belbin 1994) was used to cluster the 75 sites into 11 groups on the basis of similarity in presence of plant species at each site (Figure 13). A lower level of dissimilarity was used than for larger scale surveys ~ 0.8 compared to 1.0 (Brandle 1998, 2001).

INTERPRETATION OF DENDROGRAM

The dendrogram representing the similarity of species composition between sites is split into two major clusters (Figure 13). The first 31 sites represent the vegetation communities of the coastal dune fields and beaches. For the following analysis this has been divided into three floristic groups (1,

2 and 5). The single site group 3 is closely allied to group 2 and the site defining group 4 is not representative of the area being a mainland eucalypt woodland. The analysis grouped it in amongst the dunes because the defining shrubs and trees were removed from the analysis (occurring at three or less sites). Sites one to 23 that comprise floristic group one define the coastal dune scrub dominated by a mixture of Coast Daisy, Common Boobialla, Coastal Wattle and Coast Beard-heath. Floristic group 2 clusters together sites with a more open form of the coastal scrub community that is found in the swales and lower sandy rises on the coastal peninsulas. The understorey is dominated by sedges. The two sites comprising floristic group 5 represent the most disturbed areas of the coastal peninsulas, the seaward foredunes which are dominated by Rolling Spinifex the introduced Sea Wheat-grass and Sea Spurge.

Site 32 in the dendrogram marks the beginning of the second major cluster which is defined by sites supporting vegetation characteristic of the heavier soils of the flats and wetlands. The first 10 sites (32-41) comprise floristic group 6 which describes the low shrub samphire communities occurring on flats and swampy areas adjacent to the estuarine waters of the Coorong and Goolwa channels. The next five sites that comprise floristic group 7 represent salt bush/blubush areas that may or may not

have an overstorey of Swamp Paperbark. Sites 47-57 comprise floristic group 8 which represents more frequently inundated areas that support Beaded Samphire Low Shrublands with or without Lignum. Sites 58 to 62, floristic group 9, samples the fragments of relatively undisturbed Swamp Paperbark woodland that has a dense Sea Rush / Salt Club-rush sedge understorey.

Site 63 marks a major split within the second cluster. The first five sites, floristic group 10 which appears to be restricted to estuarine areas,

supporting a depauperate Lignum Closed Shrubland with Common Reeds as the only other dominant plant. The last 8 sites (68-75) comprising floristic group 11, represent a freshwater fringing reed community that has established itself over most of the low lying islands and along the channels upstream of the barrages.

A more complete description of the nine accepted floristic groups is presented in the following text with maps and species tables. Table 5 summarises the relationship between floristic groups and the physical parameters - landform, surface soil texture and vegetation structure.



Figure 12. *Calystegia sepium* from Myrtle Island 136MUD01201. Photo: AC Robinson NPWSA.

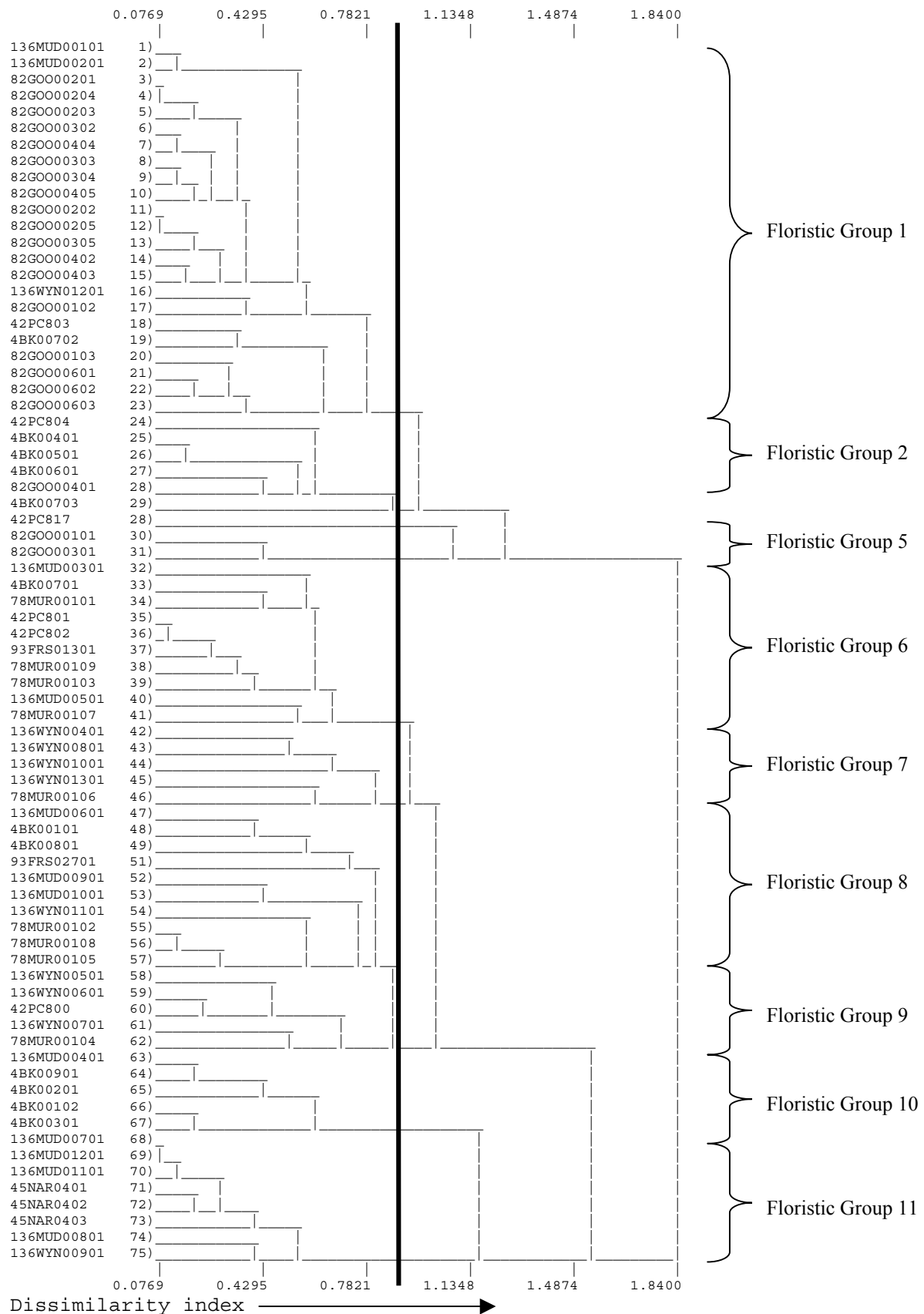


Figure 13. Dendrogram from PATN indicating classification levels used to define 11 Floristic groups.

Table 5. A summary of the relationship of floristic groups to physical habitat. Values are presented as percentages of the total number of sites in each group.

# sites in group	23		5		1		1		2		10		5		10		5		5		8	
Group number	1		2		3		4		5		6		7		8		9		10		11	
Landform Unit	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E	% of sites	O-E
Dune	9	-0.1	60	5.4	100	9.7							20	1.1								
dune crest	30	2.3																				
dune slope	26	2.3																				
lunette															10	6.5						
interdune low	4	2.3																				
interdune corridor	4	2.3																				
fore dune	9	0.3	20	2.0					100	14.0												
beach ridge															10	6.5						
210 swale	4	2.3																				
plain											10	6.5										
flat											40	2.3	20	0.7	30	1.5	20	0.7				
closed depression	9	0.6									10	0.9			10	0.9						
open depression													20	2.8	10	0.9	40	6.5				
swamp											20	-0.1	20	-0.1	30	0.3	20	-0.1	60	1.6	88	2.9
stream channel																			40	9.0	13	2.1
not recorded	4	-0.5	20	1.1			100	9.7			20	1.1	20	1.1			20	1.1				
Surface Soil Structure																						
	1		2		3		4		5		6		7		8		9		10		11	
Sand	91	1.4	80	1.1	100	1.7			100	1.7												
Sandy Clay Loam															10	1.5			40	9.0		
Loamy Sand	4	0.1									10	1.5	20	4.0								
Silty Clay Loam											10	0.1	60	5.4	10	0.1			20	1.1	13	0.3
Clay Loam Sandy															10	6.5						
Clay Loam											10	0.5			10	0.5			40	5.0	13	0.9
Light Med. Clay																	40	14.0				
Medium Clay															10	0.9	20	2.8			25	3.7
Heavy Clay											10	0.1			20	1.1					50	4.4
not recorded	4	-0.8	20	0.0			100	4.0			60	2.0	20	0.0	30	0.5	40	1.0				
Vegetation Structure																						
	1		2		3		4		5		6		7		8		9		10		11	
Open (Tussock) Grassland			20	14.0																		
(Tussock) Grassland									100	17.8	10	0.9	20	2.8								
Closed (Tussock) Grassland													20	14.0								
Sedgeland	4	-0.7											20	0.5	10	-0.3	20	0.5	20	0.5	63	3.7
Closed Sedgeland																			20	2.8	38	6.0
Low Open Shrubland	9	1.2													10	1.5						
Low Shrubland	4	-0.8									80	3.3	20	0.1	20	0.1	40	1.1				
Low Closed Shrubland											10	0.9			20	2.8	20	2.8				
Very Open Shrubland	9	1.2	20	4.0																		
Open Shrubland	26	1.0	60	3.5	100	6.5																
Shrubland	35	1.4													20	0.4			20	0.4		
Closed Shrubland															10	1.5			40	9.0		
Tall Shrubland	9	1.2													10	1.5						
Very low Woodland																	20	14.0				
Low Woodland	4	2.3																				
Woodland							100	74.0														
Low Open Forest													20	14.0								

Floristic Group 1. Coast Daisy-bush (*Olearia axillaris*) / Common Boobialla (*Myoporum insulare*) / Coastal Wattle (*Acacia longifolia*) +/- Coast Beard-heath Shrubland (*Leucopogon parviflorus*).

Overstorey structure in this group varies from Very Open Shrubland to Tall Shrubland depending on position within the coastal dune/interdune complex. This vegetation community is characteristic of the taller sand dune slopes and ridges along the Youngusband Peninsula of the Coorong National Park and Sir Richard Peninsula. The understorey is usually characterised by: low shrubs *Rhagodia candolleana*, *Pimelea serpyllifolia* and *Exocarpos syrticola*; mat plants *Kunzea pomifera* and *Carpobrotus rossii*; the sedge *Dianella brevicaulis*; and the vines *Muehlenbeckia gunnii* and *Billardiera cymosa*. The one non-coastal site that was clumped into this group (136WYN01301) should be ignored as the dominant species such as Drooping Sheoak (*Allocasuarina verticillata*) were only present at this site and were thus not included in the analysis which disregarded species present at less than four sites. The Coastal Dune and Cliff-top Survey (Oppermann 1999) Floristic Groups 50 (*Leucopogon parviflorus*/*Olearia axillaris* shrublands) and 51 contain the bulk of the sites comprising this group. The remaining sites contribute to Floristic Group 45 which represents the more degraded *O. axillaris* shrublands with introduced grasses dominating the understorey.

Number of sites: 23

Perennial Species defining group: 44

Total species at sites: 102

Average number of species at sites: 22

Introduced species at sites: 37

Range: 6-38

Average per site: 5

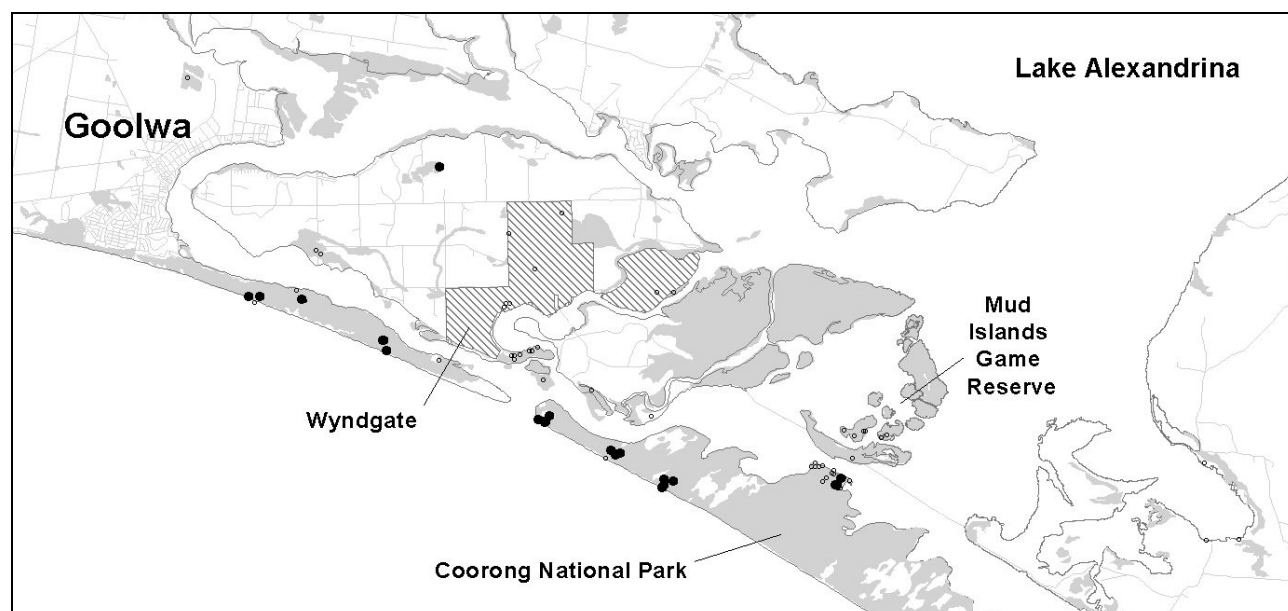
No. spp. with Southern Lofty Conservation Status: 14

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: NA

Murray Mouth Reserves: NA



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i>	Thyme Riceflower	100	0.47	23	5	30	1.40
<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry Saltbush	100	0.63	23	4	27	1.00
<i>Olearia axillaris</i>	Coast Daisy-bush	96	0.56	22	2	27	1.13
<i>Acacia longifolia</i> var. <i>sophorae</i>	Coastal Wattle	91	0.82	21	2	22	1.12
<i>Myoporum insulare</i>	Common Boobialla	65	0.43	15	4	20	1.22
<i>Exocarpos syrticola</i>	Coast Cherry	61	0.67	14	2	16	0.85
<i>Leucopogon parviflorus</i>	Coast Beard-heath	52	0.43	12	3	16	0.91
<i>Threlkeldia diffusa</i>	Coast Bonefruit	43	0.19	10	5	16	1.19
<i>Alyxia buxifolia</i>	Sea Box	17	0.52	4	2	5	1.13
<i>Lycium ferocissimum</i>	African Boxthorn *	13	0.15	3	3	5	1.75
Mat plant							
<i>Carpobrotus rossii</i>	Native Pigface	91	0.38	21	6	29	0.66
<i>Kunzea pomifera</i>	Muntries	30	0.67	7	2	8	1.86
Herb							
<i>Sonchus oleraceus</i>	Common Sow-thistle *	70	0.53	16	3	20	0.93
<i>Daucus glochidiatus</i>	Native Carrot	61	0.91	14	1	14	0.63
<i>Sagina maritima</i>	Sea Pearlwort *	48	0.62	11	2	13	1.01
<i>Crassula sieberiana</i> ssp. <i>tetramera</i>	Australian Stonecrop	35	0.91	8	1	8	0.66
<i>Galium murale</i>	Small Bedstraw *	30	0.91	7	1	7	0.94
<i>Pelargonium australe</i>	Australian Pelargonium	30	0.67	7	2	8	0.94
<i>Senecio lautus</i>	Variable Groundsel	30	0.67	7	2	8	1.17

<i>Crassula decumbens</i> var. <i>decumbens</i>	Spreading Crassula	22	0.91	5	1	5	1.00
<i>Reichardia tingitana</i>	False Sowthistle *	22	0.60	5	2	6	0.88
<i>Crassula closiana</i>	Stalked Crassula	17	0.91	4	1	4	0.75
<i>Euphorbia paralias</i>	Sea Spurge *	17	0.08	4	3	7	0.75
<i>Lotus australis</i>	Austral Trefoil	17	0.91	4	1	4	0.75
<i>Sonchus megalocarpus</i>	Coast Sow-thistle	13	0.43	3	2	4	0.50
Sedge							
<i>Dianella brevicaulis</i>	Short-stem Flax-lily	74	0.81	17	2	18	1.44
<i>Isolepis nodosa</i>	Knobby Club-rush	74	0.35	17	4	24	1.17
<i>Lepidosperma gladiatum</i>	Coast Sword-sedge	13	0.15	3	2	5	1.10
Grass							
<i>Spinifex sericeus</i>	Rolling Spinifex	43	0.47	10	3	13	0.75
<i>Ammophila arenaria</i>	Marram Grass *	22	0.91	5	1	5	1.63
<i>Bromus diandrus</i>	Great Brome *	22	0.91	5	1	5	1.83
<i>Ehrharta villosa</i> var. <i>maxima</i>	Pyp Grass *	17	0.52	4	2	5	1.02
<i>Poa poiiformis</i>	Coast Tussock-grass	17	0.52	4	2	5	1.04
<i>Sporobolus virginicus</i>	Salt Couch	13	0.43	3	2	4	1.17
Vine							
<i>Tetragonia implexicoma</i>	Bower Spinach	78	0.49	18	5	23	0.80
<i>Muehlenbeckia gunnii</i>	Coastal Climbing Lignum	74	0.71	17	3	19	1.08
<i>Billardiera cymosa</i>	Sweet Apple-berry	57	0.91	13	1	13	0.80
<i>Clematis microphylla</i>	Old Man's Beard	22	0.20	5	4	8	1.20

SITES CONTRIBUTING TO GROUP

136MUD00101, 136MUD00201, 82GOO00201, 82GOO00204, 82GOO00203, 82GOO00302, 82GOO00404, 82GOO00303, 82GOO00304, 82GOO00405, 82GOO00202, 82GOO00205, 82GOO00305, 82GOO00402, 82GOO00403, 136WYN01201, 82GOO00102, 42PC803, 4BK00702, 82GOO00103, 82GOO00601, 82GOO00602, 82GOO00603

Number of mammal and reptile sites: 4

Number of bird sites: 3

Number of Mammal Species, *introduced, (records): 6, *5, (18)

Number of Bird Species, *introduced, (records): 31, *2, (52)

Number of Reptile Species (records): 7, (14)

Number of Frog Species (records): 1, (1)

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	3	11
LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit	2	2
MURIDAE	<i>Rattus rattus</i>	Black Rat	1	2
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	1	1
LEPORIDAE	<i>Lepus capensis</i>	Brown Hare	1	1
CANIDAE	<i>Vulpes vulpes</i>	Fox	1	1

Birds: recorded at two or more sites

Family	SPECIES	Common Name	Site Frequency	Number observed
MELIPHAGIDAE	<i>Lichenostomus virescens</i>	Singing Honeyeater	3	58
ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereye	3	25
MELIPHAGIDAE	<i>Anthochaera carunculata</i>	Red Wattlebird	3	17
DICRURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail	3	5
CORVIDAE	<i>Corvus mellori</i>	Little Raven	3	2
PSITTACIDAE	<i>Neophema chrysostoma</i>	Blue-winged Parrot	2	4
ACANTHIZIDAE	<i>Sericornis frontalis</i>	White-browed Scrubwren	2	3
COLUMBIDAE	<i>Phaps elegans</i>	Brush Bronzewing	2	2
MELIPHAGIDAE	<i>Manorina melanocephala</i>	Noisy Miner	2	2
ACANTHIZIDAE	<i>Dasyornis broadbenti</i>	Rufous Bristlebird	2	heard
CASUARIIDAE	<i>Dromaius novaehollandiae</i>	Emu	2	tracks and scats

Reptiles and Frogs

Family	SPECIES	Common Name	Site Frequency	Number observed
SCINCIDAE	<i>Hemiergis peronii</i>	Four-toed Earless Skink	3	4
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye	2	3
SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink	2	2
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1	2
SCINCIDAE	<i>Morethia boulengeri</i>	Common Snake-eye	1	1
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko	1	1
AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon	1	1
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	1	1

Floristic Group 2. Coast Daisy-bush (*Olearia axillaris*) +/- Coast Beard-heath (*Leucopogon parviflorus*) Open Shrubland

This vegetation community represents a more open and disturbed sub-set of Floristic Group 1 on lower sandy interdunes and rises on the coastal peninsulas. The sedges *Isolepis nodosa*, *Lepidosperma gladiatum*, *Juncus kraussii* and the introduced grass *Ehrharta villosa* were the most important understorey species that characterised this group.

Number of sites: 5

Perennial Species defining group: 19

Total species at sites: 23

Average number of species at sites: 9.2 Range: 6-18

Introduced species at sites: 7 Average per site: 3.5

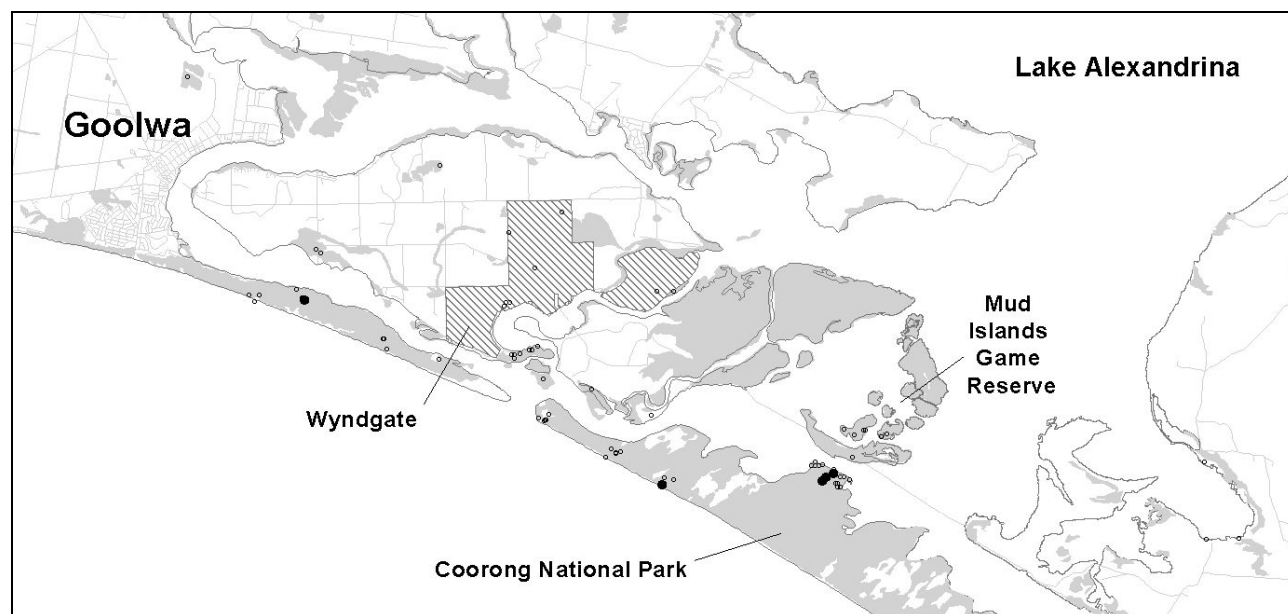
No. spp. with Southern Lofty Conservation Status: 4

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: NA

Murray Mouth Reserves: NA



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Olearia axillaris</i>	Coast Daisy-bush	100	2.66	5	2	27	1.72
<i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i>	Thyme Riceflower	80	1.64	4	5	30	1.38
<i>Leucopogon parviflorus</i>	Coast Beard-heath	60	2.72	3	3	16	2.00
<i>Exocarpos syrticola</i>	Coast Cherry	40	1.47	2	2	16	2.50
<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry Saltbush	40	0.47	2	4	27	1.00
Mat plant							
<i>Carpobrotus rossii</i>	Native Pigface	60	1.05	3	6	29	1.03
Herb							
<i>Euphorbia paralias</i>	Sea Spurge *	20	1.87	1	3	7	1.00
<i>Limonium binervosum</i>	Dwarf Sea-lavender *	20	0.98	1	4	10	3.00
<i>Pelargonium australe</i>	Australian Pelargonium	20	1.51	1	2	8	0.50
Grass							
<i>Ehrharta villosa</i> var. <i>maxima</i>	Pyp Grass *	20	3.03	1	2	5	0.50
<i>Lagurus ovatus</i>	Hare's Tail Grass *	20	1.50	1	5	8	0.50
<i>Spinifex sericeus</i>	Rolling Spinifex	20	0.54	1	3	13	1.00
Sedge							
<i>Isolepis nodosa</i>	Knobby Club-rush	100	3.12	5	4	24	1.52
<i>Juncus kraussii</i>	Sea Rush	60	2.98	3	6	15	1.17
<i>Lepidosperma gladiatum</i>	Coast Sword-sedge	40	6.94	2	2	5	2.00
Vine							
<i>Tetragonia implexicoma</i>	Bower Spinach	40	0.73	2	5	23	1.05
<i>Clematis microphylla</i>	Old Man's Beard	20	1.46	1	4	8	0.50

SITES CONTRIBUTING TO GROUP

42PC804, 4BK00401, 4BK00501, 4BK00601, 82GOO00401

Number of mammal and reptile sites: 3

Number of bird sites: 0

Number of Mammal Species, *introduced, (records): 1, *1, (2)

Number of Bird Species, *introduced, (records): not sampled

Number of Reptile Species (records): 5, (12)

Number of Frog Species (records): none recorded

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	2	2

Reptiles

Family	SPECIES	Common Name	Site Frequency	Number observed
SCINCIDAE	<i>Lerista dorsalis</i>	Southern Four-toed Slider	3	4
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye	1	2
SCINCIDAE	<i>Ctenotus robustus</i>	Eastern Striped Skink	1	2
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus	1	2
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon	1	2



Figure 14. Floristic Group 1 136MUD00101 Coast Beard-heath (*Leucopogon parvifolius*) and Coast Daisy-bush (*Olearia axillaris*) Open Shrubland.



Figure 15. Floristic group 1 136MUD00201 Coast Sword-sedge (*Lepidosperma gladiatum*) in a dune swale in coastal Open Shrubland

Floristic Group 3. Outlier of Floristic Groups 1 & 2.

Number of sites: 1 4BK00703

Perennial Species defining group 4

Total species at sites 5

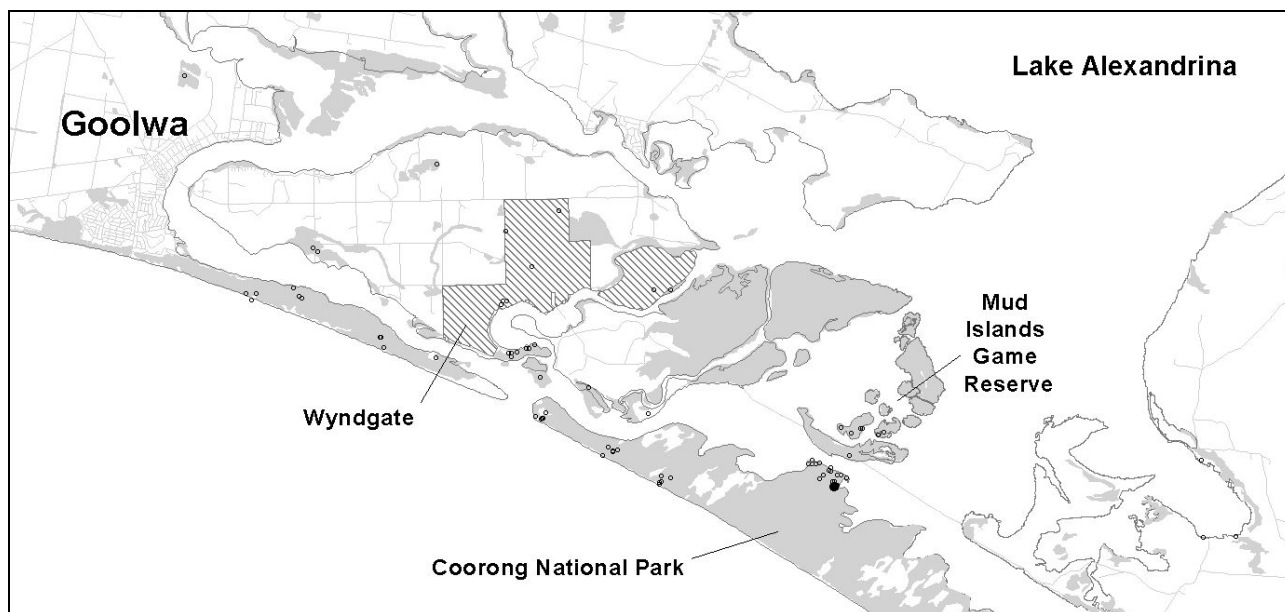
No. spp. with Southern Lofty Conservation Status: 2

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: NA

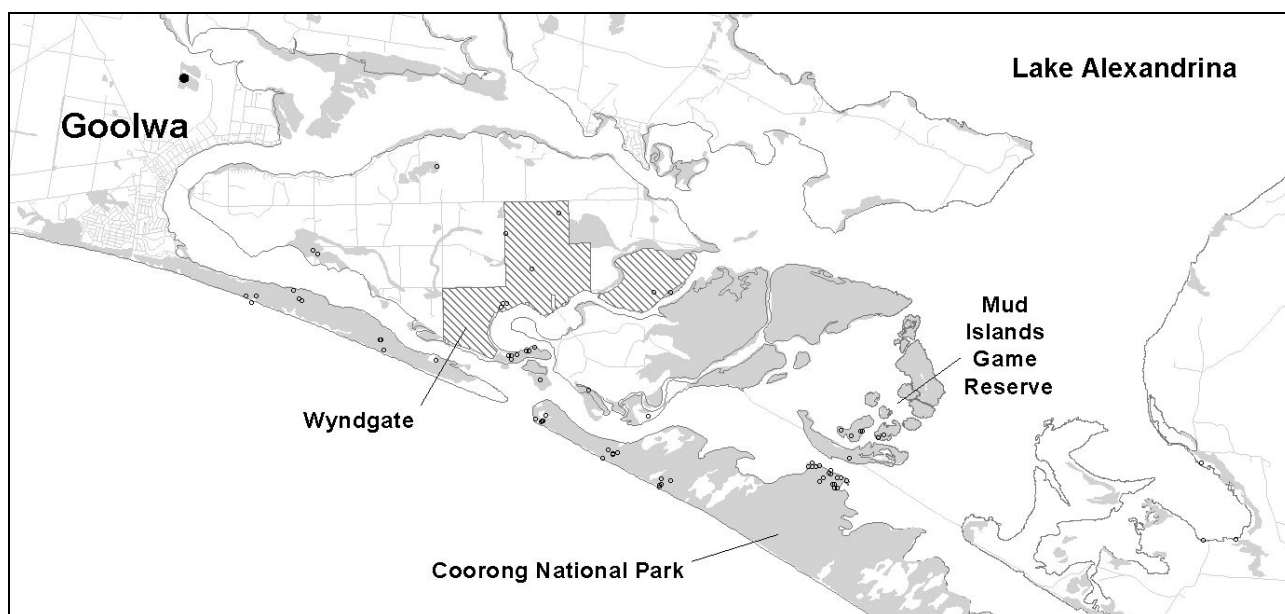
Murray Mouth Reserves: NA



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Alyxia buxifolia</i>	Sea Box	100	38.33	1	2	5	2
<i>Leucopogon parviflorus</i>	Coast Beard-heath	100	11.10	1	3	16	2
Mat plant							
<i>Carpobrotus rossii</i>	Native Pigface	100	5.68	1	6	29	2
<i>Kunzea pomifera</i>	Muntries	100	23.45	1	2	8	3

Floristic Group 4. Mainland eucalypt woodland site not relevant as overstorey dominants were taken out of analysis (present at less than 4 sites).

Number of sites: 1 42PC817



Floristic Group 5. Rolling Spinifex (*Spinifex sericeus*) and Sea Wheat-grass (*Elymus farctus*) Tussock Grassland

This low tussock grassland community is characteristic of exposed sandy foredunes along the coast. The Coastal Dune and Cliff Top Survey (Opperman 1999) classified this community as *Spinifex sericeus*/*Euphorbia paralias* Grassland (Shrubland) floristic group 51. This habitat was not sampled for vertebrates during the current survey.

Number of sites: 2

Perennial Species defining group: 5

Total species at sites: 6

Average number of species at sites: 4.5 Range: 4-5

Introduced species at sites: 3 Average per site: 2.5

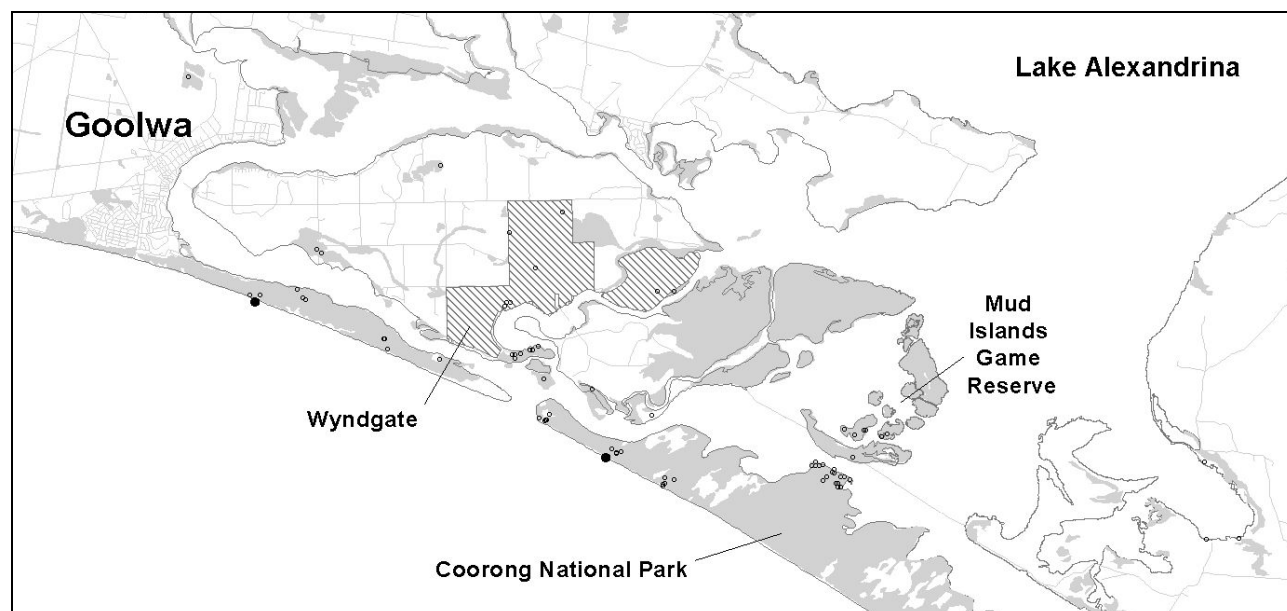
No. spp. with Southern Lofty Conservation Status: 1

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: NA

Murray Mouth Reserves: NA



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Mat plant							
<i>Carpobrotus rossii</i>	Native Pigface	50	2.81	1	6	29	0.50
Herb							
<i>Euphorbia paralias</i>	Sea Spurge *	100	30.94	2	3	7	0.50
<i>Reichardia tingitana</i>	False Sowthistle *	50	17.21	1	2	6	0.50
<i>Sonchus megalocarpus</i>	Coast Sow-thistle	50	26.66	1	2	4	0.50
Grass							
<i>Spinifex sericeus</i>	Rolling Spinifex	100	16.12	2	3	13	1.00

SITES CONTRIBUTING TO GROUP

82GOO00101, 82GOO00301

Number of mammal and reptile sites: 0

Number of bird sites: 0

Number of Mammal Species, *introduced, (records): not sampled

Number of Bird Species, *introduced, (records): not sampled

Number of Reptile Species (records): not sampled

Number of Frog Species (records): not sampled

Floristic Group 6. Thick-head Samphire (*Sarcocornia blackiana*) / Marsh Saltbush (*Atriplex paludosa*) +/- Shrubby Samphire (*Sclerostegia arbuscula*) Low Shrubland.

This Low Shrubland samphire community is characteristic of flats adjacent to the estuarine waters of the Coorong and Goolwa channels. Surface soil textures range from clay to sandy loam. On higher sandy loam situations tussock grasses such as Coast Spear-grass (*Stipa stipoides*) and Emu Grass (*Distichlis distichophylla*) can be co-dominant to dominant.

Number of sites: 10

Perennial Species defining group: 27

Total species at sites: 48

Average number of species at sites: 14 Range: 6-20

Introduced species at sites: 14 Average per site: 3.8

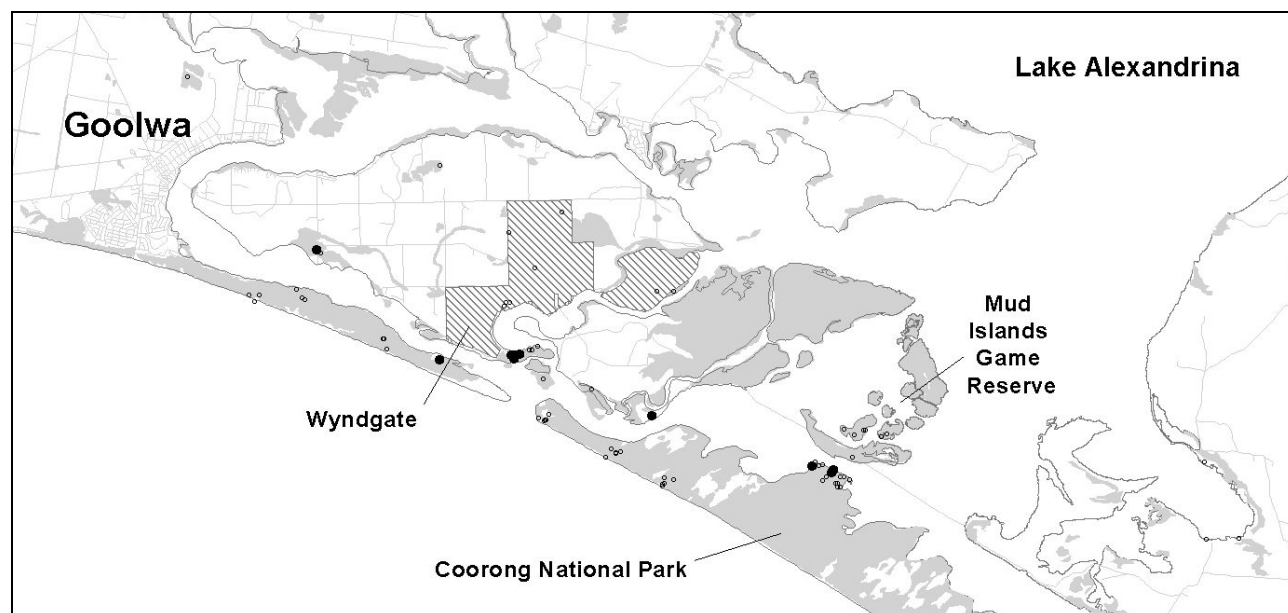
No. spp. with Southern Lofty Conservation Status: 13

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: Supratidal – Samphire & *Stipa stipoides*

Murray Mouth Reserves: Groups 8 & 10



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Frankenia pauciflora</i> var.	Southern Sea-heath	80	3.86	8	4	12	0.40
<i>Sarcocornia blackiana</i>	Thick-head Samphire	80	5.48	8	2	9	1.43
<i>Atriplex paludosa</i> ssp.	Marsh Saltbush	70	4.67	7	2	9	1.50
<i>Suaeda australis</i>	Austral Seablite	70	2.40	7	3	15	1.60
<i>Sclerostegia arbuscula</i>	Shrubby Samphire	60	5.25	6	2	7	1.67
<i>Lawrenia squamata</i>	Thorny Lawrenia	50	4.21	5	2	7	1.60
<i>Sarcocornia quinqueflora</i>	Beaded Samphire	40	0.82	4	4	16	0.75
<i>Maireana oppositifolia</i>	Salt Bluebush	30	2.12	3	2	7	1.00
Mat plant							
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	Round-leaf Pigface	60	5.25	6	2	7	1.10
Herb							
<i>Samolus repens</i>	Creeping Brookweed	90	1.98	9	5	22	0.93
<i>Limonium binervosum</i>	Dwarf Sea-lavender *	70	4.10	7	4	10	0.50
<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain *	60	2.11	6	4	14	
<i>Melilotus indica</i>	King Island Melilot *	20	1.43	2	3	6	3.00
<i>Sagina maritima</i>	Sea Pearlwort *	20	0.12	2	2	13	2.50
Grass							
<i>Distichlis distichophylla</i>	Emu-grass	60	2.64	6	4	12	1.58
<i>Critieson maritimum</i>	Sea Barley-grass *	40	1.91	4	4	10	1.17
<i>Stipa stipoides</i>	Coast Spear-grass	40	3.86	4	3	6	2.33

SITES CONTRIBUTING TO GROUP

136MUD00301, 4BK00701, 78MUR00101, 42PC801, 42PC802, 93FRS01301, 78MUR00109, 78MUR00103, 136MUD00501, 78MUR00107

Number of mammal and reptile sites: 3

Number of bird sites: 2

Number of Mammal Species, *introduced, (records): 6, *4, (16)

Number of Bird Species, *introduced, (records): 27, *0, (32)

Number of Reptile Species (records): 4, (6)

Number of Frog Species (records): none recorded

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	3	9
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	2	2
FELIDAE	<i>Felis catus</i>	Cat	2	2
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	1	1
LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit	1	1
CANIDAE	<i>Vulpes vulpes</i>	Fox	1	1

Birds: most frequently encountered species

Family	SPECIES	Common Name	Site Frequency	Number observed
CORVIDAE	<i>Corvus mellori</i>	Little Raven	2	66
ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silveryeye	2	21
MELIPHAGIDAE	<i>Lichenostomus virescens</i>	Singing Honeyeater	2	19
CORVIDAE	<i>Corvus coronoides</i>	Australian Raven	2	17
DICURURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail	2	7
SCOLOPACIDAE	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	1	81
MELIPHAGIDAE	<i>Epthianura albifrons</i>	White-fronted Chat	1	13
RECURVIOSTRIDAE	<i>Himantopus himantopus</i>	Black-winged Stilt	1	11
PSITTACIDAE	<i>Neophema elegans</i>	Elegant Parrot	1	7
PSITTACIDAE	<i>Neophema chrysostoma</i>	Blue-winged Parrot	1	6

Reptiles

Family	SPECIES	Common Name	Site Frequency	Number observed
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus	2	2
ELAPIDAE	<i>Pseudonaja textilis</i>	Eastern Brown Snake	2	2
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1	1
SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink	1	1



Figure 16. Floristic Group 6 136MUD00301 Marsh Saltbush (*Atriplex paludosa*) and Brown-head Samphire (*Halosarcia indica*) Low Shrubland



Figure 17. Floristic group 6 136MUD00501 Thick-head Samphire (*Sarcocornia blackiana*) and Austral Seablite (*Suaeda australis*) Low Shrubland

**Floristic Group 7. Salt Bluebush (*Maireana oppositifolia*) / Marsh Saltbush (*Atriplex paludosa*) Low Shrubland
+/- Swamp Paper-bark (*Melaleuca halmaturorum*).**

This low chenopod shrubland group represents a mix of sites ranging from tussock grassland to Low Shrubland with or without a woodland overstorey on the higher infrequently inundated clay loam to sandy loam flats of Hindmarsh Island and Tauwitherie Island. All but one of the sites was subject to heavy grazing by cattle. The only species common to all sites was the herb Bucks-horn Plantain (*Plantago coronopus*). The high disturbance levels are indicated by the large number of introduced species and low number of species common to most sites in the group.

Number of sites: 5

Perennial Species defining group: 35

Total species at sites: 49

Average number of species at sites: 15.8 Range: 6-27

Introduced species at sites: 20 Average per site: 6.2

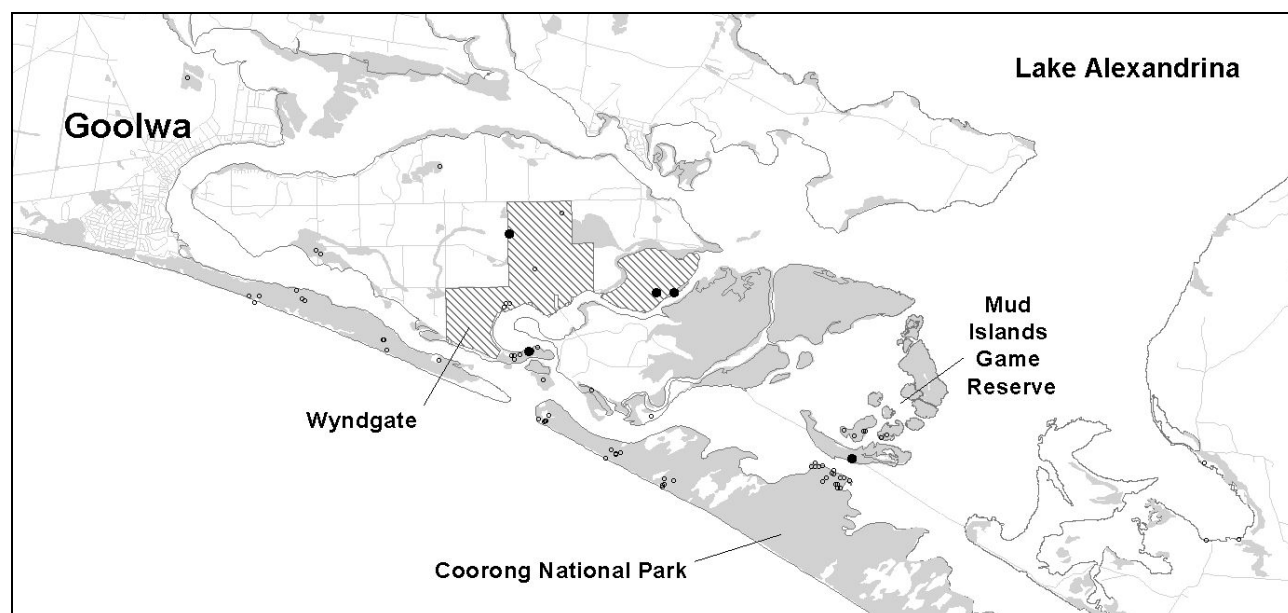
No. spp. with Southern Lofty Conservation Status: 7

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: Supratidal - Samphire

Murray Mouth Reserves: Groups 8 & 3



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Tree							
<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i>	Swamp Paper-bark	60	4.61	3	2	7	1.37
Shrub							
<i>Maireana oppositifolia</i>	Salt Bluebush	80	6.48	4	2	7	1.50
<i>Atriplex paludosa</i> ssp.	Marsh Saltbush	40	1.91	2	2	9	2.5
<i>Frankenia pauciflora</i> var.	Southern Sea-heath	40	1.18	2	4	12	0.75
<i>Lawrenzia squamata</i>	Thorny Lawrenzia	40	2.74	2	2	7	1.25
<i>Myoporum insulare</i>	Common Boobialla	40	0.31	2	4	20	0.50
<i>Lycium ferocissimum</i>	African Boxthorn *	20	1.62	1	3	5	1.00
<i>Muehlenbeckia florulenta</i>	Lignum	20	0.19	1	5	11	0.10
Herb							
<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain *	100	3.66	5	4	14	1.65
<i>Cotula coronopifolia</i>	Water Buttons *	60	6.79	3	3	5	1.20
<i>Sonchus oleraceus</i>	Common Sow-thistle *	40	0.30	2	3	20	0.50
<i>Triglochin striatum</i>	Streaked Arrowgrass	40	2.27	2	4	8	2.00
<i>Aster subulatus</i>	Aster-weed *	20	0.87	1	2	7	0.50
<i>Berula erecta</i>	Water Parsnip *	20	0.87	1	2	7	0.10
<i>Limonium binervosum</i>	Dwarf Sea-lavender *	20	0.31	1	4	10	0.50
<i>Melilotus indica</i>	King Island Melilot *	20	1.19	1	3	6	0.50
Grass							
<i>Distichlis distichophylla</i>	Emu-grass	60	2.27	3	4	12	2.00
<i>Vulpia fasciculata</i>	Sand Fescue *	60	6.75	3	2	5	1.00
<i>Lagurus ovatus</i>	Hare's Tail Grass *	20	0.66	1	5	8	0.50
<i>Paspalum vaginatum</i>	Salt-water Couch *	20	0.30	1	5	10	0.50
<i>Poa poiformis</i>	Coast Tussock-grass	20	1.67	1	2	5	2.00
<i>Sporobolus virginicus</i>	Salt Couch	20	2.28	1	2	4	0.50
<i>Stipa stipoides</i>	Coast Spear-grass	20	1.18	1	3	6	2.00
Sedge							
<i>Juncus kraussii</i>	Sea Rush	60	1.63	3	6	15	0.67

<i>Bolboschoenus caldwellii</i>	Salt Club-rush	20	0.31	1	6	10	1.00
Vine							
<i>Clematis microphylla</i>	Old Man's Beard	20	0.62	1	4	8	1.00
Mistletoe							
<i>Amyema melaleuca</i>	Tea-tree Mistletoe	20	2.27	1	2	4	0.50

SITES CONTRIBUTING TO GROUP

136WYN00401, 136WYN00801, 136WYN01001, 136WYN01301, 78MUR00106

Number of mammal and reptile sites: 4

Number of bird sites: 4

Number of Mammal Species, *introduced, (records): 5, *5, (26)

Number of Bird Species, *introduced, (records): 33, *3, (52)

Number of Reptile Species (records): 4, (5)

Number of Frog Species (records): 1, (2)

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	4	16
BOVIDAE	<i>Bos taurus</i>	Cattle	3	3
CANIDAE	<i>Vulpes vulpes</i>	Fox	2	3
CANIDAE	<i>Canis lupus familiaris</i>	Dog (domestic or feral)	2	2
BOVIDAE	<i>Ovis aries</i>	Sheep	1	2

Birds: most frequently observed species

Family	SPECIES	Common Name	Site Frequency	Number observed
HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	3	17
DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	3	8
MALURIDAE	<i>Malurus cyaneus</i>	Superb Fairy-wren	2	23
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola	2	5
ACCIPITRIDAE	<i>Elanus axillaris</i>	Black-shouldered Kite	2	2
COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon	2	2
ACANTHIZIDAE	<i>Sericornis frontalis</i>	White-browed Scrubwren	1	8
ACANTHIZIDAE	<i>Acanthiza pusilla</i>	Brown Thornbill	1	6

Reptiles and Frogs

Family	SPECIES	Common Name	Site Frequency	Number observed
ELAPIDAE	<i>Notechis ater</i>	Black Tiger Snake	1	2
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye	1	1
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko	1	1
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise	1	1
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	1	2



Figure 18. Salt Bluebush (*Maireana oppositifolia*) and Marsh Saltbush (*Atriplex paludosa*) with Swamp Paper-barks (*Melaleuca halmaturorum*). Photo: R. Brandle NPWSA.

Floristic Group 8. Beaded Samphire (*Sarcocornia quinqueflora*) Low Shrubland +/- Lignum (*Muehlenbeckia florulenta*).

This samphire low shrub community was most common in the more frequently inundated areas of the Coorong and Goolwa Channels and low areas on Wyndgate and Myrtle Island. Surface soil textures ranged from heavy clay to sandy clay loam.

Number of sites: 10

Perennial Species defining group: 25

Total species at sites: 35

Average number of species at sites: 7.2 Range: 4-17

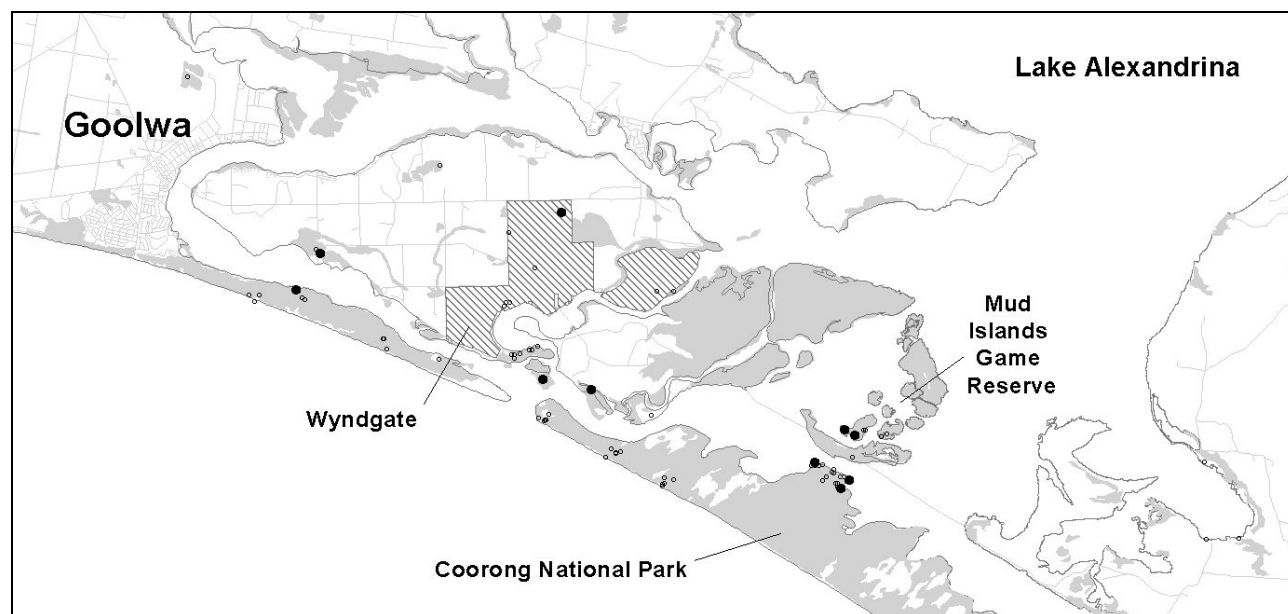
Introduced species at sites: 9 Average per site: 2.4

No. spp. with Southern Lofty Conservation Status: 6
Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: Intertidal - Samphire

Murray Mouth Reserves: Group 9



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Sarcocornia quinqueflora</i>	Beaded Samphire	80	5.78	8	4	16	1.64
<i>Suaeda australis</i>	Austral Seablite	50	3.52	5	3	15	0.78
<i>Muehlenbeckia florulenta</i>	Lignum	40	3.91	4	5	11	0.78
<i>Myoporum insulare</i>	Common Boobialla	20	0.36	2	4	20	1.00
<i>Threlkeldia diffusa</i>	Coast Bonefruit	20	0.71	2	5	16	1.50
<i>Frankenia pauciflora</i> var.	Southern Sea-heath	10	0.13	1	4	12	
<i>Lycium ferocissimum</i>	African Boxthorn *	10	1.72	1	3	5	1.00
<i>Sarcocornia blackiana</i>	Thick-head Samphire	10	0.51	1	2	9	
<i>Sclerostegia arbuscula</i>	Shrubby Samphire	10	0.94	1	2	7	1.00
Mat plant							
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	Round-leaf Pigface	10	0.94	1	2	7	0.10
Herb							
<i>Samolus repens</i>	Creeping Brookweed	90	4.54	9	5	22	0.97
<i>Triglochin striatum</i>	Streaked Arrowgrass	40	5.78	4	4	8	2.02
<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain *	20	0.93	2	4	14	5.00
<i>Cotula coronopifolia</i>	Water Buttons *	10	1.69	1	3	5	2.00
Reed							
<i>Phragmites australis</i>	Common Reed	10	0.04	1	4	13	1.00
Grass							
<i>Critesion maritimum</i>	Sea Barley-grass *	20	1.70	2	4	10	0.75
<i>Distichlis distichophylla</i>	Emu-grass	20	1.26	2	4	12	3.00
<i>Paspalum vaginatum</i>	Salt-water Couch *	20	1.70	2	5	10	3.00
<i>Stipa stipoides</i>	Coast Spear-grass	10	1.26	1	3	6	2.00
Sedge							
<i>Bolboschoenus caldwellii</i>	Salt Club-rush	20	1.72	2	6	10	3.00

SITES CONTRIBUTING TO GROUP

136MUD00601, 4BK00101, 4BK00801, 93FRS02701, 136MUD00901, 136MUD01001, 136WYN01101, 78MUR00102, 78MUR00108, 78MUR00105

Number of mammal and reptile sites: 6

Number of bird sites: 4

Number of Mammal Species, *introduced, (records): 5, *3, (21)

Number of Bird Species, *introduced, (records): 42, *1, (71)

Number of Reptile Species (records): 1, (5)

Number of Frog Species (records): none recorded

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	6	15
BOVIDAE	<i>Bos taurus</i>	Cattle	2	2
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	1	2
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat	1	1
FELIDAE	<i>Felis catus</i>	Cat	1	1

Birds: most frequently encountered species

Family	SPECIES	Common Name	Site Frequency	Number observed
HIRUNDINIDAE	<i>Petrochelidon nigricans</i>	Tree Martin	3	362
PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant	3	226
LARIDAE	<i>Sterna bergii</i>	Crested Tern	3	41
LARIDAE	<i>Larus novaehollandiae</i>	Silver Gull	3	21
MELIPHAGIDAE	<i>Lichenostomus virescens</i>	Singing Honeyeater	3	16
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola	3	12
PHALACROCORACIDAE	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	3	6
MELIPHAGIDAE	<i>Epthianura albifrons</i>	White-fronted Chat	2	38
HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	2	17
LARIDAE	<i>Sterna caspia</i>	Caspian Tern	2	7
ANATIDAE	<i>Cereopsis novaehollandiae</i>	Cape Barren Goose	2	5
ARDEIDAE	<i>Egretta novaehollandiae</i>	White-faced Heron	2	5
ARDEIDAE	<i>Ardea alba</i>	Great Egret, (White Egret)	2	4
PELECANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican	2	4
MOTACILLIDAE	<i>Anthus novaeseelandiae</i>	Richard's Pipit	2	3
THRESKIORNITHIDAE	<i>Threskiornis molucca</i>	Australian White Ibis	2	2
DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	2	2
SCOLOPACIDAE	<i>Calidris ferruginea</i>	Curlew Sandpiper	1	50
SCOLOPACIDAE	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	1	38
ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereye	1	20
CHARADRIIDAE	<i>Charadrius ruficapillus</i>	Red-capped Plover	1	17

Reptiles

Family	SPECIES	Common Name	Site Frequency	Number observed
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake	2	5

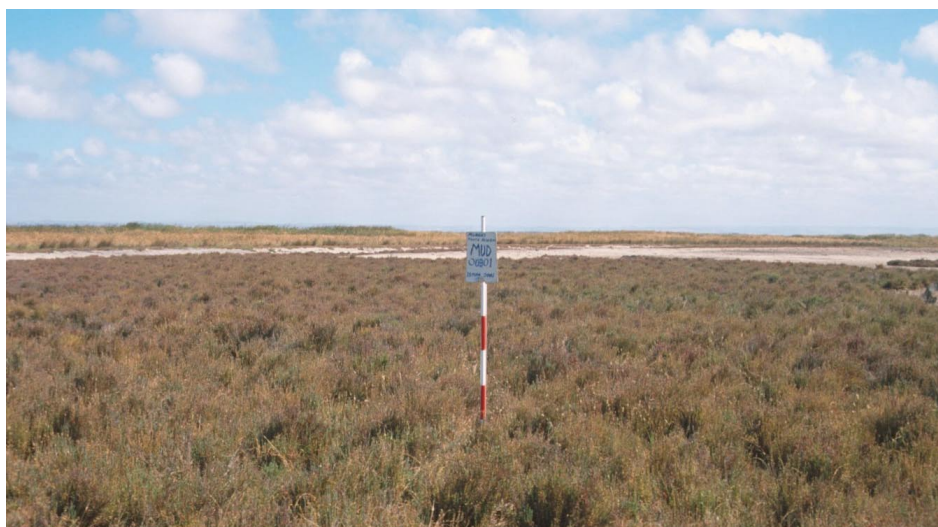


Figure 19. Floristic group 8 136MUD00901 Beaded Samphire (*Sarcocornia quinqueflora*) Low Shrubland on Myrtle Island.

Floristic Group 9. Swamp Paper-bark (*Melaleuca halmaturorum*) Low Woodland over Sea Rush (*Juncus kraussii*) +/- Salt Club-rush (*Bolboschoenus caldwellii*) Sedges and Beaded Samphire (*Sarcocornia quinqueflora*) / Austral Seablite (*Suaeda australis*) low shrubs

This low woodland community remains as small isolated fragments on rarely grazed and regularly inundated flats and depressions adjacent to the major estuarine channels of Hindmarsh Island. Surface soil textures are light to medium clays.

Number of sites: 5

Perennial Species defining group: 15

Total species at sites: 15

Average number of species at sites: 7.2 Range: 3-13

Introduced species at sites: 2 Average per site: 2

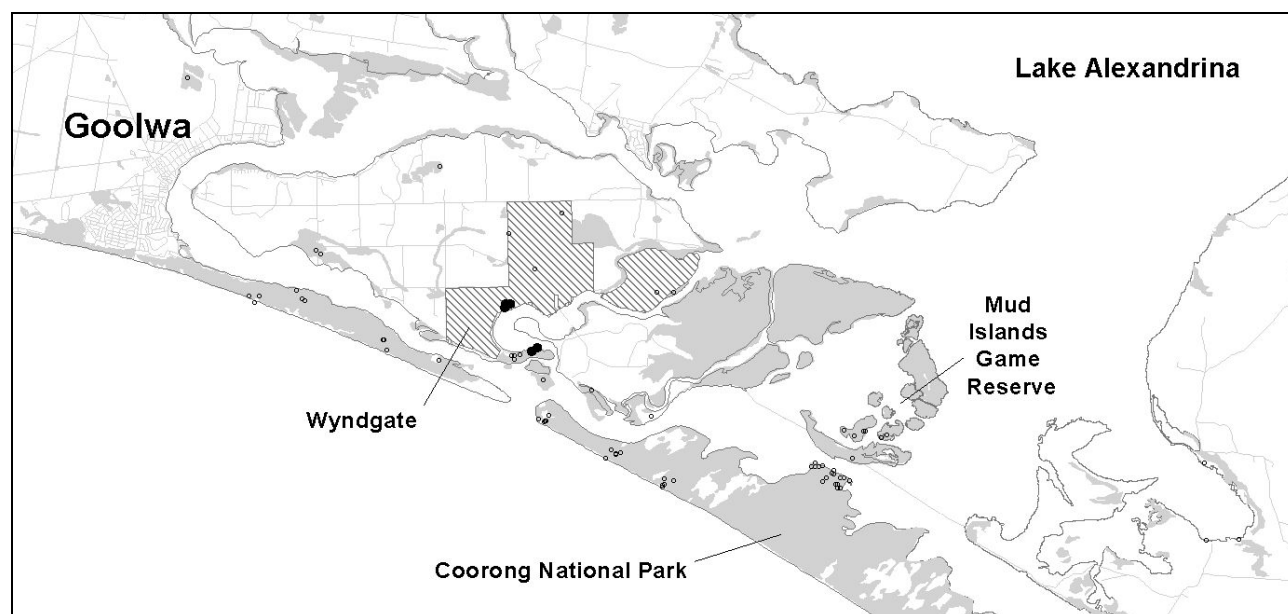
No. spp. with Southern Lofty Conservation Status: 5

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: *M.halmat.* Low Forest

Murray Mouth Reserves: Groups 3 & 6



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Tree							
<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i>	Swamp Paper-bark	80	12.79	4	2	7	2.13
Shrub							
<i>Sarcocornia quinqueflora</i>	Beaded Samphire	60	3.53	3	4	16	1.25
<i>Suaeda australis</i>	Austral Seablite	60	3.83	3	3	15	1.67
<i>Threlkeldia diffusa</i>	Coast Bonefruit	40	2.04	2	5	16	0.30
<i>Frankenia pauciflora</i> var.	Southern Sea-heath	20	1.01	1	4	12	
<i>Muehlenbeckia florulenta</i>	Lignum	20	1.19	1	5	11	0.50
Herb							
<i>Samolus repens</i>	Creeping Brookweed	40	1.19	2	5	22	0.30
<i>Limonium binervosum</i>	Dwarf Sea-lavender *	20	1.41	1	4	10	1.00
<i>Triglochin striatum</i>	Streaked Arrowgrass	20	2.02	1	4	8	0.50
Reed							
<i>Phragmites australis</i>	Common Reed	20	0.85	1	4	13	0.50
Grass							
<i>Distichlis distichophylla</i>	Emu-grass	20	1.01	1	4	12	0.50
<i>Paspalum vaginatum</i>	Salt-water Couch *	20	1.40	1	5	10	1.00
Sedge							
<i>Juncus kraussii</i>	Sea Rush	100	7.09	5	6	15	0.62
<i>Bolboschoenus caldwellii</i>	Salt Club-rush	60	6.27	3	6	10	1.75
Mistletoe							
<i>Amyema melaleucae</i>	Tea-tree Mistletoe	60	17.11	3	2	4	0.53

SITES CONTRIBUTING TO GROUP

136WYN00501, 136WYN00601, 42PC800, 136WYN00701, 78MUR00104

Number of mammal and reptile sites: 3

Number of bird sites: 3

Number of Mammal Species, *introduced, (records): 5, *3, (19)

Number of Bird Species, *introduced, (records): 22, *0, (32)

Number of Reptile Species (records): 1, (1)

Number of Frog Species (records): none recorded

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	3	12
MURIDAE	<i>Rattus rattus</i>	Black Rat	1	2
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat	1	2
CANIDAE	<i>Vulpes vulpes</i>	Fox	1	2
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	1	1

Birds: most frequently encountered species

Family	SPECIES	Common Name	Site Frequency	Number observed
HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	3	8
THRESKIORNITHIDAE	<i>Threskiornis molucca</i>	Australian White Ibis	3	4
DICURURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	2	19
MELIPHAGIDAE	<i>Epthianura albifrons</i>	White-fronted Chat	2	6
SYLVIIDAE	<i>Megalurus gramineus</i>	Little Grassbird	2	3
ANATIDAE	<i>Tadorna tadornoides</i>	Australian Shelduck	1	1200
RALLIDAE	<i>Gallinula ventralis</i>	Black-tailed Native-hen	1	10
ACANTHIZIDAE	<i>Acanthiza pusilla</i>	Brown Thornbill	1	7
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola	1	6

Reptiles

Family	SPECIES	Common Name	Site Frequency	Number observed
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1	1



Figure 20. 136WYN00501 Black-seed Samphire (*Halosarcia pergranulata*), Sea Rush (*Juncus kraussii*) Segeland/Low Shrubland

Floristic Group 10. Lignum (*Muehlenbeckia florulenta*) Closed Shrubland with Common Reed (*Phragmites australis*)

This floristic community is restricted to estuarine swamps and channels with clay loam surface soils. Typically both species grow in dense thickets that are difficult to penetrate and contain few other species.

Number of sites: 5

Perennial Species defining group: 4

Total species at sites: 5

Average number of species at sites: 2.4 Range: 1-3

Introduced species at sites: 1 Average per site: na

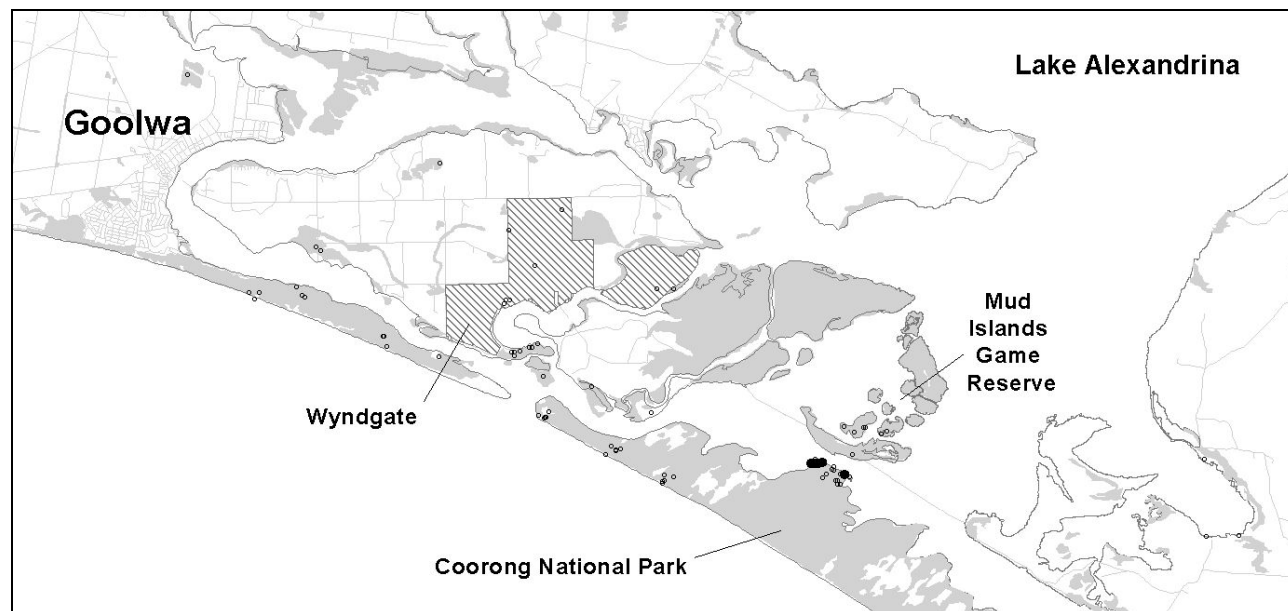
No. spp. with Southern Lofty Conservation Status: 1

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: Waterlogged soils –
Sedge & Lignum

Murray Mouth Reserves: Group 6



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Muehlenbeckia florulenta</i>	Lignum	80	24.44	4	5	11	1.52
Reed							
<i>Phragmites australis</i>	Common Reed	80	20.54	4	4	13	2.25
Sedge							
<i>Bolboschoenus caldwellii</i>	Salt Club-rush	40	13.10	2	6	10	2.75
Vine							
<i>Tetragonia implexicoma</i>	Bower Spinach	20	2.06	1	5	23	1.00

SITES CONTRIBUTING TO GROUP

4BK00901, 4BK00201, 4BK00102, 136MUD00401, 4BK00301

Number of mammal and reptile sites: 4

Number of bird sites: 0

Number of Mammal Species, *introduced, (records): 3, *1, (9)

Number of Bird Species, *introduced, (records): not sampled

Number of Reptile Species (records): none recorded

Number of Frog Species (records): none recorded

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	2	5
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat	2	3
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	1	1



Figure 21. Floristic Group 10. Lignum (*Muehlenbeckia florulenta*) and Common Reed (*Phragmites australis*) Tall Shrubland



Figure 22. Floristic Group 11 136MUD01101 Common Reed (*Phragmites australis*) and Narrow-leaf Bulrush (*Typha domingensis*) over the introduced Salt-water Couch (*Paspalidium vaginatum*)

Floristic Group 11. Narrow-leaf Bulrush (*Typha domingensis*) +/- Common Reed (*Phragmites australis*) Reedland

In the study area this community is an artifact of the stable fresh water levels created by the barrages and dominates the low-lying swampy parts of the islands and channels of the Murray Mouth. Sites sampled in this community were heavily impacted by cattle despite being on Mud Island Game Reserve.

Number of sites: 8

Perennial Species defining group: 13

Total species at sites: 38

Average number of species at sites: 11.4 Range: 6-18

Introduced species at sites: 15 Average per site: 4.3

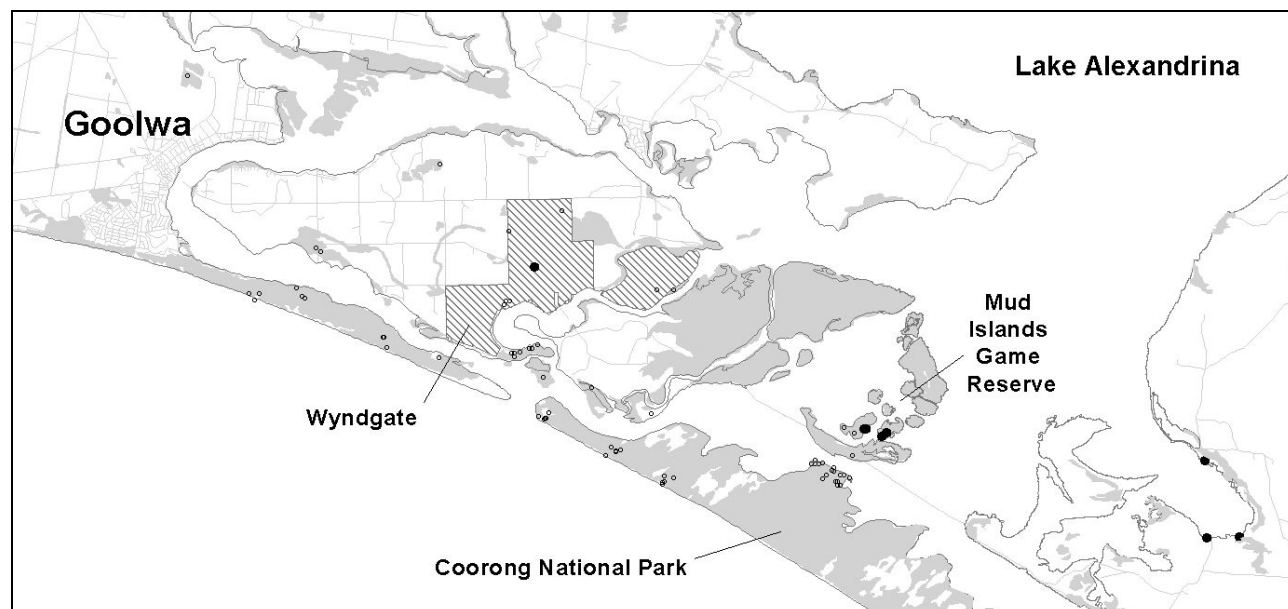
No. spp. with Southern Lofty Conservation Status: 10

Vegetation Mapping Groups

Western Murray Flats:

Murray Mouth Estuary: NA

Murray Mouth Reserves: Group 7



Plant species	Common name	% of sites in group	(O-E)/E	Frequency sites in group	Number of groups	Frequency at all sites	Ave. relative cover index
Shrub							
<i>Muehlenbeckia florulenta</i>	Lignum	13	0.50	1	5	11	0.50
Herb							
<i>Aster subulatus</i>	Aster-weed *	75	12.68	6	2	7	1.40
<i>Berula erecta</i>	Water Parsnip *	75	12.68	6	2	7	1.52
<i>Hydrocotyle verticillata</i>	shield pennywort	63	14.96	5	1	5	0.90
<i>Cotula coronopifolia</i>	Water Buttons *	13	2.29	1	3	5	0.50
<i>Plantago coronopus ssp. coronopus</i>	Bucks-horn Plantain *	13	0.18	1	4	14	
Reed							
<i>Typha domingensis</i>	narrow-leaf bulrush	100	14.96	8	1	8	0.71
<i>Phragmites australis</i>	Common Reed	88	7.62	7	4	13	1.57
Grass							
<i>Paspalum vaginatum</i>	Salt-water Couch *	63	7.01	5	5	10	1.70
<i>Critesion maritimum</i>	Sea Barley-grass *	13	0.65	1	4	10	0.10
Sedge							
<i>Schoenoplectus validus</i>	river club-rush	63	14.96	5	1	5	0.92
<i>Bolboschoenus caldwellii</i>	Salt Club-rush	13	0.67	1	6	10	0.50

SITES CONTRIBUTING TO GROUP

136MUD00701, 136MUD01201, 136MUD01101, 45NAR0401, 45NAR0402, 45NAR0403, 136MUD00801, 136WYN00901

Number of mammal and reptile sites: 5

Number of bird sites: 5

Number of Mammal Species, *introduced, (records): 3, *1 (21)

Number of Bird Species, *introduced, (records): 37, *0, (81)

Number of Reptile Species (records): 2, (3)

Number of Frog Species (records): 2, (5)

Mammals

Family	SPECIES	Common Name	Site Frequency	Number observed
MURIDAE	<i>Mus musculus</i>	House Mouse	5	18
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat	2	2
BOVIDAE	<i>Bos taurus</i>	Cattle	1	1

Family	SPECIES	Common Name	Site Frequency	Number observed
ANATIDAE	<i>Anas superciliosa</i>	Pacific Black Duck	4	66
LARIDAE	<i>Sterna bergii</i>	Crested Tern	4	54
ANATIDAE	<i>Tadorna tadornoides</i>	Australian Shelduck	4	19
PELECANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican	4	13
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola	4	12
ARDEIDAE	<i>Ardea alba</i>	Great Egret, (White Egret)	4	9
STURNIDAE	<i>Sturnus vulgaris</i>	Common Starling	3	136
PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant	3	23
LARIDAE	<i>Sterna caspia</i>	Caspian Tern	3	11
DICRURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail	3	4
HIRUNDINIDAE	<i>Petrochelidon nigricans</i>	Tree Martin	2	37
HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	2	31
RALLIDAE	<i>Porphyrio porphyrio</i>	Purple Swampphen	2	18
CORVIDAE	<i>Corvus coronoides</i>	Australian Raven	2	12
CHARADRIIDAE	<i>Vanellus miles</i>	Masked Lapwing	2	8
ANATIDAE	<i>Cygnus atratus</i>	Black Swan	2	8
PHALACROCORACIDAE	<i>Phalacrocorax varius</i>	Pied Cormorant	2	7
PHALACROCORACIDAE	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	2	3
SYLVIIDAE	<i>Acrocephalus australis</i>	Australian Reed Warbler	2	3
SYLVIIDAE	<i>Megalurus gramineus</i>	Little Grassbird	2	3
ACCIPITRIDAE	<i>Haliastur sphenurus</i>	Whistling Kite	2	2
ACCIPITRIDAE	<i>Circus approximans</i>	Swamp Harrier	2	2

Family	SPECIES	Common Name	Site Frequency	Number observed
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake	2	2
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1	1
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	2	4
LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	1	1

DISCUSSION OF FLORISTIC GROUPS

The patterning of the vegetation in the Murray Mouth Reserves is strongly influenced by the soil type, proximity to the water table and salinity. The latter two parameters are also inter-related with inundation frequency.

The analysis of the site data reflects and refines most of the descriptions for the region covered by Specht (1972) and Davies (1982). The first cluster of groups mirror the associations described by Specht (1972), Davies (1982) and Oppermann (1999) for the dune complex (*Spinifex hirsutus* and *Scirpus nodosus* Tussock Grassland formations on the foredunes and *Olearia axillaris* – *Leucopogon parviflorus* and *Acacia sophorae* - *Leucopogon parviflorus* Open-heath formations). The low chenopod shrub and Swamp

Paperbark woodland communities of the swamps and flats described by Specht (1972) and in more detail by Davies (1982) are covered by floristic groups 6 to 9. Groups 10 and 11 cover the dense reedlands and Lignum closed shrub communities of the more regularly inundated wetlands. The Drooping Sheoak community that may once have dominated the now cleared parts of the region (in particular Hindmarsh Island) was sampled at the only remaining remnant. Because only one site with this composition was sampled it was not identified as a community in the analysis. However this is now a remnant of considerable conservation value as it can provide the seed source for any serious future revegetation plans on the northern section of the island.

SPECIES OF CONSERVATION SIGNIFICANCE

The 75 sites located within the study area did not support species of national or state conservation significance during the survey period. Murfet's surveys of Hindmarsh Island identified five species that are rated as rare in the current National Parks and Wildlife Act Schedules. *Atriplex australasica* was recorded in the Murray Mouth area. *Stipa tenuifolia* was recorded at several locations in the Sheoak woodland and several Aleppo Pine woodland areas in the centre of the

island. *Acacia dodonaeifolia* was also recorded in the Sheoak woodland and the eastern Aleppo Pine woodland. *Myoporum parvifolium* was only recorded at the cemetery and *Correa alba* var. *pannosa* was found in the small remnant mallee with pine area in the center of the Island. (Murfet 1996).

Species reported as threatened or rare at a national level in earlier studies (Renfrey *et al.* 1989, Edyvane

1996) are no longer rated at the state and national levels.

The sites within the study area are at the edge of the Mt Lofty Herbarium Region. A total of 46 species have regional conservation significance for this region according to the Department for Environment's flora database (updated by PJ Lang): two Endangered (E); five Vulnerable (V); one Threatened (T: data deficient); 13 Rare (R); 12 Uncertain (K: rare but this may reflect a lack of information); 13 are uncommon (U). These species are listed in Table 6.

The Murray Mouth Reserves are at the edge of the Southern Lofty herbarium region and the major

habitats are atypical which is largely the reason for the high number of rated species. The Youngusband Peninsula is an extension of the South East region (10 of the Southern Lofty rated species also have a South East rating with an extra four being of questionable status). The Murray Lakes also straddle the Murray Mallee region and 15 of the 46 species are rated with an extra one being questionable). Twenty-two of the 46 rated species are also rated in the adjacent herbarium regions of which two are questionable. The conservation ratings on the remaining 23 species are therefore an artifact of habitat extent within the Southern Lofty Region. These species are marked with an asterisk in Table 6.

Table 6. Species recorded at survey sites that have conservation ratings for the Southern Lofty Herbarium region.

FAMILY	SPECIES	Common Name	No. of sites	Southern Lofty	Murray Mallee	South East
PROTEACEAE	<i>Hakea vittata</i>	Limestone Needlebush*	1	K		
SANTALACEAE	<i>Exocarpos syrticola</i>	Coast Cherry*	16	K		
LORANTHACEAE	<i>Amyema melaleuca</i>	Tea-tree Mistletoe	4	K	R	Q
POLYGONACEAE	<i>Muehlenbeckia florulenta</i>	Lignum	11	R		R
POLYGONACEAE	<i>Persicaria lapathifolia</i>	Pale Knotweed	3	T	U	
CHENOPODIACEAE	<i>Atriplex paludosa</i> ssp. <i>paludosa</i>	Marsh Saltbush	1	K		Q
CHENOPODIACEAE	<i>Rhagodia parabolica</i>	Mealy Saltbush	3	V	U	
AMARANTHACEAE	<i>Hemichroa pentandra</i>	Trailing Hemichroa*	3	R		
CRASSULACEAE	<i>Crassula helmsii</i>	Swamp Crassula*	1	R		
LEGUMINOSAE	<i>Acacia cupularis</i>	Cup Wattle	2	R	R	
LEGUMINOSAE	<i>Daviesia arenaria</i>	Sand Bitter-pea	1	K	R	E
LEGUMINOSAE	<i>Lotus australis</i>	Austral Trefoil*	4	U		
GERANIACEAE	<i>Geranium potentilloides</i> var. <i>potentilloides</i>	Downy Geranium*	1	K		
GERANIACEAE	<i>Pelargonium australe</i>	Australian Pelargonium*	8	U		
SAPINDACEAE	<i>Dodonaea baueri</i>	Crinkled Hop-bush*	1	R		
MALVACEAE	<i>Lawrenzia squamata</i>	Thorny Lawrenzia*	7	K		
MYRTACEAE	<i>Eucalyptus incrassata</i>	Ridge-fruited Mallee*	1	U		
MYRTACEAE	<i>Eucalyptus porosa</i>	Mallee Box*	1	U		
MYRTACEAE	<i>Kunzea pomifera</i>	Muntries*	8	U		
MYRTACEAE	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i>	Swamp Paper-bark*	7	V		
MYRTACEAE	<i>Melaleuca uncinata</i>	Broombush*	1	R		
ONAGRACEAE	<i>Epilobium pallidiflorum</i>	Showy Willow-herb	1	U	K	K
HALORAGACEAE	<i>Myriophyllum caput-medusae</i>	Coarse Milfoil	1	R		K
HALORAGACEAE	<i>Myriophyllum salsugineum</i>	Lake Milfoil	1	K		Q
UMBELLIFERAE	<i>Apium annuum</i>	Annual Celery	2	R	K	
UMBELLIFERAE	<i>Centella asiatica</i>	Asian Centella	1	U	Q	K
UMBELLIFERAE	<i>Hydrocotyle capillaris</i>	Thread Pennywort*	1	R		
UMBELLIFERAE	<i>Hydrocotyle medicaginoides</i>	Medic Pennywort	1	E	K	K
UMBELLIFERAE	<i>Hydrocotyle verticillata</i>	Shield Pennywort*	5	K		
PRIMULACEAE	<i>Samolus repens</i>	Creeping Brookweed	22	U	R	
APOCYNACEAE	<i>Alyxia buxifolia</i>	Sea Box	5	R	U	
CONVOLVULACEAE	<i>Calystegia sepium</i>	Large Bindweed	3	U	U	
CONVOLVULACEAE	<i>Wilsonia backhousei</i>	Narrow-leaf Wilsonia*	1	V		
CONVOLVULACEAE	<i>Wilsonia humilis</i> var. <i>humilis</i>	Silky Wilsonia	2	U	R	U
LABIATAE	<i>Lycopus australis</i>	Australian Gipsywort	1	R	R	Q
SCROPHULARIACEAE	<i>Mimulus repens</i>	Creeping Monkey-flower*	2	R		
COMPOSITAE	<i>Brachycome exilis</i>	Slender Daisy	1	E	R	R
COMPOSITAE	<i>Cotula vulgaris</i> var. <i>australasica</i>	Slender Cotula*	2	K		
COMPOSITAE	<i>Ozothamnus turbinatus</i>	Coast Bush-everlasting	1	V		U
COMPOSITAE	<i>Sonchus megalocarpus</i>	Coast Sow-thistle*	4	K		
COMPOSITAE	<i>Vittadinia condyloides</i>	Club-hair New Holland daisy*	1	V		
GRAMINEAE	<i>Amphipogon caricinus</i> var. <i>caricinus</i>	Long Grey-beard Grass	1	U		R
GRAMINEAE	<i>Stipa stipoides</i>	Coast Spear-grass	6	R	K	
CYPERACEAE	<i>Lepidosperma gladiatum</i>	Coast Sword-sedge*	5	U		
CYPERACEAE	<i>Schoenoplectus pungens</i>	Spiky Club-rush	2	U	U	
ORCHIDACEAE	<i>Pterostylis dolichochila</i>	Mallee Shell-orchid*	1	K		

INTRODUCED SPECIES

Seventy-three alien species were recorded at the 75 sites in the study area and are listed in Table 7. The Common Sow Thistle (*Sonchus oleraceus*) was most frequently encountered (27% of sites). The next most regularly encountered weeds were Sea Barley-grass (*Critetion maritimum*) (19% of sites) and Sea Pearlwort (*Sagina maritima*) (17% of sites). At most sites these herbs and grasses were sparsely present, or if numerous covered less than 5% of the area. Species that attained the highest density and relative cover include: Sand Fescue (*Vulpia fasciculata*) and Bucks-horn Plantain (*Plantago coronopus* ssp. *coronopus*), which were estimated to cover more than 75% of the area at some sites. Tree Tobacco (*Nicotiana glauca*), Large Quaking-grass (*Briza maxima*), False Caper (*Euphorbia terracina*) and Salt-water Couch (*Paspalum vaginatum*) were estimated to cover 50-75% of some of the sites in which they were found. Common Mouse-ear Chickweed (*Cerastium glomeratum*), Water Bent (*Polypogon viridis*), Greater Plantain (*Plantago major*), Rough Sow-thistle (*Sonchus asper* ssp. *Glaucescens*), Sea Wheat-grass (*Elymus farctus*), Water Parsnip (*Berula erecta*), African Boxthorn (*Lycium ferocissimum*), Dwarf Sea-lavender (*Limonium binervosum*) and Small Bedstraw (*Galium murale*) reached relative cover abundance values from 25-50% at many of the sites in which they occurred. An accurate analysis of dominance of alien species should not be drawn from the site data, as biological survey sites usually favour the least disturbed habitats in the landscape. The list in Table 7 and the relative abundance values are probably an under estimate of the dominance and function of weeds in the Murray Mouth region with the possible exception of the Younghusband Peninsula.

Environmental Problem Weeds

Bridal Creeper: This South African import is a major problem in Mallee and temperate woodland vegetation communities due to its ability to smother native vegetation both above and below ground. In south Australia it is a proclaimed noxious weed under the Animal and Plant Control Act and is rated as 19th on the list of Australian Weeds of National Significance (<http://www.weeds.org.au/natsig.htm> Aug 2002). This species was sparsely present only at the eucalypt woodland site to the west of Goolwa. Murfett (1996) noted its presence on Hindmarsh Island in the sheoak

woodland, at the cemetery, central pines track and east central pines. The potential for Bridal Creeper to spread through the sheoak woodland on Hindmarsh Island should be addressed with a control program.

Perennial Veldt-grass: This hardy tussock grass, also originally from South Africa was sparsely present at site WYN01201 in the sheoak woodland on Hindmarsh Island. Murfett (1996) indicates that the understorey of this remnant is dominated by this species on the looser sandy soils of the dunes. It appears to be widespread across the sandier part of the island. It is not a proclaimed plant in South Australia and has been advocated as being a good pasture species to stabilise cleared sand dunes by the Department for Primary Industry and Resources SA. It has the ability to form dense thickets that can gradually displace indigenous understorey species (Muyt 2001). If this area is brought into the reserve system a control program will need to be developed to allow native understorey species to recover.

African Boxthorn: This proclaimed noxious pest also originated from Southern Africa. It was the most widespread noxious weed in remnant native vegetation (located at 7%) of sites. It is currently the most problematic weed for remnant vegetation along the coastal peninsulas because of its longevity and ability to form dense, impenetrable thickets that crowd out other species. At one site on Younghusband Peninsula it covered 25-50% of the area. It was also present at sites on Hindmarsh Island and Mud Island Game Reserve.

Other species recorded at sites that are proclaimed noxious pest plants in South Australia include: Soursob, False Caper and Spear Thistle. Of these, Soursob is considered the only serious bushland weed (Muyt 2001) because of it forms dense clumps which crowd out the root zone for the smaller native species. During the Coastal Dune and Cliftop Survey it was recorded at relatively low densities at two sites on the coastal peninsulas. It was likely to have been under represented during the Murray Mouth Reserves Survey because it has no above ground parts during late summer and Autumn when the survey was conducted. For this reason annual weeds are also under represented in Table 7.

Table 7. Exotic plant species recorded at sites in the survey area. Relative cover refers to the following cover class index: 0.1=<10plants (small cover), 0.5=sparsely present (cover <5%), 1=numerous (cover<5%), 2=cover 5-25%, 3=cover 25-50%, 4=cover 50-75%, 5=cover >75%.

FAMILY NAME	SPECIES	Common Name	Site frequency	Ave. relative cover	Min. relative cover	Max. relative cover
URTICACEAE	<i>Urtica urens</i>	Small Nettle	1	2.00	2	2
POLYGONACEAE	<i>Rumex conglomeratus</i>	Clustered Dock	1	0.50	0.5	0.5
	<i>Rumex crispus</i>	Curled Dock	1	1.00	1	1
CARYOPHYLLACEAE	<i>Cerastium balearicum</i>	Chickweed	1	1.00	1	1
	<i>Cerastium glomeratum</i>	Common Mouse-ear Chickweed	1	3.00	3	3
	<i>Sagina maritima</i>	Sea Pearlwort	13	1.10	0.1	2
	<i>Stellaria media</i>	Chickweed	3	0.83	0.5	1
CHENOPODIACEAE	<i>Atriplex prostrata</i>	Creeping Saltbush	1	2.00	2	2

	<i>Chenopodium glaucum</i>	Glaucous Goosefoot	1	0.50	0.5	0.5
CRUCIFERAE	<i>Cakile maritima</i> ssp. <i>maritima</i>	Two-horned Sea Rocket	3	0.50	0.5	0.5
	<i>Hymenolobus procumbens</i>	Oval Purse	2	1.00	1	1
LEGUMINOSAE	<i>Acacia saligna</i>	Golden Wreath Wattle	1	0.50	0.5	0.5
	<i>Medicago polymorpha</i> var. <i>polymorpha</i>	Burr-medic	1	0.10	0.1	0.1
	<i>Melilotus indica</i>	King Island Melilot	6	0.52	0.1	1
	<i>Trifolium fragiferum</i> var. <i>fragiferum</i>	Strawberry Clover	3	0.83	0.5	1
	<i>Trifolium striatum</i>	Knotted Clover	1	2.00	2	2
OXALIDACEAE	<i>Oxalis pes-caprae</i>	Soursob	2	0.75	0.5	1
EUPHORBIACEAE	<i>Euphorbia paralias</i>	Sea Spurge	7	0.75	0.5	1
	<i>Euphorbia terracina</i>	False Caper	2	2.25	0.5	4
MALVACEAE	<i>Lagunaria patersonii</i>	Pyramid Tree	1	0.50	0.5	0.5
UMBELLIFERAE	<i>Berula erecta</i>	Water Parsnip	7	1.36	0.5	3
	<i>Bupleurum semicompositum</i>	Hare's Ear	1	0.50	0.5	0.5
PRIMULACEAE	<i>Anagallis arvensis</i>	Pimpernel	2	0.10	0.1	0.1
LIMONIACEAE	<i>Limonium binervosum</i>	Dwarf Sea-lavender	10	0.97	0.1	3
	<i>Limonium companyonis</i>	Sea-lavender	2			
ASCLEPIADACEAE	<i>Asclepias rotundifolia</i>	Broad-leaf Cotton-bush	1	0.10	0.1	0.1
RUBIACEAE	<i>Galium murale</i>	Small Bedstraw	7	0.94	0.1	3
LABIATAE	<i>Mentha x piperita</i> var.	Peppermint	2	0.50	0.5	0.5
SOLANACEAE	<i>Lycium ferocissimum</i>	African Boxthorn	5	1.13	0.5	3
	<i>Nicotiana glauca</i>	Tree Tobacco	1	4.00	4	4
	<i>Solanum linnaeanum</i>	Apple of Sodom	1	1.00	1	1
SCROPHULARIACEAE	<i>Parentucellia latifolia</i>	Red Bartsia	1	0.10	0.1	0.1
	<i>Verbascum virgatum</i>	Twiggy Mullein	1	2.00	2	2
PLANTAGINACEAE	<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain	10	1.80	1	5
	<i>Plantago major</i>	Greater Plantain	1	3.00	3	3
COMPOSITAE	<i>Aster subulatus</i>	Aster-weed	7	0.67	0.1	2
	<i>Cirsium vulgare</i>	Spear Thistle	1	0.10	0.1	0.1
	<i>Conyza albida</i>	Tall Fleabane	1	2.00	2	2
	<i>Conyza bonariensis</i>	Flax-leaf Fleabane	1	1.00	1	1
	<i>Cotula coronopifolia</i>	Water Buttons	5	0.80	0.5	1
	<i>Dimorphotheca pluvialis</i>	Cape Marigold	1	1.00	1	1
	<i>Hypochaeris glabra</i>	Smooth Cat's Ear	3	1.00	1	1
	<i>Hypochaeris radicata</i>	Rough Cat's Ear	3	1.00	0.5	2
	<i>Reichardia tingitana</i>	False Sow-thistle	6	0.88	0.5	2
	<i>Sonchus asper</i> ssp. <i>glaucescens</i>	Rough Sow-thistle	2	2.50	2	3
	<i>Sonchus oleraceus</i>	Common Sow-thistle	20	0.86	0.1	2
	<i>Urospermum picroides</i>	False Hawkbit	2			
LILIACEAE	<i>Myrsiphyllum asparagoides</i>	Bridal Creeper	1	0.10	0.1	0.1
GRAMINEAE	<i>Ammophila arenaria</i>	Marram Grass	5	1.17	0.5	2
	<i>Avellinia michelii</i>	Avellinia	1	0.50	0.5	0.5
	<i>Avena barbata</i>	Bearded Oat	2	0.30	0.1	0.5
	<i>Avena fatua</i>	Wild Oat	2	1.00	1	1
	<i>Briza maxima</i>	Large Quaking-grass	2	2.50	1	4
	<i>Bromus diandrus</i>	Great Brome	5	1.10	0.5	2
	<i>Bromus madritensis</i>	Compact Brome	1	0.10	0.1	0.1
	<i>Critesion maritimum</i>	Sea Barley-grass	14	0.66	0.1	1
	<i>Cynodon dactylon</i>	Couch	1			
	<i>Ehrharta calycina</i>	Perennial Veldt Grass	1	0.50	0.5	0.5
	<i>Ehrharta longiflora</i>	Annual Veldt Grass	2			
	<i>Ehrharta villosa</i> var. <i>maxima</i>	Pyp Grass	5	0.70	0.5	1
	<i>Elymus farctus</i>	Sea Wheat-grass	3	2.50	2	3
	<i>Holcus lanatus</i>	Yorkshire Fog	1	0.50	0.5	0.5
	<i>Lagurus ovatus</i>	Hare's Tail Grass	8	0.87	0.1	2
	<i>Parapholis incurva</i>	Curly Ryegrass	3	0.50	0.5	0.5
	<i>Paspalum distichum</i>	Water Couch	3	1.50	0.5	2
	<i>Paspalum vaginatum</i>	Salt-water Couch	10	1.40	0.5	4
	<i>Pennisetum clandestinum</i>	Kikuyu	1	2.00	2	2
	<i>Polypogon maritimus</i>	Coast Beard-grass	1	2.00	2	2
	<i>Polypogon monspeliensis</i>	Annual Beard-grass	2	0.30	0.1	0.5
	<i>Polypogon viridis</i>	Water Bent	1	3.00	3	3
	<i>Puccinellia distans</i>	Reflexed Poa	3	0.37	0.1	0.5
	<i>Rostraria cristata</i>	Annual Cat's-tail	1	1.00	1	1
	<i>Vulpia fasciculata</i>	Sand Fescue	5	1.88	0.5	5

Murfett (1996) listed 163 extra exotic species.

VEGETATION MAPPING

The Murray Mouth region has been mapped for vegetation communities at a variety of scales. The Younghusband and Sir Richard Peninsulas were mapped as part of the Western Murray Flats regional map project by the Geographic Analysis and Research Unit of Planning SA (now part of the Department for Environment and Heritage). Only some areas on the Islands were included in this mapping and were not adequately ground truthed for accuracy. A more detailed map restricted to the shore edge plant communities was drawn for the Murray Mouth Estuary in Edyvane *et al.* (1996). The current mapping project relied on visual interpretation of 1:20,000 scale aerial photographs, topographic maps, existing mapping where applicable, survey site information and extensive ground truthing. Vegetation group polygons were digitised using ARCINFO software and the vegetation map was produced at 1:40,000 scale. A copy of this map is included at the back of this report.

Mapped Vegetation Communities

1. Aleppo Pine (*Pinus halepensis*)/- *Eucalyptus* spp. Low Forest. Aleppo Pines were probably planted on some parts of Hindmarsh Island but have now spread themselves over a larger area of the higher elevated northern part of Hindmarsh Island. Some small stands of native eucalypts (*E. incrassata* and *E. porosa*) survive on privately owned land approximately five kilometres east of the bridge to Goolwa. This habitat was not sampled during the surveys.
2. Drooping Sheoak (*Allocasuarina verticillata*) Low Woodland. This habitat is confined to a small remnant on the northern part of the island approximately six kilometres east of the Goolwa Bridge. Whilst degraded with dense grassy weed cover the area contains a number of regionally threatened plant species (Murfet 1996). This community was sampled with one site WYN01201. No floristic group was applicable to this community.
3. Swamp Paperbark (*Melaleuca halmaturorum* ssp. *halmaturorum*) Low Forest. This wetland fringe community is now very rare, being confined to the eastern end of Hindmarsh Island, Lucerne Island and part of Mundoo Island. The samphire and sedge understorey is degraded by cattle grazing in all areas except the small population between Mundoo Channel and Hunters Creek on Hindmarsh Island. This area is fenced-off and showed only minor intrusion by cattle. This mapping group represents floristic groups 7 and 9. The understorey differences between the healthy site adjacent to the estuarine Mundoo Channel and the Freshwater Holmes Creek well-grazed site separated them on species composition despite their common dominant overstorey. Three sites sampled this community though scattered individuals were recorded at other sites.
4. Dryland Teatree (*Melaleuca lanceolata* ssp. *lanceolata*) Tall Shrubland. This very open and fragmented community was confined to several very small patches mixed with Drooping Sheoak nine kilometres east of the Goolwa bridge. No sites sampled this habitat.
5. African Boxthorn (*Lycium ferocissimum*) +/- Common Boobialla (*Myoporum insulare*) sparse Tall Shrubland over introduced grasses and herbs. This very degraded community of low sand ridges occurs on the islands in the east of the study area. Boobialla may once have dominated some of these ridges as only very large trunked specimens remain. Other such areas were described by Newell (1929) as being covered in tall grass. Heavy prolonged use by cattle appears to have deflated these sandy areas and stripped them of most perennial vegetation.
6. Sea Rush (*Juncus kraussii*) &/or Salt Club-rush (*Bolboschoenus caldwellii*) Sedgeland +/- *Sarcocornia* spp. This community occurs on intertidal flats in the estuarine parts of the study area. This mapping group best represents floristic groups 9 and 10. Edyvane *et al.* (1996) mapped this group as Waterlogged/Submerged Soils - Sedge and Lignum Communities.
7. Common Reed (*Phragmites australis*) &/or Narrow-leaf Bulrush (*Typha domingensis*) Tall Sedgeland. This community of the freshwater littoral zone and adjacent freshwater flood flats are the dominant vegetation community of the freshwater islands in the study area. This mapping group represents floristic group 11. Before permanent flooding of Lake Alexandrina by the barrages the extent of this community in the study area would have been more fragmented. It also occurs in association with freshwater soaks on the Younghusband Peninsula.
8. Marsh Saltbush (*Atriplex paludosa*) +/- Salt Bluebush (*Maireana oppositifolia*) &/or Thick-head Samphire (*Sarcocornia blackiana*) +/- Shrubby Samphire (*Sclerostegia arbuscula*) Low Shrubland. This mixed community was widespread on the uncleared plains and depressions of the larger islands and low-lying interdune areas on Younghusband Peninsula. Floristic groups 6 and 7 are best represented by this map group. Edyvane *et al.* (1996) mapped this group as Supratidal - Samphire communities and *Stipa stipoides* Tall Grass.
9. Beaded Samphire (*Sarcocornia quinqueflora*) Low Shrubland. This community was restricted to estuarine intertidal flats in similar situations to map group 6 and was most

common on islands opposite the Murray Mouth, a tidal creek at the south-western end of Hindmarsh Island and adjacent to the mudflats on Youngusband Peninsula. Floristic group 9 is represented by this map group which was also mapped by Edyvane *et al.* (1996) as Intertidal Habitat - Dense Low Heath.

10. Coast Spear-grass (*Stipa stipoides*) Tussock Grassland. This community was restricted to the southern central coast of Hindmarsh Island where it was associated with sandy loam soils. Most of the mapped community was in a degraded state. The best examples being in

association with map group 8. Floristic group 6 is best represented by this group as no sites sampled the more extensive degraded grassland area. Edyvane *et al.* (1996) mapped this as Supratidal Habitat - *Stipa stipoides* Tall Grass.

Agricultural land refers to land that has been cultivated in the past or is currently under cultivation. Some minor areas of semi-natural herbland are also included in this group as it was not possible to separate these minor areas using the aerial photography. This habitat was not sampled during the survey.



Figure 23. Drooping Sheoak (*Allocasuarina verticillata*) Woodland at Jolly's Scrub on northern Hindmarsh Island (site 136WYN01201). Photo: R Brandle NPWSA.



Figure 24. Tall unconsolidated dune with introduced Marram Grass (*Ammophila arenaria*) on Tauwitcherie Point looking across the Coorong and Tauwitcherie Island. Photo: AC Robinson NPWSA.

Biological Survey of the Murray Mouth Reserves

MAMMALS

R Brandle¹

Prior to the 1982 South East Coast Survey there were nine records for four species in the study area. Along the Coorong the 1982 South East Coast Survey contributed to our knowledge of the Younghusband Peninsula in the vicinity of Tauwichee Island. The survey recorded two native mammal species, the Swamp Rat (*Hydromys chrysogaster*) and the Water Rat (*Rattus lutreolus*) (Appendix m1). These are also the only two species held in the South Australian Museum collection for Hindmarsh Island. Three more species were added to the Museum collection between 1984 and 1996 (two bats and two Echidnas). The South Australian Herpetology Group during a reptile survey of Hindmarsh Island (Milne and Matejcic 2001) also recorded the presence of echidna (scratchings and diggings) and a species of kangaroo (tracks and faeces)

within an area of introduced Aleppo Pines. Only the Western Grey Kangaroo (*Macropus fuliginosus*) has been recorded for the island (NPWSA database). The South Australian Museum database indicates that five native species have been collected in the area. This includes the Echidna, two species of bat and two native rodents. Two introduced rodents (House Mouse and Black Rat) and seven species of marine mammal (1 seal, 2 dolphins and 4 whales) have also been recorded in the area. Following the March 2002 survey a small mammal/reptile monitoring trap line on Younghusband Peninsula was set for the second time and captured a Silky Mouse (*Pseudomys apodemoides*) (Steve Gilbert pers comm.). This record is the most westerly location for this species and the first capture of this species in typical coastal shrubland.

RESULTS

The South East Coast Survey (1982) contributed 16 records and the Murray Mouth Reserves Survey (2002) 123 records to the mammal information for the study area. Table 8 lists the species, the number of sites at which they were recorded for survey 4 in 1982, survey 136 in 2002, and the total number of records.

Of the twelve species recorded at sites only 4 were native to the area. House mice were the most widespread and abundant animals having been recorded at 29 sites and comprising 66% of the total number of mammal observation during both surveys. In 2002 they were recorded at all sites sampled.

Three species that were not observed at sites were recorded opportunistically. The Common Ringtail Possum (*Pseudocheirus peregrinus*) was recorded on the north-east of the island around the buildings at Narnu Farm adjacent to a large area of Aleppo Pine forest and an area of shacks and houses with associated

gardens. It is unlikely that these represent a remnant from a former population, as there are no records from along the Coorong where habitat remains that may have been similar to that once found on Hindmarsh Island. It is more likely that these animals or their parents were introduced to the island as escaped pets or as part of a deliberate private release.

The Lesser Long-eared Bat (*Nyctophilus geoffroyi*) was captured using a harp trap during the survey period. A Harp Trap was set for three nights on Younghusband Peninsula at the MUD camp without success. One species, Gould's Wattled Bat (*Chalinolobus gouldii*) was recorded flying over MUD camp using an ANABAT recorder.

The only species known to have occurred in the study area that were not recorded during the surveys were the Echidna (*Tachyglossus aculeatus*) and the Large Forest Bat (*Vespadelus darlingtoni*).

Table 8. Frequencies of mammal species observations from this survey and the South East Coast Survey at sites and opportunistically.

Family	SPECIES	Common Name	South East Coast Survey	Murray Mouth Reserves Survey	Total
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		4	4
CANIDAE	* <i>Canis lupus familiaris</i>	Dog (domestic or feral)		2	2
	* <i>Vulpes vulpes</i>	Fox		5	7
FELIDAE	* <i>Felis catus</i>	Cat		3	3
BOVIDAE	* <i>Bos taurus</i>	Cattle		6	6
	* <i>Ovis aries</i>	Sheep		1	2
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	1	3	5
MURIDAE	* <i>Mus musculus</i>	House Mouse	7	22	92
	<i>Rattus lutreolus</i>	Swamp Rat	2	4	8
	* <i>Rattus rattus</i>	Black Rat		2	4
LEPORIDAE	* <i>Lepus capensis</i>	Brown Hare		1	1
	* <i>Oryctolagus cuniculus</i>	Rabbit		4	5
Opportune Records only					
PSEUDOCHEIRIDAE	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum		2	2
VESPERTILIONIDAE	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		1	1
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		1	1

SPECIES OF CONSERVATION SIGNIFICANCE

No mammals of conservation significance were recorded during the survey.

SPECIES PATTERNS

Mammals were analysed by comparison of captures by habitat variables. Most capture rates were too low to provide reliable data about species habitat preferences with the exception of House Mice (92 captures from 32 sites) and Swamp Rats (8 captures from 6 sites). However the tables 9-11 depicting species by habitat variables are informative. Kangaroos and foxes were detected (mostly from scats) across the habitat types as could be expected for large mobile animals. Both of the native rodent species were associated with swamps and stream channels. Water Rats were observed mostly

in the water adjacent to areas with samphire and taller denser cover such as Lignum, Swamp Paperbark or reeds. The Swamp Rats were present at sites with dense cover such as Lignum or tall reeds. House Mice were present in all locations and habitats with no preference for a particular habitat type evident from the data. Black Rats were captured on Hindmarsh Island in the Sheoak Woodland on a consolidated sand dune and in the sedgeland with Lignum adjacent to Mundoo Channel. Both sites were no more than a kilometre from the nearest human habitation.

Table 9. Frequencies of mammal species occurrence within landform element types.

Family	SPECIES	Common Name	lunette	dune	swale	depression	swamp	stream channel
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		1	2		1	
CANIDAE	<i>Canis lupus familiaris</i>	Dog		1				
CANIDAE	<i>Vulpes vulpes</i>	Fox		3		2	1	
FELIDAE	<i>Felis catus</i>	Cat			1		2	
BOVIDAE	<i>Bos taurus</i>	Cattle				3	1	1
BOVIDAE	<i>Ovis aries</i>	Sheep						
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat				1	3	1
MURIDAE	<i>Mus musculus</i>	House Mouse	3	17	10	15	39	4
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat				2	4	2
MURIDAE	<i>Rattus rattus</i>	Black Rat		2		2		
LEPORIDAE	<i>Lepus capensis</i>	Brown Hare		1				
LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit		3	2			
		Number of species	1	7	4	6	7	4
		Number of sites	1	9	2	5	13	3

Table 10. Frequencies of mammal species occurrence within structural vegetation types.

Family and Subfamily	SPECIES	Common Name	Tussock Grassland	Sedgeland	Low Shrubland	Shrubland	Low Woodland	Low Open Forest
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo		1	2	1		
CANIDAE	<i>Canis lupus familiaris</i>	Dog (domestic or feral)	1	1				
CANIDAE	<i>Vulpes vulpes</i>	Fox	2	1	3		1	
FELIDAE	<i>Felis catus</i>	Cat			2	1		
BOVIDAE	<i>Bos taurus</i>	Cattle		2	3			1
BOVIDAE	<i>Ovis aries</i>	Sheep		2				
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat			2	3		
MURIDAE	<i>Mus musculus</i>	House Mouse	4	36	23	17	8	4
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat		7		1		
MURIDAE	<i>Rattus rattus</i>	Black Rat		2			2	
LEPORIDAE	<i>Lepus capensis</i>	Brown Hare					1	
LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit		1	1	3		
		Number of species	3	9	7	6	4	2
		Number of sites	1	11	7	12	2	1

Table 11. Frequencies of mammal species occurrence within floristic groups 1-11 (cf vegetation chapter).

Family	SPECIES	Common Name	1	2	6	7	8	9	10	11
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	1		2					
CANIDAE	<i>Canis lupus familiaris</i>	Dog (domestic or feral)				2				
CANIDAE	<i>Vulpes vulpes</i>	Fox	1		1	3		2		
FELIDAE	<i>Felis catus</i>	Cat			2		1			
BOVIDAE	<i>Bos taurus</i>	Cattle				3	2			1
BOVIDAE	<i>Ovis aries</i>	Sheep				2				
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat			1		2	1	1	
MURIDAE	<i>Mus musculus</i>	House Mouse	11	2	9	16	15	12	5	18
MURIDAE	<i>Rattus lutreolus</i>	Swamp Rat					1	2	3	2
MURIDAE	<i>Rattus rattus</i>	Black Rat	2					2		
LEPORIDAE	<i>Lepus capensis</i>	Brown Hare	1							
LEPORIDAE	<i>Oryctolagus cuniculus</i>	Rabbit	2		1					
		Number of species	6	1	5	5	5	5	3	3
		Number of sites	4	3	3	4	6	3	4	5



Figure 25. The Swamp Rat *Rattus lutreolus* is restricted to dense reeds, sedges or Lignum usually adjacent to open water. Photo: S. Doyle.



Figure 26. Tiger Snake that is intermediate between the Eastern Tiger Snake (*Notechis scutatus*) and the Black Tiger Snake (*N. ater*). Photo: AC Robinson NPWSA.

BIRDS

BACKGROUND INFORMATION

R Brandle¹

Compared with the mammals and reptiles, the bird fauna of the Murray Mouth region is relatively well studied and well known. In 1914, the South Australian Government dedicated islands in The Coorong were as a sanctuary for breeding Pelicans. The South Australian Ornithological Association has been receiving notes on birds in the study area since at least 1927 (Newell 1927). The area is most recognised for its waterbird refuge value and as a seasonal feeding area for international migratory waders and was declared a Wetland of International Importance in 1985 under the Ramsar Convention (Carpenter 1995, DEH 2000, Kahrimanis *et al.* 2001). For this reason the Murray Mouth and Coorong region has been the focus of a number of studies into the distribution and abundance of birds, particularly migratory waders and other waterbirds listed under other international agreement such as the Japan - Australia Migratory Bird Agreement JAMBA and the CAMBA (China). The study area forms part of the East Asian-Australasian Shorebird Reserve Network (DEH 2000). The area has been the focus of a study by the Australasian Wader Studies Group since 1981 and DC Paton of the University of Adelaide. Carpenter (1995) summarised total abundances of birds in the lower Murray Lakes and upper Coorong based on summer counts from all available sources:

- ~ 60,000 waders (40,000 migratory) of 30 species (20 migratory)
- 110,000 waterfowl of 14 species
- 70,000 other waterbirds of 38 species

Of these ~ 240,000 waterbirds, 100,000 used the Murray Mouth Eastuary which includes the upper Coorong (the saline waters in the study area). A further 30,000 concentrate on the islands of the Murray Mouth including the eastern end of Hindmarsh Island and 10,000 use the permanent freshwater habitats on the north side of the Tauwichee Barage. The area was also described as being a major non-breeding habitat for ~35 species, including waders of freshwater habitats, grebes, spoonbills, ibis and egrets, bitterns, swampheens, terns of freshwater habitats and Cape Barren Geese. It supports important breeding colonies of Australian Pelicans, ibis, egrets, spoonbills and cormorants and is the largest freshwater drought refuge in South Australia.

Wader counts covering just the Murray Mouth area have indicated a declining trend in numbers since the 1980s from relative abundances of over 20,000 birds to less than 14,000 birds after 1994 (Paton *et al.* 2000). Paton *et al.* (2000) indicates a much greater decline from the greater than 250,000 birds that were estimated to be using the area in the 1960's. The story for the whole Coorong – Murray Mouth area is similar with counts between 130,000 – 235,000 during the 1980's declining to 48,000 – 103,000 in the 2000s (Gosbell *et al.* 2002). Some of the fluctuations in numbers can be

attributed to an increase of resources suitable for waders in northern and Central Australia. Widespread drought is likely to have increased Banded Stilts and Red-necked Avocets numbers in the Coorong in 1982, while good seasons in north eastern Australia in 2000/2001 may have led to less Sharp-tailed Sandpipers moving on to Southern Australia (Wilson 2001, Gosbell *et al.* 2002). The breeding and migratory success of species in other parts of the world and Australia also impacts on the counts in the region. Within the Murray Mouth area, studies by Paton *et al.* (2000) on sediments and wader food resources, provide some evidence for the hypothesis that the general trend may be in response to a decrease in available wader food resulting from a change from fine sediments to coarser sands. The decrease in quantity and timing of flow and floodwater through the Murray Mouth (because of upstream flow regulation and extraction) is regarded as the most likely cause of this change.

PREVIOUS RECORDS

An extensive grid survey of the birds of Hindmarsh Island over one summer detected 114 species of which 31% were waterbirds and 16% were waders (10% migratory, 7% non-migratory) These species also made up 74% of all observations (Paton *et al.* 1989). Hindmarsh Island is the largest Land Mass in the area though more extensively vegetated areas occur along the Younghusband and Sir Richard Peninsulas. Paton *et al.* (1989) also lists an extra 67 species occasionally recorded in the region since 1965 and not seen during the survey. Forty-three of these were either beached southern seabirds, other vagrants or confined to eucalypt savannah habitats east of Goolwa. The South Australian Museum collection from the Murray Mouth dates back to 1904 and holds 63 species (of which 22% were waders and 46% other waterbirds). A search of the Environmental Databases of South Australia prior to the current survey revealed only 35 records of 32 species (9% non-migratory waders and 78% other waterbirds). The majority (31) came from a list of observations by MM Bonnin for the Coorong National Park Management Plan (DEP 1982). Birds Australia Inc. have collated records from ornithologists across Australia to create the Atlas of Australian Birds (1984 and 2001). Species information has been extracted from this database for the Murray Mouth area between latitudes 35°29' – 35°37' and longitudes 138°46' and 139°06'. From 1977 to 1981, 135 species were recorded in the study area (22% waders and 32% other waterbirds). From February 1999 to May 2001, nine locations (seven in the Murray Mouth area, one on Sir Richard Peninsula and one in Goolwa) were visited on 43 occasions. A total of 63 species were recorded (13% waders and 37% other waterbirds). The Bird Atlas Database also holds historic records prior to 1977 that date back to 1901. These records contributed 190 species to the combined species list for the area (Appendix IX).

¹ Biodiversity Survey and Monitoring, National Parks and Wildlife SA.

RESULTS FROM THE MURRAY MOUTH RESERVES SURVEY

The Murray Mouth Reserves Survey contributed 524 records of 3374 individuals representing 85 species to the Biological Survey Database (9% waders and 27% other waterbirds). Birds were also recorded away from sites opportunistically by survey ornithologists. This added 65 records of 42 species to the Opportune Database (26% waders and 50% other waterbirds). Appendix IX lists 234 native and nine introduced species that have been recorded in the region from the sources mentioned. The various surveys targeted different areas and habitats within the study area and therefore turned up some different species and are not directly comparable. Five of the species recorded in the Murray Mouth area are considered occasional vagrants to South Australia (Robinson *et al.* 2000) and probably 100 others are occasional visitors to the habitats of the Murray Mouth or restricted to the eucalypt woodlands west of Goolwa. These species tend not to appear in the first three columns of Appendix IX. The current survey added one species to the list of species from other sources. This was a Weebill (*Smicornis*

brevirostris) which was located at a *Leucopogon parviflorus* dune site on Younghusband Peninsula.

COMMON SPECIES

The most frequently encountered species (observed at more than 25% of sites) during the Murray Mouth Reserves survey in March 2002 are listed in Table 12. As the majority of sites were dryland sites, passerine species dominate the table. Only two species were located at more than 50% of the 21 sites sampled. The most abundant species were those that fly in large flocks and were usually recorded flying over or through sites. Species of waders were also recorded at the few sites where tidal samphire graded into mudflats along the Coorong – however the waders in the region were not systematically counted. Of note is the presence of the Golden-headed Cisticola (*Cisticola exilis*) at 11 sites. This species is considered rare in South Australia and its common occurrence within the study area reflects the nature of the remnant habitats; reedbeds, sedgeland and dense samphire shrublands.

Table 12. Bird species detected at more than 25% of sites sampled in descending order of site frequency.

Family	SPECIES	COMMON NAME	Number of sites	Number of individuals
MELIPHAGIDAE	<i>Lichenostomus virescens</i>	Singing Honeyeater	11	100
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola	11	39
HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	10	73
DICRURIDAE	<i>Rhipidura leucophrys</i>	Willie Wagtail	10	20
DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	9	32
ARDEIDAE	<i>Ardea alba</i>	Great Egret, (White Egret)	8	15
THRESKIORNITHIDAE	<i>Threskiornis molucca</i>	Australian White Ibis	8	12
ANATIDAE	<i>Tadorna tadornoides</i>	Australian Shelduck	7	1222
HIRUNDINIDAE	<i>Petrochelidon nigricans</i>	Tree Martin	7	409
LARIDAE	<i>Sterna bergii</i>	Crested Tern	7	95
CORVIDAE	<i>Corvus mellori</i>	Little Raven	7	73
MELIPHAGIDAE	<i>Epthianura albifrons</i>	White-fronted Chat	7	68
ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereye	7	67
LARIDAE	<i>Larus novaehollandiae</i>	Silver Gull	7	33
PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant	6	249
LARIDAE	<i>Sterna caspia</i>	Caspian Tern	6	21
PELECANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican	6	17

SPECIES OF CONSERVATION SIGNIFICANCE

Carpenter (1995) summarised what was known about the birds of the Lower Murray Region of SA for a Biological Resource Assessment Workshop (Edyvane and Carvahlo 1995). This paper indicated the significance of the area to birds for: total abundance; species strongholds; rare and threatened species; drought refuge; international agreements; and significant non-waterbirds. In 1995, nine of the species recorded in the region were considered Vulnerable and three were listed as Rare in the schedules of the National Parks and Wildlife Act. The conservation status for birds in South Australia was subsequently reassessed for the National Parks and Wildlife Act schedules in 2000 (Robinson *et al.* 2000). Ten of these species are highlighted in Table 13 with their conservation status in bold type. Two species, the Little Egret and Spotless Crake are no longer rated.

Three of the species previously rated as vulnerable have had their ratings downgraded to rare (Musk Duck, Cape Barren Goose and Southern Emu-wren).

Forty-three of the 243 species recorded for the Murray Mouth region have South Australian conservation ratings (22 Vulnerable and 21 Rare). Of these four are also of national conservation significance (One Endangered and three Vulnerable under the EPBC Act 1999). The Endangered Little Tern is a rare visitor to South Australia with only four records for the study area from the Australian Birds Alas database (three in 1960's and one in 1981). It has not been listed in more recent times. The Atlas of Australian Birds (Blakers *et al.* 1984) indicates that historic atlases report occasional breeding colonies in the Coorong. The two nationally vulnerable albatross species are vagrants to

the Murray Mouth Region as its resources do not provide habitat for these species. In contrast, the Hooded Plover (also nationally vulnerable) is a regular breeder along the oceanic beach of Youngusband Peninsula, which is recognised as an “Area of International Importance” for this species in South Australia (Watkins 1993). Prior to the 1950’s, this species also bred on the Sir Richard Peninsula (Strathalbyn Naturalists 2000).

Of the 22 South Australian Vulnerable species recorded, the area represents significant breeding habitat for three species (Hooded Plover on the Oceanic Beach, Rufous Bristlebird in the coastal dune shrubland, and Lewin’s Rail in the dense fringing reedbeds and Lignum patches). Five of the 22 SA Vulnerable species are vagrant oceanic birds, six are rare visitors or at the edges of their distribution or favoured habitat types and four have suffered declines and largely disappeared from the region. These are the Little Tern (mentioned previously), the Bush Stone-curlew, Australian Bustard and Brolga. The last three

species are all large ground-nesting species which are now Rare and seldom breed on mainland South Australia. The remaining four species are regular users of the area, but it is unlikely to be critical habitat for their survival.

The Murray Mouth region provides an important area of breeding habitat for four of the 21 SA Rare species recorded for the area (Musk Duck, Baillon’s Crake, Southern Emu-wren, Golden-headed Cisticola). It is also an important area of non-breeding habitat for Cape Barren Goose and Great Crested Grebe (historically the Lower Murray Lakes were a breeding locality for this species (Blakers *et al.* 1984)). Nine of the SA Rare listed are essentially vagrants or use eucalypt woodland at the western edge of the study area (two oceanic birds, one bird of prey, a cuckoo and four passerines). The other six species are regular users of the area, and while the area is probably important for the individuals, it is unlikely to be critical habitat for the survival of those species.

Table 13. Species with a conservation rating: AUS:EN = Australian Endangered, AUS:VU = Australian vulnerable (EPBC Act 1999), SA:R = South Australian Rare and SA:V = Vulnerable (NPW Act 2000). Ratings in bold indicate species mentioned by Carpenter (1995).

Family	Species	Common Name & Status	MMR	Opp	Paton & Pedler 1989	Paton 1965-88	SAM	bird atlas 96-2001	bird atlas 77-81	bird atlas pre1977
ANATIDAE	<i>Biziura lobata</i>	Musk Duck SA:R			1		1		1	1
ANATIDAE	<i>Oxyura australis</i>	Blue-billed Duck SA:R				1	1		1	1
ANATIDAE	<i>Stictonetta naevosa</i>	Freckled Duck SA:V							1	
ANATIDAE	<i>Cereopsis novaehollandiae</i>	Cape Barren Goose SA:R	1	1	1			1	1	1
ANATIDAE	<i>Anas rhynchotis</i>	Australasian Shoveler SA:R			1		1	1	1	1
PODICIPEDIDAE	<i>Podiceps cristatus</i>	Great Crested Grebe SA:R		1	1		1		1	1
PROCELLARIIDAE	<i>Halobaena caerulea</i>	Blue Petrel SA:V								1
PROCELLARIIDAE	<i>Pachyptila vittata</i>	Broad-billed Prion SA:R								1
PROCELLARIIDAE	<i>Puffinus carneipes</i>	Fleshy-footed Shearwater SA:R							1	1
DIOMEDEIDAE	<i>Diomedea cauta</i>	Shy Albatross SA:V AUS:VU					1		1	1
DIOMEDEIDAE	<i>Diomedea chlororhynchos</i>	Yellow-nosed Albatross SA:V								1
DIOMEDEIDAE	<i>Diomedea chrysostoma</i>	Grey-headed Albatross SA:V AUS:VU								1
DIOMEDEIDAE	<i>Diomedea melanophris</i>	Black-browed Albatross SA:V								1
ARDEIDAE	<i>Botaurus poiciloptilus</i>	Australasian Bittern SA:V							1	1
ARDEIDAE	<i>Egretta sacra</i>	Eastern Reef Egret SA:R							1	
THRESKIORNITHIDAE	<i>Plegadis falcinellus</i>	Glossy Ibis SA:R				1	1		1	1
ACCIPITRIDAE	<i>Pandion haliaetus</i>	Osprey SA:R								1
ACCIPITRIDAE	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle SA:V			1		1		1	1
FALCONIDAE	<i>Falco peregrinus</i>	Peregrine Falcon SA:R	1	1						1
GRUIDAE	<i>Grus rubicunda</i>	Brolga SA:V								1
RALLIDAE	<i>Porzana pusilla</i>	Baillon's Crake SA:R				1	1			
RALLIDAE	<i>Rallus pectoralis</i>	Lewin's Rail SA:V	1				1			1
OTIDIDAE	<i>Ardeotis australis</i>	Australian Bustard SA:V								1
SCOLOPACIDAE	<i>Gallinago hardwickii</i>	Latham's Snipe SA:V		1		1	1		1	1
SCOLOPACIDAE	<i>Numenius madagascariensis</i>	Eastern Curlew SA:V			1		1		1	1
BURHINIDAE	<i>Burhinus grallarius</i>	Bush Stone-curlew SA:V								1
CHARADRIIDAE	<i>Thinornis rubricollis</i>	Hooded Plover SA:V AUS:VU				1				
LARIDAE	<i>Sterna albifrons</i>	Little Tern SA:V AUS:EN							1	1
LARIDAE	<i>Sterna hirundo</i>	Common Tern SA:R			1				1	1
LARIDAE	<i>Sterna nereis</i>	Fairy Tern SA:V				1			1	1
PSITTACIDAE	<i>Glossopsitta pusilla</i>	Little Lorikeet SA:V								1
PSITTACIDAE	<i>Neophema chrysostoma</i>	Blue-winged Parrot SA:V	1	1						1
PSITTACIDAE	<i>Neophema petrophila</i>	Rock Parrot SA:R	1	1				1	1	1
CUCULIDAE	<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo SA:R			1					
MALURIDAE	<i>Stipiturus malachurus</i>	Southern Emu-wren SA:R	1			1			1	

ACANTHIZIDAE	<i>Dasyornis broadbenti</i>	Rufous Bristlebird SA:V	1						1	1
MELIPHAGIDAE	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater SA:R					1			1
PETROICIDAE	<i>Petroica phoenicea</i>	Flame Robin SA:R								1
PETROICIDAE	<i>Petroica rosea</i>	Rose Robin SA:R				1				
DICRURIDAE	<i>Myiagra cyanoleuca</i>	Satin Flycatcher SA:V								1
CAMPEPHAGIDAE	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike SA:R							1	
SYLVIIDAE	<i>Cisticola exilis</i>	Golden-headed Cisticola SA:R	1		1			1	1	1
ESTRIDIDAE	<i>Stagonopleura guttata</i>	Diamond Firetail SA:V				1				
Total			8	6	9	9	12	4	22	34

INTRODUCED SPECIES

Nine species not indigenous to South Australia were recorded in the study area. Of these the Common Starling is the most numerous and potentially the most destructive from both an agricultural and environmental perspective. Starlings were recorded at five survey sites in all parts of the study area. Only three other alien species were recorded at survey sites, the Eurasian Skylark, the European Goldfinch and the

Spotted Turtle-dove, all on Hindmarsh Island. Mallards, Feral Pigeons (Rock Dove), House Sparrows and the Eurasian Blackbird are all probably common around the urban areas of Goolwa and the western end of Hindmarsh Island. The European Goldfinch is a relatively recent addition to the species list for the region (Paton 1989).

SPECIES PATTERNS

Conclusions about species habitat patterns that can be drawn from two one-hour searches at sites at one time of the year are limited. Table 14 presents the number of sites containing each species for landform element and floristic groups. The following discussion relates to major groups of birds and is restricted to species recorded at sites

Four migratory waders species were mostly recorded at sites projecting into the extensive tidal mud flats opposite Tauwitcherie Island, an area identified for its importance to waders for feeding (Pedler 1994). These birds were recorded within the low samphire habitat at two sites (MUD005 and 6). Very low numbers were recorded at other sites where minor mudflats fringed channels on Hindmarsh Island.

Four non-migratory wader species were predominantly recorded at the same estuarine sites. Site MUD00901 a temporarily inundated samphire shrubland on Myrtle Island supported the greatest number of Red-Capped Plovers.

The twenty-three species of waterbirds recorded at sites represent five species of duck, four species of cormorant, spoonbills, ibises, herons, gulls, terns, water hens and rails. Apart from the water hens and rails, most species are commonly observed in open waters. The four species of ducks were mostly found in shallower waters and channels associated with reedbeds. Similarly the cormorants, spoonbills and ibis were at sites associated with water in the MUD Island Game Reserve sites (the latter also being sparsely present on Hindmarsh Island (WYN005, 9 and 10). The water hens, rails and crakes were found at sites with or adjacent to dense reedbeds or sedgeland.

The eight bird of prey species were recorded flying over a variety of habitat types and the same individual

birds may have been recorded at several sites as these were clumped in easy flying distance of each other.

The only large ground dwelling species, the emu appears to be restricted to the Younghusband Peninsular where they appear to be relatively abundant and their signs are evident in all habitat types. Brush Bronzewings were similarly restricted to the coastal peninsulas being only recorded in the *Leucopogon* coastal shrubland of the dunes and adjacent swales. The only other Pigeon recorded at more than one site was the Crested Pigeon which was found in a variety of open habitats on Hindmarsh Island.

The most commonly encountered parrots during the survey were three species of *Neophema*. All made most use of low chenopod shrublands. Blue-winged Parrots were found at the three sites including the *Leucopogon* shrubland of the dunes and swales. One group of three Rock Parrots was sighted on the south-eastern tip of Hindmarsh Island and two Galahs, also in chenopod low shrubland were, the only parrots recorded on Hindmarsh Island. Paton *et al.* (1989) reports that Galahs are common in the agricultural lands and pine forests on Hindmarsh Island.

Two species of wren were recorded. Superb Fairy-wrens were only recorded on Hindmarsh Island, at two woodland sites and one low shrubland community. The Southern Emu-wren was recorded at one site on Younghusband Peninsula in a low shrub community with emergent tall shrubs. Thornbills and pardalotes were also restricted to woodland habitats on Hindmarsh Island. The Rufous Bristlebird and Weebill were only found in open shrubland on Younghusband Peninsula.

Five species of honeyeater were able to utilise the relatively intact open shrub communities on Younghusband Peninsula. Only the Singing

Honeyeater was present at sites in the three reserves. This reflects the lack of suitable flowering plants for the other species in the degraded remnant habitats on the islands.

The majority of the remaining passerines were more frequently encountered on Younghusband Peninsula. Exceptions to this include birds that prefer open and grassland habitats such as Magpie Larks, Magpies, swallows and martins or woodland birds like the Grey Fantail, Rufous Whistler and Mistletoe Bird.

Table 14. Bird species listed in taxonomic order showing the frequency of occurrence by landform element and floristic groups. Recording rate is the relative abundance recorded for the species divided by the combined abundance for all species multiplied by 100.

SPECIES	Common Name	Landform Element							Floristic Groups						% Recording rate
		dune	swale	closed depression	open depression	lunette	swamp	stream channel	1	6	7	8	9	11	
<i>Dromaius novaehollandiae</i>	Emu	1	1				1		2	1					0.16
<i>Coturnix pectoralis</i>	Stubble Quail	1	1					1	1		1			1	0.24
<i>Cereopsis novaehollandiae</i>	Cape Barren Goose			1	2	1					1	2	1		0.41
<i>Cygnus atratus</i>	Black Swan				1		1	1			1			2	0.49
<i>Tadorna tadornoides</i>	Australian Shelduck			1	1		5				1	1	1	4	49.86
<i>Anas gracilis</i>	Grey Teal				1								1		0.04
<i>Anas superciliosa</i>	Pacific Black Duck				1		3	1					1	4	2.73
<i>Phalacrocorax carbo</i>	Great Cormorant			1		1	4					3		3	10.16
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant			1		1	2	1				3		2	0.37
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant					1						1			0.08
<i>Phalacrocorax varius</i>	Pied Cormorant					1	2					1		2	0.41
<i>Pelecanus conspicillatus</i>	Australian Pelican			1		1	4					2		4	0.69
<i>Ardea alba</i>	Great Egret, (White Egret)			1	2	1	4				1	2	1	4	0.61
<i>Egretta novaehollandiae</i>	White-faced Heron			1	1		1	1			1	2		1	0.41
<i>Platalea flavipes</i>	Yellow-billed Spoonbill				1						1				0.08
<i>Platalea regia</i>	Royal Spoonbill			1								1			0.08
<i>Threskiornis molucca</i>	Australian White Ibis			1	2	1	3	1		1	1	2	3	1	0.49
<i>Circus approximans</i>	Swamp Harrier			1	2		2				1	1	1	2	0.20
<i>Circus assimilis</i>	Spotted Harrier						1							1	0.08
<i>Elanus axillaris</i>	Black-shouldered Kite				1		1				2				0.08
<i>Haliastur spheurnus</i>	Whistling Kite			1			3			1		1		2	0.37
<i>Falco berigora</i>	Brown Falcon			1				1		1				1	0.08
<i>Falco cenchroides</i>	Nankeen Kestrel		1		1			1	1		1			1	0.16
<i>Falco longipennis</i>	Australian Hobby		1			1			1			1			0.08
<i>Falco peregrinus</i>	Peregrine Falcon						1			1					0.04
<i>Gallinula ventralis</i>	Black-tailed Native-hen				1	1						1	1		0.49
<i>Porphyrio porphyrio</i>	Purple Swamphen					1	1	1				1		2	0.82
<i>Porzana tabuensis</i>	Spotless Crane			1								1			0.04
<i>Rallus pectoralis</i>	Lewin's Rail				1								1		0.04
<i>Tringa nebularia</i>	Common Greenshank				1		1	1			1	1		1	0.16
<i>Tringa stagnatilis</i>	Marsh Sandpiper						1					1			0.04
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper						2			1		1			4.86
<i>Calidris ferruginea</i>	Curlew Sandpiper						1					1			2.04
<i>Haematopus longirostris</i>	Pied Oystercatcher						1					1			0.12
<i>Himantopus himantopus</i>	Black-winged Stilt						1			1					0.45
<i>Charadrius ruficapillus</i>	Red-capped Plover			1			1			1		1			0.73
<i>Vanellus miles</i>	Masked Lapwing						2	1		1				2	0.41
<i>Larus novaehollandiae</i>	Silver Gull	1		1	1	1	3			1	1	3	1	1	1.35
<i>Larus pacificus</i>	Pacific Gull						1							1	0.33
<i>Sterna bergii</i>	Crested Tern			1		1	5					3		4	3.88
<i>Sterna caspia</i>	Caspian Tern	1		1		1	3				1	2		3	0.86
<i>Geopelia placida</i>	Peaceful Dove	1							1						0.04
<i>Ocyphaps lophotes</i>	Crested Pigeon	2			1		1		1		2		1		0.16
<i>Phaps elegans</i>	Brush Bronzewing	1	1						2						0.08
<i>Streptopelia chinensis</i>	Spotted Turtle-dove						1				1				0.00
<i>Cacatua roseicapilla</i>	Galah				1						1				0.08
<i>Neophema chrysostoma</i>	Blue-winged Parrot	1	1	1					2	1					0.41
<i>Neophema elegans</i>	Elegant Parrot			1						1					0.29
<i>Neophema petrophila</i>	Rock Parrot				1								1		0.12
<i>Malurus cyaneus</i>	Superb Fairy-wren	1			1		1		1		2				1.22
<i>Stipiturus malachurus</i>	Southern Emu-wren			1						1					0.08
<i>Pardalotus punctatus</i>	Spotted Pardalote	1							1						0.08

SPECIES	Common Name	Landform Element							Floristic Groups						% Recording rate
		dune	swale	closed depression	open depression	lunette	swamp	stream channel	1	6	7	8	9	11	
<i>Dasyornis broadbenti</i>	Rufous Bristlebird	1	1	1					2	1					0.20
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	1							1						0.33
<i>Acanthiza pusilla</i>	Brown Thornbill						2				1		1		0.53
<i>Sericornis frontalis</i>	White-browed Scrubwren	1	1				2		2		1		1		0.53
<i>Smicrornis brevirostris</i>	Weebill	1							1						0.08
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	1		1			1		1	1		1			0.12
<i>Anthochaera carunculata</i>	Red Wattlebird	2	1	1					3	1					0.69
<i>Lichenostomus virescens</i>	Singing Honeyeater	3	1	2	1		3		3	2	1	3	1	1	4.08
<i>Manorina melanocephala</i>	Noisy Miner	1	1						2						0.08
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater		1				1		1			1			0.12
<i>Epthiamura albigula</i>	White-fronted Chat	1		1	2		3			1	1	2	2	1	2.77
<i>Pomatostomus superciliosus</i>	White-browed Babbler		1						1						0.04
<i>Colluricincla harmonica</i>	Grey Shrike-thrush	1					1		1	1					0.12
<i>Pachycephala rufiventris</i>	Rufous Whistler	1							1						0.16
<i>Grallina cyanoleuca</i>	Magpie-lark	1		1	4		2	1		1	3	2	2	1	1.31
<i>Rhipidura albiscapa</i>	Grey Fantail	1		1			1		1		1	1			0.33
<i>Rhipidura leucophrys</i>	Willie Wagtail	2	1	1			5	1	3	2	1	1		3	0.82
<i>Cracticus torquatus</i>	Grey Butcherbird		1				1		1			1			0.04
<i>Gymnorhina tibicen</i>	Australian Magpie		1		1		3		1	1	1	1		1	0.37
<i>Corvus coronoides</i>	Australian Raven			1			3			2				2	1.18
<i>Corvus mellori</i>	Little Raven	2	1	1			3		3	2		1		1	2.98
<i>Sturnus vulgaris</i>	Common Starling		1		1		3		1		1			3	6.32
<i>Hirundo neoxena</i>	Welcome Swallow	1			5	1	2	1			3	2	3	2	2.98
<i>Petrochelidon nigricans</i>	Tree Martin		1	1	1	1	3		1		1	3		2	16.69
<i>Zosterops lateralis</i>	Silvereye	2	1	1			3		3	2		1	1		2.73
<i>Acrocephalus australis</i>	Australian Reed Warbler						2							2	0.12
<i>Cincloramphus cruralis</i>	Brown Songlark	1									1				0.04
<i>Megalurus grammurus</i>	Little Grassbird				3		1	1			1		2	2	0.29
<i>Cisticola exilis</i>	Golden-headed Cisticola			1	2	1	7			1	2	3	1	4	1.59
<i>Alauda arvensis</i>	Eurasian Skylark	1			1						1	1			0.12
<i>Dicaeum hirundinaceum</i>	Mistletoebird			1						1					0.04
<i>Anthus novaeseelandiae</i>	Richard's Pipit			1		1		1				2		1	0.16
<i>Carduelis carduelis</i>	European Goldfinch	1							1						0.04
	Number of Species	30	20	35	30	18	53	16	31	27	33	42	21	37	
	# sites sampled	3	1	2	5	1	8	1	3	2	4	4	3	5	



Figure 27. Cape Barren Geese grazing with sheep and cattle on the islands of the Murray Mouth. Photo: AC Robinson NPWSA.

Biological Survey of the Murray Mouth Reserves

REPTILES

R Brandle¹

Prior to the 1982 survey the South Australian Museum collection held seven specimens of three species for the study area. The South East Coast survey added a further eight species to this total and the Murray Mouth Reserves Survey in 2002 a further six species (including two frogs). The SA Herpetology Group survey of four sites on Hindmarsh Island in November 2001 recorded twelve species (including two frogs) of which three were new records for the study area. No specimens were collected however, and the new frog record of the Brown Tree Frog was not observed but detected from its distinctive call (Appendix X).

The Frogwatch program run through the Environment Protection Authority (Walker and Goonan 2000)

collected taped calls from 25 locations in the study area (the majority being from Goolwa with one site on north eastern Hindmarsh Island two sites site in Clayton and two more on the Sturt Peninsula. Frog watch 2000 recorded six species in the area. Frogwatch has been conducted annually since 1994 (appendix X).

The South East Coast Survey (1982) contributed 18 records and the Murray Mouth Reserves Survey (2002) contributed 36 records to the reptile information for the area. The Murray Mouth Reserves Survey also contributed eight frog records Table 15 lists the species, the number of sites at which they were recorded for this survey, the South East Coast Survey and the total number of records.

RESULTS

The combined surveys detected 17 of the 26 species known for the study area and listed in Appendix X. No reptiles were particularly abundant during the survey period, which to some extent reflected the timing of both surveys in early March. During this time, short lived species such as Painted Dragons have died-off with only a few large individuals surviving. Young animals are likely to have just recently hatched and are therefore small, cryptic and relatively sedentary. Many larger long-lived species such as blue-tongue lizards, goannas and tortoises are likely to have stopped eating and be less active than in summer. Also, very few frogs call at this time of the year, making them difficult to detect. The survey results therefore only give an indication of the species present and are not a good guide to relative abundance or total reptile and frog diversity at each site. Only four species were recorded opportunistically during the survey.

Two species of large venomous snakes were amongst the most commonly observed reptiles, which indicates that the area probably supports a relatively high density

of these species compared with drier areas of the State. Snakes are rarely recorded on most biological surveys (Biological Survey Databases).

Only the Common Long-necked Tortoise (*Chelodina longicollis*) was observed during the survey. The lack of success with tortoise traps probably reflects the timing of the survey corresponding to a lack of interest in food by the tortoises as they prepare for winter hibernation. It is likely that a short-necked species, the Macquarie Tortoise (*Emydura macquarii*) inhabits the fresh water channels around the islands of the Murray Mouth. The Tiger Snake population in the Murray Mouth region appears to intergrade between the Eastern Tiger Snake *Notechis scutatus* and the Black Tiger Snake *Notechis ater* with examples of both species being present (M Hutchinson pers. comm. And see Fig. 26). Tiger Snakes seen on the islands were Black Tiger Snakes whilst one Eastern Tiger Snake was captured on Youngusband Peninsula where a single dead juvenile was also collected.

Table 15. Frequencies of reptile and frog species recorded at sites from the current and the South East Coast Survey.

Family	SPECIES	Common Name	MURRAY MOUTH RESERVES	SE COAST 1982	Total
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise	1		1
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon	1	1	2
	<i>Pogona barbata</i>	Eastern Bearded Dragon	1		1
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko	2		2
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus	2	3	5
	<i>Ctenotus robustus</i>	Eastern Striped Skink		1	1
	<i>Hemiergis peronii</i>	Four-toed Earless Skink	4		4
	<i>Lerista dorsalis</i>	Southern Four-toed Slider		3	3
	<i>Menetia greyii</i>	Dwarf Skink	2	2	4
	<i>Morethia boulengeri</i>	Common Snake-eye	1		1
	<i>Morethia obscura</i>	Mallee Snake-eye	2	2	4
	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	3	1	4
ELAPIDAE	<i>Notechis cf ater</i>	Black Tiger Snake	3		1
	<i>Notechis scutatus</i>	Eastern Tiger Snake	2		2
	<i>Pseudonaja textilis</i>	Eastern Brown Snake	3		3
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	4		4
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	1		1

¹ Biodiversity Survey and Monitoring, National Parks and Wildlife SA.

SPECIES OF CONSERVATION SIGNIFICANCE

No reptiles or frogs of conservation significance were recorded during the survey. However, the Southern or Golden Bell Frog (*Litoria reniformis*) is likely to occur in the swamps on the islands of the Murray Mouth, having been recorded in similar habitat near Clayton. It

is considered a Vulnerable species in South Australia (Robinson *et al.* 2000). Strategic frog recordings should be undertaken at swamps on Wyndgate after rainfall during summer months.

SPECIES PATTERNS

Reptiles and frogs were analysed for species patterns by comparing captures with habitat variables at sites (Tables 16-19). From the species by habitat comparisons and with the low numbers of records for each species only trends were apparent. Habitats associated with sandy soils appeared to have the most species rich and diverse assemblage of reptiles (ie floristic group 1). The intertidal and sedgeland communities appeared to have the least diverse reptile communities (floristic groups 8-11), but swampy reedlands are important for frogs, which were poorly sampled during the survey period.

Within the study area it appears that two species, Painted Dragons (*Ctenophorus pictus*) and Southern Four-toed Sliders (*Lerista dorsalis*), have a preference for coastal dune habitats characterised by sandy soils, with coastal heath shrubland communities. The arboreal Marbled Gecko (*Christinus marmoratus*) was confined to the rare woodland habitats and the Southern Grass Skink (*Pseudemoia entrecasteauxii*) preferred low shrubland and sedgeland communities on non-dune habitats.

Table 16. Frequencies of reptile and frog species records within landform element types.

Family	SPECIES	Common name	lunette	dune	dune crest	dune slope	swale	open depression	closed depression	swamp	stream channel
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise						1			
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon		2							
AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon			1						
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko				1				1	
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus		3					1	1	
SCINCIDAE	<i>Ctenotus robustus</i>	Eastern Striped Skink		1							
SCINCIDAE	<i>Hemiergis peronii</i>	Four-toed Earless Skink		1	1	1	1				
SCINCIDAE	<i>Lerista dorsalis</i>	Southern Four-toed Slider		3							
SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink		2		1				1	
SCINCIDAE	<i>Morethia boulengeri</i>	Common Snake-eye				1					
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye		2			1			1	
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink					1	1		2	
ELAPIDAE	<i>Notechis ater</i>	Black Tiger Snake						1			
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake	1	1						3	
ELAPIDAE	<i>Pseudonaja textilis</i>	Eastern Brown Snake		1					1	1	
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet				1				2	1
LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog									1
		# sites	1	7	1	1	1	5	2	13	3

Table 17. Frequencies of reptile and frog species records within soil surface texture types.

Family	SPECIES	Common name	Heavy Clay	Light Medium Clay	Silty Clay Loam	Clay Loam	Loamy Sand	Sand
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise			1			
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon						2
AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon						1
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko			1		1	
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus				1	1	3
SCINCIDAE	<i>Ctenotus robustus</i>	Eastern Striped Skink						1
SCINCIDAE	<i>Hemiergis peronii</i>	Four-toed Earless Skink					1	3
SCINCIDAE	<i>Lerista dorsalis</i>	Southern Four-toed Slider						3

SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink				1	1	2
SCINCIDAE	<i>Morethia boulengeri</i>	Common Snake-eye					1	
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye			1			3
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1	1		1		1
ELAPIDAE	<i>Notechis ater</i>	Black Tiger Snake			1			
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake	3		1			1
ELAPIDAE	<i>Pseudonaja textilis</i>	Eastern Brown Snake	1				1	1
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	1		2		1	
LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog			1			
		# sites	7	2	5	4	3	8

Table 18. Frequencies of reptile and frog species records within structural vegetation types.

Family	SPECIES	Common name	Low Open Forest	Low Woodland	Closed Shrubland	Shrubland	Open Shrubland	Low Closed Shrubland	Low Shrubland	Closed Sedgeland	Sedgeland
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise									1
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon				1	1				
AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon				1					
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko	1	1							
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus				1	2		2		
SCINCIDAE	<i>Ctenotus robustus</i>	Eastern Striped Skink					1				
SCINCIDAE	<i>Hemiergis peronii</i>	Four-toed Earless Skink		1		2					1
SCINCIDAE	<i>Lerista dorsalis</i>	Southern Four-toed Slider					3				
SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink		1		1	1		1		
SCINCIDAE	<i>Morethia boulengeri</i>	Common Snake-eye		1							
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye	1				2				1
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink							2	1	1
ELAPIDAE	<i>Notechis ater</i>	Black Tiger Snake									1
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake			1	1				2	1
ELAPIDAE	<i>Pseudonaja textilis</i>	Eastern Brown Snake				1		1	1		
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	1	1						1	1
LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog									1
		# sites	1	1	2	5	5	1	6	4	7

Table 19. Frequencies of reptile and frog species records within floristic groups (refer to vegetation chapter).

Family	SPECIES	Common name	1	2	3	6	7	8	9	11
CHELIDAE	<i>Chelodina longicollis</i>	Common Long-necked Tortoise					1			
AGAMIDAE	<i>Ctenophorus pictus</i>	Painted Dragon	1	1						
AGAMIDAE	<i>Pogona barbata</i>	Eastern Bearded Dragon	1							
GEKKONIDAE	<i>Christinus marmoratus</i>	Marbled Gecko	1				1			
SCINCIDAE	<i>Ctenotus orientalis</i>	Eastern Spotted Ctenotus	1	1	1	2				
SCINCIDAE	<i>Ctenotus robustus</i>	Eastern Striped Skink		1						
SCINCIDAE	<i>Hemiergis peronii</i>	Four-toed Earless Skink	4							
SCINCIDAE	<i>Lerista dorsalis</i>	Southern Four-toed Slider		3						
SCINCIDAE	<i>Menetia greyii</i>	Dwarf Skink	3			1				
SCINCIDAE	<i>Morethia boulengeri</i>	Common Snake-eye	1							
SCINCIDAE	<i>Morethia obscura</i>	Mallee Snake-eye	2	1			1			
SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>	Southern Grass Skink	1			1			1	1
ELAPIDAE	<i>Notechis ater</i>	Black Tiger Snake					1			
ELAPIDAE	<i>Notechis scutatus</i>	Eastern Tiger Snake	1					2		2
ELAPIDAE	<i>Pseudonaja textilis</i>	Eastern Brown Snake	1			2				
LEPTODACTYLIDAE	<i>Crinia signifera</i>	Common Froglet	1				1			2
LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog								1
		# sites	5	3	1	3	4	6	3	5

FRESHWATER FISHES

Michael Hammer³, Scotte Wedderburn and Simon³ Westergaard³

SUMMARY

Contrasts in species composition and habitat with surrounding regions, and the isolation of species from other populations, literally make Wyndgate an island refuge within a vastly altered Lower River Murray system. Nearly half the freshwater species known from the Lower Murray occur within Wyndgate on Hindmarsh Island, including two species that have a national conservation status; the Murray Hardyhead and the Yarra Pygmy Perch are both listed as 'vulnerable'. Wyndgate presents a rare occasion for freshwater fish and aquatic habitats to be represented within the reserve system. The area appears to be one of the most significant regions in terms of fish diversity

and composition within the South Australian section of the Murray Darling Basin. Wyndgate offers exciting opportunities for future study of threatened species and a unique ecological community, as well as challenging opportunities and cautions for adaptive management working within a highly regulated system to maintain aquatic values. In a time where the decline of the Murray has reached a critical point, the unique aquatic community at the terminus of the system is positive news, providing fresh incentive to push for environmental improvements within the Murray Darling Basin.

BACKGROUND INFORMATION

Freshwater fishes are still poorly known in South Australia, with large gaps in our basic knowledge of species distributions, local ecology and relationships with habitat and flow requirements. As a result, management and protection of these freshwater fauna have so far been minimal with few dedicated programs or areas assigned to the protection of native fish.

The River Murray in South Australia supports around 26 native freshwater fish species with seven introduced species also occurring. Around three of the native species are believed regionally extinct and a range of others threatened (Lloyd and Walker 1986; Wedderburn 2000, Hammer and Butler 2001a,b). At the same time we are still learning of new species and populations today (Hammer 2001). It is worth noting that many of the species in question are small, generally less than 100 mm. While of no direct commercial importance, they are intrinsically linked within ecosystems that for example support well-known larger species such as Murray Cod (*Maccullochella peelii peelii*) and Callop (*Macquaria ambigua*) and offer an array of interesting forms and traits as a major core of aquatic biodiversity (e.g. diverse genetic variation, unique life history strategies).

Freshwater fish can potentially tell us much about the current and historic health of habitats, mostly due to

their total reliance on aquatic (underwater) habitats for survival. A wide range of changes both locally (e.g. barrages, levees, locks and weirs) and upstream (e.g. extraction and regulation) means that the Lower Murray is now a vastly altered environment (e.g. Walker and Thoms 1993). Several native fish species appear to be able to tolerate or even rely on some aspects of the human imposed changes, while others now only occur in small isolated populations that are threatened with extinction.

The Wyndgate area on Hindmarsh Island presents the perfect opportunity for investigating relationships between freshwater fishes and river regulation as well as documenting and protecting the regional fauna. Only general data exists for the area (e.g. Sim *et al.* 2000), though other areas of Lake Alexandrina are now increasingly being recognised as important fish refuges (Hammer 2002). This report documents the fishes and aquatic habitats of the Wyndgate area as part of the Biological Survey program. These findings are used to discuss the significance of the Wyndgate area to fish conservation and highlights possible management actions and further research required to sustain local native fish populations.

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METHODS

A freshwater fish survey was conducted from the 20/3/02 – 22/3/02 at Wyndgate, Hindmarsh Island. A supplementary field trip was conducted on the 18/5/02 to collect additional information. Three broad

freshwater habitat types were sampled – a shallow open wetland, shallow creeks and drains (Table 19). A total of 10 sites were sampled.

Table 19. Sampling site locations and description.

Aquasave site no.	Bio Survey 136 site no.	Grid Ref. Zone 54 Easting, Northing	Date	River System	Habitat Type
ML02-23	WYN00901	0309221, 6066355	20/03/02	Hunters Creek (at Denver Road)	creek
ML02-24		0312566, 6065900	20/03/02	Eastick Creek	wetland
ML02-25		0310326, 6065983	20/03/02	Holmes Creek	drain
ML02-26	WYN00501	0308282, 6065523	20/03/02	Hunters Creek	creek
ML02-27	WYN00502	0308298, 6065529	21/03/02	Hunters Creek	creek
ML02-28		0309580, 6066894	22/03/02	Connected to Hunters Creek	drain
ML02-29		0311050, 6065759	21/03/02	Boggy Creek	creek
ML02-30		0308432, 6065931	21/03/02	Hunters Creek	creek
ML02-31	WYN01001	0308444, 6067365	21/03/02	Often connected to Hunters Creek	drain
ML02-32		0308700, 6066400	18/05/02	Hunters Creek	creek

SAMPLING EFFORT

Four sampling techniques were used:

- Seining using a 7 x 2 m seine net of 6 mm mesh size. Two people hauled the net through the water over a distance of 5-10 m. This procedure was replicated three times.
- Bait traps baited with cat biscuits placed in the water for 1 hour. Six traps were placed in various microhabitat types 20-30 m away from the seining area.
- Dip-netting for 15 minutes through varied microhabitat types.
- A Fyke net was set overnight at sites WYN00501 and WYN00601.

Sampling was conducted under a Section 59 permit in accordance with the *Fisheries Act 1982*. Site ML02-24 was sampled for 15 minutes with a dip net as it was too shallow for other equipment. Two remaining NPWSA sites could not be sampled because access was denied.

INFORMATION RECORDED

At each site fish were identified, counted and recorded for each sampling method. Voucher specimens for each species were lodged at the South Australian Museum. Hardyheads were originally designated to a single species but following laboratory examination of specimens, a reassessment and calibration was made for field data (see results).

Environmental data was recorded for sites to assist with understanding the fish assemblage:

- Conductivity, pH and temperature using a TPS combination water quality meter.
- Water transparency and depth.
- An estimate of the bank slope and substrate characteristics.
- Flow environment in terms of connectivity to other waterbodies.
- The dominant habitat types (particular attention to vegetation) and riparian (bank) cover.

RESULTS

A total of 13 native freshwater fishes, three estuarine and four exotic species were recorded during the Wyndgate survey (Tables 20 & 21). Freshwater species are categorised as those capable of completing their entire life-cycle within freshwater or those who spend a considerable period in freshwater (e.g. Congolli and Common Galaxias need to migrate between fresh and saltwater for particular life stages). Four species of national and regional conservation significance were represented; Murray Hardyhead, Yarra Pygmy Perch, Southern Pygmy Perch and Dwarf Flathead Gudgeon. A pictorial guide and ecological introduction to the

fishes of the Lower Murray is contained in Hammer and Bulter (2001a,b) while pictures of the most significant species encountered are displayed below.

Hardyhead species show a high degree of visual similarity in the field and the presence of three sympatric species was not determined until after initial sampling. A follow up field trip was used to calibrate the ratios of species at particular sites and specifically to detect the presence of Murray Hardyhead. Hence data represents the minimum distribution and abundance for sites and requires further investigation.



Figure 28. Male (top) and female Southern Pygmy Perch (© M. Hammer). A locally endangered species that prefers swamp and stream habitats with good levels of cover and edge vegetation.



Figure 29. Large adult Male (top) and female Southern Pygmy Perch from site ML02-23 (© S. Wedderburn). The discovery of the species at Wyndgate represents an important addition to the endangered Lake Alexandrina sub-population.



Figure 30. The nationally "Vulnerable" Yarra Pygmy Perch from the Murray Darling Basin (© M. Hammer). A locally endangered species, its occurrence in the Murray was only realised in 2001. The local ecology of the species is unknown but it seems to prefer dense aquatic macrophyte beds and good water quality.

Table 20. Fish species recorded at Wyndgate.

FAMILY	Species	Common name	Conservation status	
			Regional	National
Kuhliidae	<i>Nannoperca australis</i>	Southern Pygmy Perch	(E, P)	
Kuhliidae	<i>Nannoperca obscura</i>	Yarra Pygmy Perch	(E, P)	(V)
Atherinidae	<i>Atherinosoma microstoma</i>	Small-mouth Hardyhead		
Atherinidae	<i>Craterocephalus fluviatilis</i>	Murray Hardyhead	(E)	(V)
Atherinidae	<i>Craterocephalus stercusmuscarum fulvus</i>	Fly Specked Hardyhead		
Eleotridae	<i>Philypnodon grandiceps</i>	Flathead Gudgeon		
Eleotridae	<i>Philypnodon</i> sp.	Dwarf Flathead Gudgeon	(R)	
Gobiidae	<i>Pseudogobius olorum</i>	Western Blue Spot Goby		
Galaxiidae	<i>Galaxias maculatus</i>	Common Galaxias		
Eleotridae	<i>Hypseleotris</i> spp. (species complex)	Carp Gudgeon	(I)	
Retropinnidae	<i>Retropinna semoni</i>	Australian Smelt		
Bovichthyidae	<i>Pseudaphritis urvillii</i>	Congolli	(I)	
Gobiidae	[†] <i>Favonigobius tamarensis</i>	Tamar River Goby		
Mugilidae	[†] <i>Aldrichetta forsteri</i>	Yellow-eyed Mullet		
Clupeidae	[†] <i>Hyperlophus vittatus</i>	Sandy sprat		
Poeciliidae	* <i>Gambusia holbrooki</i>	Gambusia		
Cyprinidae	* <i>Carassius auratus</i>	Goldfish		
Cyprinidae	* <i>Cyprinus carpio</i>	Carp		
Percidae	* <i>Perca fluviatilis</i>	Redfin Perch		

[†] Estuarine species, * Introduced species. Conservation status: National conservation status (*EPBC Act 1999*); Regional conservation status (no formal recognition in South Australia) based on Lloyd and Walker (1986), Wedderburn (2000) and Hammer personal assessment [E - Endangered; V - Vulnerable; R - Rare; I - Indeterminate (taxonomic uncertainty or data deficient); P - Protected under the *Fisheries Act 1982*].

Table 21. Species composition and abundance at the Wyndgate fish survey sites.

SPECIES	ML02-23	ML02-24	ML02-25	ML02-26	ML02-27	ML02-28	ML02-29	ML02-30	ML02-31	ML02-32
Southern Pygmy Perch	14	-	-	-	-	20	22	-	-	5
Yarra Pygmy Perch	-	-	-	-	-	-	-	-	-	10
Small-mouth Hardyhead	-	1	8	8	>200	42	8	11	40	x
Murray Hardyhead	-	-	2	x	-	-	-	-	60	1
Fly Specked Hardyhead	-	-	x	-	-	-	-	-	-	-
Flathead Gudgeon	-	-	3	-	-	1	1	-	-	-
Dwarf Flathead Gudgeon	26	3	32	3	-	124	19	31	-	2
Western Blue Spot Goby	-	x	2	14	2	-	-	5	1	-
Common Galaxias	2	-	-	3	-	7	1	10	-	15
Carp Gudgeon	15	-	-	-	-	8	-	-	-	-
Australian Smelt	-	-	-	-	-	-	1	-	-	-
Congolli	-	-	-	1	2	-	-	-	-	9
Tamar River Goby	-	-	-	-	5	-	-	-	-	-
Yellow-eyed Mullet	-	-	-	-	2	-	-	-	-	-
Sandy sprat	-	-	-	1	-	-	-	-	-	-
Gambusia	42	6	7	2	-	9	22	4	-	-
Goldfish	1	6	-	-	-	-	6	-	-	4
Carp	1	-	-	-	-	-	1	x	-	-
Redfin Perch	-	-	1	-	-	-	-	-	-	-
Total	4(3)	3(2)	6(2)	7(1)	5	6(1)	6(3)	4(2)	3	7(1)

^x present (observational record), Hardyhead abundances are approximate due to initial confusion recognising three sympatric species. Hence some species are only known as present (x) at this stage. Total shows number of native species with number of introduced species in brackets. Drains are indicated with bold site codes.



Figure 31. The nationally “vulnerable” Murray Hardyhead (© M. Hammer). The refuge population at Wyndgate is highly significant for this little known species, it has virtually disappeared from the Lower Murray since the early 1980’s.

ENVIRONMENTAL DESCRIPTORS

Most sites have a still or slow-flowing, permanent water regime (Table 22). An exception is the drain at site ML02-31 (WYN01001) where re-filling had occurred only several weeks before the survey. This site, where Murray Hardyhead and Small-mouth Hardyhead were very abundant and dominant, had very little aquatic vegetation. The other drain site ML02-28 is also reported to have been dry several years ago but has been permanently flooded since. The abundance of aquatic vegetation was comparatively high at this site. Similarly, all permanently watered sites had a high abundance of submerged vegetation except the two sites ML02-26 and ML02-27 at the mouth of Hunters Creek.

A wide variety of aquatic macrophytes were encountered, most are poorly represented elsewhere in the Lower Murray. Particularly good beds or floating mats of *Vallisneria americana*, *Ceratophyllum demersum* and *Myriophyllum* spp. often formed dense

cover. Emergent vegetation was occasionally prominent, mainly consisting of *Typha* and occasionally *Schoenoplectus*. A variety of amphibious species such as *Crassula helmsii* and *Hydrocotyle* sp. were also present. Combined with overhanging terrestrial grasses the above aquatic plants were the dominant form of cover at Wyndgate (Table 22).

Evidence of riparian damage due to trampling by stock was observed at most sites except ML02-24 and ML02-29 where dense vegetation prevents access by cattle. Riparian damage due to trampling was particularly evident at site ML02-31.

Transparency at sites was generally high, particularly in comparison to turbid waters feeding in from Lake Alexandrina. The conductivities encountered were slightly high, but within normal summer limits.

Table 22. Water quality and habitat parameters.

Site	Temp. (°C)	Conductivity (mS)	pH	Transparency (m)	Depth (cm)	Cover (%)	Flow Environment
ML02-23	19.0	1.06	8.2	0.4-0.5	1.5	50M 20E	Permanent
ML02-24	25.0	1.30	8.5	>0.25	0.25	60M	Wetland
ML02-25	22.9	1.77	8.7	0.4	<0.40	80M 5E	Permanent
ML02-26	22.0	2.16	9.2	0.1	0.5-1.0	none	Permanent
ML02-27	26.4	>25	9.2	0.2	0.2-0.4	2S	Estuarine
ML02-28	20.4	1.48	8.8	0.3	0.2-0.4	30M 50E	Sometimes dry
ML02-29	18.5	1.10	8.2	0.8	0.6-1.0	90M 10E	Permanent
ML02-30	25.7	1.17	8.8	0.3	0.3	50M 40E	Permanent
ML02-31	24.6	3.04	9.4	0.1	0.2	1M 1E	Sometimes dry
ML02-32	16.0	0.90	-	0.5	1.0	80M 5E	Permanent

Cover (submerged or emergent) types: M - Macrophytes submerged; E - Macrophytes emergent; S - Snags (woody debris and rocks).



Figure 32. Checking a fyke net in the freshwater side at the mouth of Hunters Creek (near site ML02-26, WYN00501) (© S. Wedderburn). Despite this site having very little aquatic vegetation, it had one of the highest diversities of native fish, highlighting the importance of habitat variability within Wyndgate.



Figure 33. Artificially modified habitat at site ML02-31, near WYN01001 (© S. Wedderburn). The area was freshly flooded prior to sampling and had been colonised by Murray Hardyhead, Small Mouthed Hardyhead and Western Blue Spot Goby.



Figure 34. Aquatic habitat at Hunters Creek site ML02-32 (© S. Wedderburn). The water here has a much better transparency and colour compared to that which might be encountered in the Lower Murray (highly turbid). Dense beds of *Vallisneria*, *Myriophyllum* and *Ceratophyllum*, combined with emergent vegetation, provided important cover at this site for threatened pygmy perch.

DISCUSSION

NATIONAL AND REGIONAL SIGNIFICANCE

The aquatic habitats within Wyndgate provide a significant refuge for freshwater fishes, and a positive message that there are still high conservation values at the terminus of an ailing River Murray. The twelve native species recorded represent almost half the known fish fauna of the Murray Darling Basin in South Australia, including four species of national or regional conservation significance.

The detection of two nationally listed species is particularly important considering their limited distribution elsewhere. The 'vulnerable' Yarra Pygmy Perch was only discovered to inhabit Lake Alexandria in 2001 (Hammer 2001), and Wyndgate represents one of just two locations where the species is known to occur in the Murray Darling Basin (a genetically distinct lineage). Reasonable numbers of the 'vulnerable' Murray Hardyhead (endemic to the Murray Darling Basin) is encouraging, given a virtual disappearance from the Lower Murray since the 1980's and a confirmed presence at only one other South Australian location since this time (Hammer pers. obs.; Wedderburn 2000). For both these species the survey findings represent significant range increases.

The locally endangered Southern Pygmy Perch has been the subject of recent ecological and genetic research (Hammer 2001). Research findings show that fish in the Murray Darling Basin are likely to be a separate sub-species and that small pockets remaining in the Lower Murray represent five highly genetically distinct sub-populations. A 'regionally endangered' Lake Alexandrina sub-population was historically wide spread from Mannum downstream into the Lake, but now only occurs at small discrete sites. The occurrence of this species at a number of Wyndgate sites is a major increase in the known area of occupancy of the Lake Alexandrina sub-population and links well with a current regional conservation program (Hammer 2002).

An additional species of significance is the Dwarf Flathead Gudgeon, which is generally patchily distributed and in low abundance elsewhere, but was widespread and sometimes abundant during the current study. Similarly other species recorded at Wyndgate, namely, Congolli and Fly Specked Hardyhead, are fairly widespread but patchily distributed and have experienced large declines from historical abundance elsewhere.

In terms of diversity and conservation significance, Wyndgate could easily be considered as one of the most important areas for freshwater fish conservation in the South Australian section of the Murray Darling Basin. There are no other areas in the Lower Murray or eastern Mount Lofty Ranges where fish and aquatic habitats are included within the reserves system. Further, state protection of freshwater fish is limited to "protection" under the *Fisheries Act 1982*, which currently aims to control exploitation of certain

species. Hence there is considerable value for incorporating the Wyndgate aquatic habitats into the reserves system and for protection of what may well be a threatened ecological community.

HABITAT AND ECOLOGY

The fishes recorded principally complete their whole lifecycle in freshwater, with some species able or required to move between fresh and salt water for particular life stages. This sort of fauna is typical of the lower Murray and contrasts with the estuarine community of the Coorong (i.e. comparison of sites ML02-26 and ML02-27). Notably, the presence of threatened species and the generally low abundance of exotic species (these generally thrive in degraded habitats or areas easily invaded) provide an indication of the general health of aquatic habitats. The high diversity and composition of species recorded is no doubt a reflection of the variation and high structural complexity of the habitats represented. Specific habitat components link with the ecology of certain species (e.g. Pygmy Perch), while the fish community is likely supported by a mosaic of different stages and types of habitat created by the channel network and flow patterns (e.g. Murray Hardyhead, see later).

Healthy aquatic vegetation provides for large areas of shelter and a food source for small fish. The vegetation community itself seems significant on the regional scale and has an important role in underpinning the local aquatic ecosystem. The submerged and aquatic macrophytes that provided the majority of cover at sites, are likely to be a particularly important refuge and habitat for pygmy perch. These species generally move in and around vegetation and juveniles utilise thick edge cover such as *Typha* and overhanging grasses for shelter (Hammer 2001). The same structural complexity would help habitat partitioning between species, particularly between small fish and larger predators. At many sites the vegetation and shallow habitat would be physically restrictive to larger species, providing an ideal refuge for smaller species and limiting the impacts of larger exotic species such as Carp and predatory Redfin. Hence maintaining the aquatic vegetation at Wyndgate is imperative for conserving the diverse fish assemblage.

The high water transparency noted at sites is an important feature of Wyndgate, particularly considering it is bounded and fed to the north by highly turbid Murray waters. The clarity is probably directly beneficial to many fish species and also as a strong base for aquatic vegetation growth and food chains. While high transparency was a general feature, it is hard to group sites using physical habitat features. Differences were apparent between sites in terms of sediment, channel shape and water quality, providing a network of different habitat types.

Seasonal and temporal variations are important ecological values to be maintained within future

management of Wyndgate. For example, preliminary investigation showed Murray Hardyhead to be in low numbers generally, but in higher abundance in saltier or more open areas (e.g. ML02-31). Hence the species may be able to take advantage of conditions (vacant resources) not suitable for other species and persist with occasional population “bursts”. At the same time species require core refuge or source habitat.

Natural variation seemed to be driven mostly by flow patterns and channel type (excavated regularly, deeper, open water, etc), and this variability is likely a key reason for the current health of the area. Many areas are artificially constructed, but these seemed to be built within the dynamics of the system, with flow through the channels and creeks into the Coorong as the overriding factor maintaining the natural variability and health of the sites. Obviously much more than a seasonal snap shot is required to strengthen direct management outputs. Initial observation from this survey suggest that the artificial channels or drains have high conservation values similar to the natural drainage lines in terms of high fish species diversity and low numbers of introduced fish species. This is likely to be the result of healthy aquatic plant communities and hence suitable habitat for a range of native fish species.

REGIONAL MANAGEMENT

Historically Lake Alexandrina and Hindmarsh Island channels would have alternated between fresh and salt water, with freshwater fish relying on fringing swamps and local stream discharge for persistence. The permanent flooding of the Lower Murray Lakes with the barrage system since 1936 altered this system of dynamic streams and swamp areas. Species such as the Yarra and Southern Pygmy Perch are now reliant on the resulting permanent freshwater habitat and depend on man-made changes for their existence. This can be seen in the broader sense of having a continued freshwater environment as well as local management to ensure that flows between Lake Alexandrina and the Coorong via Wyndgate are maintained.

Moves to replace the current barrages with a structure at Wellington would likely be detrimental to the threatened fishes of Lake Alexandrina due to the inevitable replacement of reliable freshwater habitat with more variable saline estuarine conditions. Fish passage, while a badly needed measure for a range of commercial and smaller species, could be detrimental in specific areas due to increased predation and competition with faster predatory estuarine species. This would mainly be a consideration in the smaller vegetated channels. The current survey results indicate that re-enabling fish passage through Hunters Creek is clearly not desirable.

Without regular flooding cycles of the River Murray, channel maintenance flows providing important physical functions such as desiltation, removal of organic matter and prevention of vegetation encroachment, are lacking. Hence the intervention of channel maintenance is required, but an appropriate

level and cost effective methodology requires considerably more investigation.

Education and raising awareness regarding the importance of the region is a key to its long-term survival. While site specific details of threatened fish is sensitive information, raising the issue that there are endangered species on Hindmarsh Island that will benefit from efforts to restore the River Murray is a priority. The community generally responds well to issues relating to fish, and the information could be extremely useful to fill current knowledge gaps (prevent ill-informed decisions) and provide a focus within government agencies.

FURTHER RESEARCH REQUIREMENTS

Further, more detailed sampling is required within Wyndgate to fully understand the distribution patterns of the fish community, particularly the range and population size of threatened fishes (especially to separate the three sympatric species of Hardyheads). Extending sampling to other nearby areas of Hindmarsh Island and Lake Alexandrina is also important in regard to understanding the extent of the unique regional freshwater fish community. There is also the possibility of uncovering other species with additional sampling. Additional species not found during the study that could be present based on ideal habitat include the Murray Rainbowfish (*Melanotaenia fluviatilis*) (not recorded in Lake Alexandrina since the early 1980's) and two presumed regionally extinct species the Chanda Perch (*Ambassis agassizi*) and the Southern Purple Spotted Gudgeon (*Mogurnda adspersa*).

Virtually nothing is known about the ecology of the Murray Hardyhead, and of the Yarra Pygmy Perch in the Murray Darling Basin. Wyndgate presents a rare opportunity for research into the life history, habitat and flow requirements of these species to provide management for their future protection locally and nationally. An exciting prospect also exists in terms of understanding the functioning and dynamics of the local ecological community. A specific research focus should also lie with the investigation of stock impacts to riparian areas, with controlled experimental conditions to investigate the ecological response to stock exclusion (local and broader implications). Investigation of habitat, biology and resource partitioning between the three Hardyheads would also be an interesting ecological study.

Long-term monitoring at key sites will help detect any seasonal changes or deterioration in conditions that might threaten important fauna and flora. Long-term monitoring should ideally involve community participation and education. Key species from different habitat and trophic groups require special attention: Yarra and Southern Pygmy Perch, Murray Hardyhead and Dwarf Flathead Gudgeon.

Biological Survey of the Murray Mouth Reserves

TERRESTRIAL MACRO-INVERTEBRATES

L Queale⁴

Approximately 25% of the insects in Australia have names. It is therefore difficult to discuss their ecology if we are not even sure which species we are looking at. Insects are included in this report in an attempt to make a small contribution to distribution and some ecological data. At least 59 species of macro-insects were collected from macro and micro pitfall traps set at 16 of the 22 survey sites sampled. However, the small diversity of species collected may reflect the level of disturbance by grazing and drainage of the Wyndgate area surveyed.

The 59 species represented 13 orders (Appendix XI) of which the Diptera (flies), Orthoptera (grasshoppers and crickets) and Coleoptera (beetles) were the most widespread and abundant groups (refer to Table 23). The Orthoptera were the most dominant group. Twenty-two sites were surveyed over one week only and therefore do not represent a comprehensive listing of the invertebrates living in these habitats. Also, the trapping methods biased samples toward ground dwelling invertebrates. No light trapping was carried out, as the weather was cool and windy. Some hand netting, particularly for grasshoppers was effective in the grassy sites.

Table 23. Orders of invertebrates pit trapped at sites in descending frequency order

Order	total	No. of sites
INSECTS		
DIPTERA	21	11
ORTHOPTERA	20	11
COLEOPTERA	21	10
HYMENOPTERA	8	7
DERMAPTERA	7	6
HEMIPTERA	6	5
COLLEMBOLA	4	4
BLATTODEA	1	1
MANTODEA	1	1
ODONATA	1	1
PSOCOPTERA	1	1
THYSANURA	1	1
TRICHOPTERA	1	1
OTHER INVERTEBRATES		
DECAPODA		5
CRUSTACEA		4
ARANEAE		4
AMPHIPODA		3
ACARINA		2
CHILOPODA		2
GASTROPODA		1
DIPLOPODA		1

Species richness and abundances of insects and spiders were very low. Therefore few conclusions can be

drawn between insects and soil or plant associations. Coastal dunes showed limited species richness, which is to be expected because there is low species richness of plants.

The most widespread and abundant of the 41 Families trapped were the Gryllidae (Crickets). These were present at 10 sites and were represented by five species. The most species rich Families were the Tenebrionidae (piedish beetles) with eight species, the Carabidae (ground beetles) with five species and the Acrididae (grasshoppers) also with five species.

HABITAT PATTERNS

Sites with loam components in the surface (sandy or clay appeared to be more species rich (average between 7 and 10 taxa) than either straight sand sites (average 4.5 taxa) and clay sites (average 2-3 taxa). There were no clear trends with vegetation structure except that the two sites with a significant tree layer were amongst the most species rich sites (WYN012 with 9 and WYN013 with 14 taxa). These two sites also had a significant cover of grasses providing favoured habitat for the grasshoppers.

Only one Blattoidea (cockroach) was collected. This is low when compared with results from other surveys (Brandle, 2000, Robinson and Copley in prep).

The Lepidoptera (moths and butterflies) and Formicidae (ants) of the region are discussed in the Natural History of the Strathalbyn and Goolwa Area. Among the common ant species expected in the survey area are the genera: *Camponotus*, *Iridomyrmex*, *Myrmecia* and *Rhytidiponera*. See also Shattuck 1999 and Greenslade 1979.

Only four Collembola (springtails) were found which is an unusually low number for this type of survey. They all belong to the family Entomobryidae. As these specimens were not identified to species, their specific habitat cannot be confirmed. The lack of these creatures may also indicate the degradation of the insect habitat in this area.

Species lists comparing landform elements, soil surface texture, vegetation structure and floristic groups are presented in Appendix XII

FUTHER NOTES ON SELECTED INSECT GROUPS

Flies: Diptera

Dipterans were collected at most sites. The usual suite

⁴ Biodiversity Survey and Monitoring, Dept. for Environment and Heritage, PO Box 1047, Adelaide, SA 5001

of families found on surveys was collected in the micropitfalls in low numbers. One Sepsid fly was collected. They are very small and mimic ants in body shape and are seen infrequently. The distribution of fly species is difficult to comment on as the status of fly taxonomy in Australia is limited.

Grasshoppers and Crickets: Orthoptera

These species are common throughout the wetter parts of South Australia. The Acrididae (Short-horned grasshoppers) are active during the day and the Gryllidae (crickets) tend to be active at night.

Sites with plentiful grasses yielded higher numbers of grasshoppers than sites with minimal cover of grasses. A number of juvenile gryllids and acridids were collected. These groups were mostly found at sites with silty/clay loamy soil, especially the *Ailopus* spp. and gryllids. Short-horned grasshoppers of the “slant faced” group are often found in this type of grassy habitat. They are active during the day when the weather is sunny and warm. Large numbers of the acridid *Oedalus* sp. were seen adjacent to site WYN01101, on a grassy hill. Several species of acridids were collected at site WYN01301.

One gryllacridid was collected from WYN00801, a sandy site, and one *Gryllotalpa* sp. (a mole cricket) at site WYN01001. These two species are active at night. The gryllacridids are predators of other insects. *Gryllotalpa* lives in burrows that it digs in the soil and feeds on underground plant material. The females carve an hourglass-shaped burrow to maximise the volume of their chirping calls.

There were large numbers of black crickets (*Teleogryllus commodus*) at sites WYN009 and WYN010. This species is found commonly in gardens in Adelaide and in cracking soils in agricultural areas.

Beetles: Coleoptera

Piedish beetles (*Helea* sp., Tenebrionidae) were common on the dunes of the MUD sites. They were also common on dunes sampled across a number of arid areas during previous biological surveys. This suggests that soil type is significant to these animals across a range of climatic conditions. Five *Ecnolargia rufescens* (another Piedish beetle) and the coccinellid (ladybird), *Micrapsis* sp were collected at silty/clay/loamy sites.

Several carabids were collected on a variety of soil types. These are commonly found with tenebrionids (piedish beetles) on surveys. Carabids are predatory and tenebrionids are usually herbivorous. The species from these two families found on this survey are similar to those collected during the survey of the Southern Mount Lofty Ranges. These two families usually dominate pitfall survey results along with Scarabaeidae and Curculionidae, both of which were absent from collections on this survey. There tends to be a suite of species in each beetle family found in a particular area and this varies from area to area with

similarities between similar areas. This seems to reflect rainfall and soil type more than particular plant associations

Earwigs: Dermaptera

The presence of *Forficula* sp. (a common introduced earwig) is among the species indicating significant disturbance of natural habitat. It was found in a variety of habitats. Two specimens of the genus *Labidura* were collected.

Bugs : Hemiptera

Very few Hemipterans were collected. The most notable was one belostomatid, *Lethocerus* sp. This genus contains the largest bug in Australia. They live in water and are predatory unlike many other plant-feeding Hemipterans.

Butterflies: Lepidoptera

Butterflies were not collected on the survey, however common species reported by R. Grund (pers. comm.) are:

“*Danaus p. plexippus*, *Vanessa itea*, *Theclinessthes s. serpentata*, *T.albocincta*, *Hesperilla donnysa diluta*, *Ancycincta c. cynone* and *Zizina l. labradas*.

Patches of remnant vegetation containing *Gahnia filum*, should be conserved as this plant is an important food source for butterflies especially those rarer species.

The habitats of the Hindmarsh Island area have been severely degraded by past farming practices and beach-shack development, and as a result foodplants for larvae of rare and threatened butterfly species are now very scarce. Only 27 species of butterflies are still known to occur, and nearly all of these are either annual migrants or endemic common species that can adjust to agricultural and urban development. Notable butterflies that are lost to the area include *Antipodia atralba*, *Herimosa albovenata*, *Hesperilla chrysotricha*, *Motasingha trimaculata*, *Trapezites lutea* (Hesperiidae); *Candalides heathi*, *Cyprotides cyprotus*, *Hypochrysops ignita*, *Jalmenus icilius*, *Lucia limbaria*, *Neolucia agricola*, *Ogyris idmo*, *Ogyris otaes* (Lycaenidae).

Notable non-migrant butterflies that are extant are *Anisynta cynone* and *Hesperilla donnysa* (pale forms). The Hindmarsh Island area is now the only area in Australia where the small, but pretty coloured vulnerable skipper *Anisynta cynone* subspecies *cynone* is still known to occur. It is autumn flying and requires open grassland that is lightly or non-grazed, and free of agricultural sprays. The remnant stands of *Gahnia filum* north of the Hindmarsh Island Bridge support a small colony of a pale form of *Hesperilla donnysa* form *diluta*, and sometimes the endangered extreme pale colour variant form *flavescens* is also seen. The surrounding areas of *Gahnia filum* along Currency Creek, Finnis Estuary, Goolwa and Clayton also support small local colonies of the skipper where the *Gahnia* has not been degraded by overgrazing. It may be possible to reintroduce the vulnerable skipper *Hesperilla chrysotricha* if large enough stands of *Gahnia filum* were protected. However, nectaring plants for the skippers, such as *Melaleuca lanceolata* and non-suckering *Melaleuca halmaturum* would also need to be planted at the fringes of the wetlands. The melaleucas could be seeded with *Amyema melaleucae*, which could maintain populations of *Delias aganippe* (Wood White) and *Ogyris amaryllis* in the area. *Gahnia lanigera*, the larva foodplant for the rare *Antipodia atralba* is present in some conserved native

vegetation areas. The area of *G. lanigera* may be large enough to support a reintroduction of the skipper, *H. chrysotricha*. *Adriana klotzschii*, the larval foodplant for *Theclinesches albocincta* (Bitterbush Blue) exists precariously as occasional plants on roadside verges, and these plants support viable colonies of the butterfly. However, protected locations are required for the foodplant before urbanisation causes its complete demise.” See Appendix XIII for a complete list of species that once occurred in the area.

Millipedes and Centipedes: Diplopoda and Chilopoda
One native millipede and two centipedes (all unidentified) were collected.

Spiders: Arachnida

Two females of the uncommon *Polys* sp. (Araneidae) (orbweavers) were collected from MUD00101. There are many orb-weaver species in the areas surrounding the Murray Mouth, some of which should be more common and apparent in the daylight hours as well as at night, (D.Hirst, pers. comm.)

Mites: Acarina

Eight erythraeid mites were found at the MUD sites. These are relatively large for mites, red and with long legs. They are often associated with eucalypts.

Crabs: Decapoda

Crabs Grapsidae: *Helograpsus haswellianus* were the dominant invertebrates in the swampy sites: MUD00501, MUD00601 and WYN005-WYN007. Other crustaceans including various yabbies, prawns and crabs could be expected to occur in the area

Slaters and Amphipods: Crustacea

Five unidentified slaters and three unidentified amphipods were collected from some of the more tidal sites.

Snails: Mollusca

The Common Garden Snail (*Helix aspersa*) and the other introduced species *Theba pisana*, *Cermea virgata* and *Cochlicella* spp., which are regarded as agricultural pests, are present in this area.



Figure 35. *Helograpsus haswellianus* the dominant crab along the Coorong shoreline was commonly caught in pitfall traps. Photo: AC Robinson NPWSA.

Biological Survey of the Murray Mouth Reserves

AQUATIC INVERTEBRATES

Russell Seaman⁵

SUMMARY

The aim of the aquatic survey was to sample the diversity of wetland habitats for invertebrates at Wyndgate NPWSA Reserve and collect baseline water chemistry parameters within those habitats. The survey took place in conjunction with the biological survey of the Murray Mouth Reserves during March 2002. The aquatic sampling occurred from 19-20 March 2002.

Water chemistry parameters recorded include nitrogen, phosphorous, nitrate, chlorophyll a and b, pH, temperature, dissolved oxygen, conductivity and turbidity. All of the water chemistry results returned acceptable readings, with all recorded levels below “trigger” values outlined in the Australian and New

Zealand Guidelines for Fresh and Marine Water Quality 2000.

Aquatic invertebrates were sampled using a Plankton Net with 250µm pore size. The invertebrates recorded include species routinely found in aquatic environments in South Australia. The Planorbis snail, *Pygmanisus* was recorded and is considered uncommon for the region. Only one large predator species was recorded which is unusual, but could be due to limited sampling. Overall, the results indicate a healthy invertebrate food chain within the surveyed sites.

BACKGROUND INFORMATION

Five sites were sampled across the variety of wetland habitats supporting free-standing water during March 2002. Other habitats would become available to aquatic invertebrates during winter and spring or when river levels rise during floods.

Chemical and physical water parameters were measured at sites to enable assessment of the habitat in relation to the aquatic invertebrate communities they support, and as a baseline for future sampling. Their importance in freshwater ecology is briefly discussed.

Nitrogen is found in the cells of all living organisms and is a major component of proteins. These organisms die and decompose, releasing nitrogen as ammonia that undergoes two stages of oxidation producing nitrite as nitrogen. This nitrate is used in plant and animal protein. Nitrates in freshwater stimulate the growth of algae and other plankton which provide food for invertebrates and fish. An excess of nitrogen can cause over-production of plankton that can lead to an oxygen imbalance within the water. This decrease in oxygen stresses aquatic flora and fauna and can have major negative impacts on aquatic food chains.

Phosphorus is another key element necessary for growth of plants and animals. Excess phosphates in water can lead to rapid growth of aquatic vegetation that eventually dies and uses oxygen in the decaying process. This process usually causes low levels of dissolved oxygen and stresses aquatic flora and fauna. Phosphorus compounds are transported into freshwater systems at high concentrations by heavy rain events. The primary source of phosphorous as a pollutant is from the breakdown of organic pesticides.

Chlorophyll is the pigment that allows plants to convert sunlight that is needed to fix carbon dioxide into carbohydrates. Excessive amounts of chlorophyll are usually evident in the form of algae blooms, which often consist of a single species and indicate high N and P levels.

In South Australia the Acidity/Alkalinity (pH) of natural water generally ranges between 6.0 and 8.5 with most water bodies in the neutral to alkaline range of 7.0-8.0. High bicarbonate levels are responsible for the slightly alkaline nature of many natural water bodies. Water pH fluctuates with day and night, increasing by day and decreasing at night. Chemicals entering the water can also affect pH. At extremely high or low pH values, the water becomes unsuitable for most organisms.

Conductivity is a method for measuring the concentration of salt in water (salinity). High salt levels seriously affect biological communities and can result in reduction in species richness and diversity as less salt-tolerant species are replaced by fewer more salt tolerant species. These effects can cause permanent degradation and ecosystem collapse (Williams 2001).

Turbidity is a measure of water clarity and can be affected by the amount of suspended particles (clay, silt, plankton, industrial wastes and sewage) in water. At higher turbidity levels biodiversity levels are generally reduced in response to decreased photosynthesis and dissolved oxygen concentrations. Suspended particles may also clog aquatic invertebrate

⁵ Goolwa Office, National Parks & Wildlife South Australia. PO Box Goolwa SA 5

appendages and fish gills, reduce growth rates, and prevent egg and larval development.

Many of the physical, biological and chemical characteristics of a wetland are directly affected by temperature. It affects the solubility of oxygen in water with warmer water holding less oxygen than cooler water. These factors affect the rate of photosynthesis by algae and larger water plants, with warm water being more susceptible to eutrophication. The sensitivity of organisms to toxic waste, parasites and diseases is also related to water temperature. Organisms can become stressed as temperatures rise and become less resilient to other stresses. Most aquatic organisms have a fairly narrow temperature range in which they can function effectively. Temperatures over 20 degrees can start impacting on aquatic flora and fauna in Mediterranean climates.

Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms. Dissolved oxygen levels (DO) are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support aquatic life. Levels above 5 milligrams per litre (mg O₂/L) are considered optimal and most fish cannot survive for prolonged periods at levels below 3 mg O₂/L. The National Science Foundation in America has developed the following guidelines for tolerance levels for aquatic invertebrates: No production impairment above 8 mg/L; Moderate production impairment at 5 mg/L; and the limit to avoid acute mortality at 4 mg/L.

INVERTEBRATES

Macro and micro invertebrates are an essential component of the wetland food web. They are responsible for a significant proportion of the secondary production occurring in wetlands, and form two interconnected wetland food chains, a grazing food chain and a detrital food chain. Invertebrates comprise much of the diet of waterfowl populations and the diversity and abundance of waterfowl can be a direct consequence of the invertebrate food supply.

Standing water communities are dynamic systems which reflect change in many variables. The trophic state of a wetland depends on nutrient inputs from the catchment and within the wetland (Boulton and Brock, 1999). If samples from all trophic groups are collected, this could suggest that the aquatic ecosystem is in a reasonable state of equilibrium. The top of the food chain is occupied by vertebrate predators, including fish, water rats and water birds. These terrestrial predators can be considered to be on the top of the aquatic food chain, and provide a pathway for the export of nutrients and other material from the wetland ecosystem (Boulton and Brock 1999). A description of these trophic levels follows.

Primary producers form two groups, those that are suspended or floating and those attached to substrate or other plants. Attached macrophytes includes fringing reeds and submerged plants and periphyton (the biota attached to submerged surfaces). Suspended or floating forms generally consist of the phytoplankton and algae groups. Phytoplankton form the photosynthetic basis for the open water food web in most standing waters.

There are two main types of consumers based on diet: grazers that consume plants and predators that consume other animals.

Invertebrate grazers consist of aquatic snails (Gastropoda) and some mayfly nymphs (Ephemeroptera), caddisfly larvae (Trichoptera) and beetles (Coleoptera). These groups are usually found near the edges of the water body. Within the open water, some of the important grazers are zooplankton, including water fleas (Cladocera) and copepods (Calanoida and Cyclopoida). Vertebrate grazers generally consist of groups such as tadpoles, fish and waterbirds. Vertebrate grazers can influence the food web considerably when attracted to water bodies in times of flood or in types of drought.

Predators include dragonfly larvae (Odonata) which tend to ambush invertebrates that hunt in open water, such as diving beetles (Dytiscidae, Coleoptera) (Boulton and Brock 1999). Areas such as the littoral zone tend to have a high biodiversity of grazers which in turn attracts many invertebrate predators

SURVEY SITE LOCATIONS

Six sites were surveyed within Wyndgate, five of these sites are classified as freshwater habitats and one site is classified as an estuarine. Refer to Fig. 37 for survey locations.



WYN00501 54/308295/6065530



WYN00402 54/312506/6065900



WYN00502 54/308286/6065537



WYN014 54/310326/6065983



WYN00901 54/309116/6066404



WYN01001 54/308435/6067373

Figure 36. Photographs of freshwater invertebrate sampling sites and their Australian map grid reference locations. Photos: Russell Seaman NPWSA.

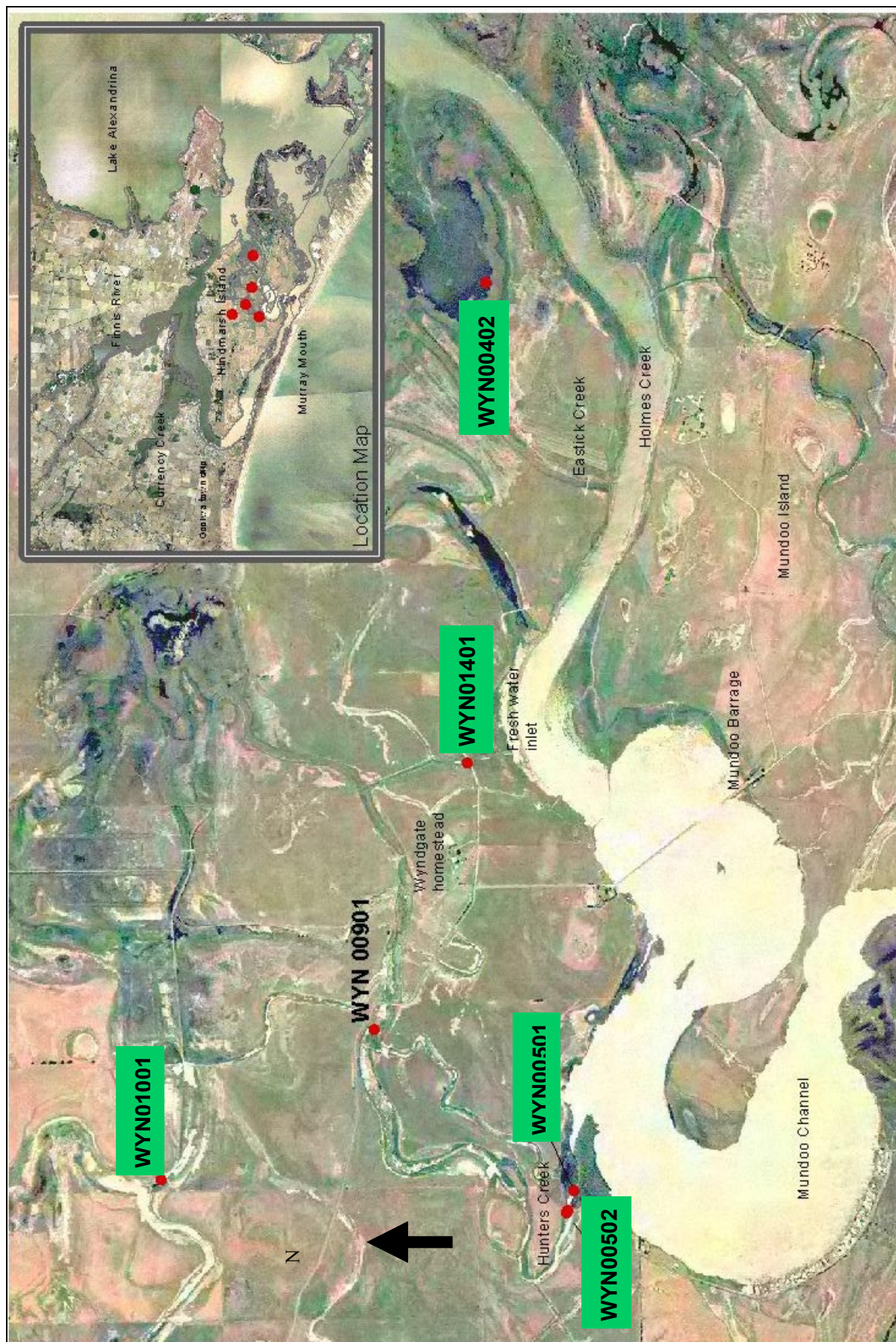


Figure 37. Survey site locations

METHODS

WATER CHEMISTRY

Five water chemistry parameters were measured at sites using the following meters and methods. Acidity/Alkalinity (pH) was recorded using a Hanna HI 9025 pH meter. Conductivity was recorded using a Hanna HI 9635 meter which can measure in the 0 to 199 μScm^{-1} range (deionised to highly saline water). Turbidity was recorded using a Hanna HI 93703 portable microprocessor turbidity meter (readings are given in NTU units) and samples were taken from undisturbed areas. Dissolved O_2 was recorded using a Hanna HI 9142 dissolved oxygen meter as tenths of parts per million ($\text{ppm}=\text{mgL}^{-1}$). Water temperature was read from the thermometers that are part of the pH or Dissolved Oxygen meters.

Water samples were collected in black 1.2 litre plastic bottles for nutrient analysis at the Australian Water Quality Centre. The following seven nutrients were analysed: Nitrate as nitrogen (Nutrient 106-01 and Nutrient 107-01); Nitrate and Nitrite as N (Nutrient 161-01); Filter Reactive Phosphorus P (Nutrient 108-

01); Chlorophyll a (Nutrient 380-02); Chlorophyll b (Nutrient 381-02).

INVERTEBRATES

A plankton net of 250 μm pore size was used to sample invertebrates by pulling it through the water towards the user with a rope. In shallow water the metal rim of the net was held and manually scooped through the water. These techniques were repeated until sufficient sample material was collected in the plastic vial at the end of the net. Sample material was transferred from the sample vial and stored in 10% Formalin. Formalin is used to fix the micro-invertebrates as they become soft, delicate and denature in the 70% alcohol solution often used to preserve macro-invertebrates. Sample labels included: Site/Wetland number, Name of wetland, Collection Date, Australian Map Grid Reference, Method of collection (hand net or plankton net). Invertebrate samples were sorted and identified to family before being sent to the Australian Water Quality Centre for further identification to genus and species level.

CHEMICAL AND PHYSICAL RESULTS

Table 24. Site water chemistry and physical measurements.

Survey site Id	Nitrate as nitrogen Nutrient 106-01 mgL^{-1}	Nitrate as nitrogen Nutrient 107-01 mgL^{-1}	Nitrate + Nitrite as N Nutrient 161-01 mgL^{-1}	Reactive Phosphorus as P Nutrient 108-01 mgL^{-1}	Phosphorus - Total as P Nutrient 109-01 mgL^{-1}	Chlorophyll a Nutrient 380-02	Chlorophyll b Nutrient 381-02	pH	Conductivity $\mu\text{S}=\text{milli-siemens}$ $\text{Ms} = \text{micro-siemens}$	Turbidity (NTU)	Dissolved oxygen	Temperature (degrees C)
WYN 00901	0.000	<0.005	<0.005	<0.005*	0.030	33	1.9	6.89	1047 μS	2.31	7.9	18
WYN 01001	0.000	<0.005	<0.005	<0.005*	0.362	89	<0.1*	6.3	1411 μS	49.25	6.4	20
WYN 00501	0.000	<0.005	<0.005	0.015	0.128	23	<0.1*	8.5	45.3 Ms	12.41	16	27.4
WYN 00502	0.000	<0.005	<0.005	<0.005*	0.138	34	1.9	8.5	1151 μS	30.36	10.3	23.9
WYN 00402	0.000	<0.005	<0.005	<0.005*	0.076	21	1.4	8.5	1396 μS	12.64	12.5	25
WYN 01401	0.000	<0.005	<0.005	<0.005*	0.022	3.6	0.4	8.7	1003 μS	1.77	11.6	22.9

* Detection Limit

Nitrogen levels were below detection level (<0.005 mg/L) at all sites at time of sampling. Levels below 0.005 mg/L are considered to be very low, however nitrogen levels fluctuate with time and regular sampling is required to gain an accurate understanding of nitrogen levels at a site. These initial results indicate that aquatic environments sampled do not have high levels of nitrogen. This is encouraging considering the potential for excess nitrates entering the system from grazing by-products. Reactive phosphorous levels were also low, the highest being at the saline estuarine site WYN00501. Total phosphorus was substantially higher at WYN01001 than other sites and also had the highest Chlorophyll-a levels that were visible as an alga bloom. This probably contributed to the higher turbidity measured at this temporary waterbody which also has a fine silty-clay substrate and was drying out. Sites with

<5 NTU are considered to be have good tubidity levels and those with 5-50 NTU are considered fair for fish activity (Boulton and Brock 1999). The pH at all sites fell into the mild (6 and 9) and pristine (7-8) categories (Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 guidelines). Conductivity readings at all freshwater sites indicate the waters of Hindmarsh Island are defined as marginal (900-2700 μS) using the guide developed by the Land Management Society Inc. (see www.space.net.au/~lmsinfo). The estuarine site (WYN 00501) fell into the brackish water definition. Dissolved oxygen was lowest at WYN01001 and this may be related to the drying process which is usually associated with organic decay.

AQUATIC INVERTEBRATES RESULTS

The six sites yielded 223 identifiable individual macro-invertebrates from 21 Genera in 13 Families and 52

identifiable individuals of zooplankton from three Subclasses. These Results are listed in Table 25.

Table 25. Invertebrates recorded at sites.

			Site & Date					
Macro-invertebrates			WYN00901 19/03/02	WYN00501 19/03/02	WYN014 19/03/02	WYN01001 19/03/02	WYN00502 19/03/02	WYN00402 19/03/02
FAMILY	Genus/species	Common name						
Hydridae	<i>Hydra sp.</i>	Hydra			1			
Nematoda	<i>Nematoda spp.</i>	Round worm				55	1	
Planorbidae	<i>Pygmanisus sp.</i>	Snail	1	1				
Tubificidae	<i>Tubificidae spp.</i>	Segmented worm			5	15		
Naididae	<i>Chaetogaster</i>	Segmented worm			1			
Talitridae	<i>Talitridae sp.</i>	Scud					1	
Ceiniidae	<i>Austrochiltonia australis</i>	Scud			1	4	5	
Eusiridae	<i>Eusiridae spp.</i>	Scud					1	
Corophiidae	<i>Corophiidae SAsp1</i>	Scud						2
Aytidae	<i>Caridina indistincta</i>	Freshwater shrimp			1			
Aytidae	<i>Paratya australiensis</i>	Freshwater shrimp			2		1	3
Chironominae	<i>Cladotanytarsus sp.</i>	Non-biting midge larvae			1			
Chironominae	<i>Paratanytarsus sp.</i>	Non-biting midge larvae			3			
Chironominae	<i>Chironomus spp.</i>	Non-biting midge larvae	2					
Chironominae	<i>Polypedilum sp.</i>	Non-biting midge larvae				2		
Chironomini	<i>Chironomini sp.</i>	Non-biting midge larvae			2			
Corixidae	<i>Sigara sp (Imm & Females)</i>	Water boatmen			1			1
Corixidae	<i>Agraptocorixa (Imm & Females)</i>	Water boatmen				2		
Corixidae	<i>Micronecta robusta</i>	Water boatmen				14		
Corixidae	<i>Micronecta annae</i>	Water boatmen			9			8
Corixidae	<i>Micronecta spp (Imm & female)</i>	Water boatmen	1		13	48		15
Lestidae	<i>Austrolestes annulosus</i>	Damselfly larvae			1			
Micro-invertebrates Zooplankton								
Subclass	Order/Suborder	Common Name						
Copepoda	Calanoida	Copepod			8	1	1	1
Copepoda	Cyclopoida	Copepod	1		1	7		1
Copepoda	Harpacticoida	Copepod			1	1		
Branchiopoda	Cladocera	Water flea	1		17		1	2
Ostracoda		Seed shrimp				8		
Total Diversity			5	1	16	11	7	7
Total Abundance			6	1	68	157	11	33

The zooplankton diversity was high with large numbers of cladocera recorded. In sample 308268 (WYN 00502). The Planorbid snail, *Pygmanisus*, (regarded as the uncommon taxa for the region) was recorded at WYN00901 and WYN00501. Only one large predator species, the Damselfly *Austrolestes annulosus*, was detected at WYN014. From the number of sites and samples collected no obvious relationships between species diversity or abundance and the habitat parameters measured could be discerned. The least diverse site WYN501 was the most saline being under estuarine influence.

The highest abundance of invertebrates was recorded at WYN01001 (Fifty-five round worms, fifteen segmented worms and sixty-four waterboatmen). This is a substantial number compared to other sites and can be attributed to the increased productivity of a waterbody during the drying phase. Boulton and Brock (1999) describe this process as the creation of a predator soup, the Round Worms and the Waterboatmen are fulfilling this role of opportunistic predators. The somewhat depauperate nature of the samples recorded at Wyndgate are not uncommon to the area, Edyvane (1996), Geddes (1987) and Geddes and Butler (1984) have all mentioned the low faunal diversity of the Lower Murray area.



Figure 38. Chironomidae, 40X (non-biting midges, bloodworms). A total of five genera recorded. WYN00501 (brackish water) was the only site that did not record Chironomids. They are detritivores feeding on a mixture of algae and bacteria in soft sediments. Photo: from Williams (1980).



Figure 39. *Paratya australiensis*, 40X (Shrimps) tend to congregate amongst aquatic vegetation and under banks. They feed on detritus, fine decomposing vegetation, bacteria and algae particles. This species benefits from the seasonal drying of waterbodies which triggers breeding. It was recorded at WYN014, WYN00501 and WYN00402. Photo: from Williams (1980).

GENERAL DISCUSSION AND SUMMARY

HABITATS OF THE MURRAY MOUTH REGION

The Murray Mouth region is a complex of aquatic and terrestrial habitats. A number of studies have investigated aspects of their fauna and flora. The current studies targeted areas that had been overlooked but with a focus on areas in the public reserve system managed by National Parks and Wildlife SA.

The major habitat types and their component flora and fauna are detailed below:

AQUATIC HABITATS

Half of the study area is aquatic habitat and this can be separated into estuarine and freshwater, both of which have two major habitat components: open permanent waters and the zone where the aquatic and terrestrial habitats meet.

Estuarine waters: These are confined to the Coorong and Goolwa Channels between the Murray Mouth and the barrages. These habitats were studied by Edyvane *et al.* (1996) in an assessment of the natural resources of the Murray Mouth. Studies targeted fish in the sub-tidal areas and aquatic vegetation (Renfrey *et al.* 1983) in the tidal areas. Tidal areas, in particular the mud flats, have also been studied from the perspective of birds and their invertebrate food sources (Pedler 1994, Paton *et al.* 2000a and b, Wilson 2001, Gosbell *et al.* 2002).

Estuarine channels provide habitat for a variety of marine and estuarine fish, invertebrates and plants. The Biological Assessment of the Murray Mouth Estuary (Edyvane *et al.* 1996) found that the estuary was typified by very low faunal and floral species diversity which they in part attributed to flow manipulation and poor water quality. Whilst the subtidal habitats provide for low species diversity, the high abundance of some groups such as amphipods are important in the growth of juvenile estuarine fishes. In August 1995 the barages were open and 15 species of fish were captured in the estuary from the Murray Mouth to Pelican Point. Of these 10 were marine/estuarine species and five were freshwater species. Only one marine species (Australian Salmon) was captured and this was at the Murray Mouth. One freshwater species (Bony Bream *Nematolosa erebi*) that was captured in the estuary was not captured by the freshwater fish team in March 2002. The fish resource in this area is also important to a diverse and abundant waterbird fauna which includes pelicans, four species of cormorant, three species of tern, gulls, grebes and swans.

Tidal flats and beaches are biological hotspots because of the interaction between terrestrial and aquatic species. The limited areas of this habitat type and the

concentration of invertebrates that are accessible to wading bird species at low tide attract large concentrations of these birds (Paton 1992, Pedler 1994). The flats also provide relatively safe resting areas for the birds that feed in the channels and thus often also support large groupings of pelicans, cormorants, gulls and terns. At high tide, many of the fish in the channels take advantage of the invertebrates that come out of the sediments to feed. Water rats are probably the only native mammal to utilise this habitat extensively as they burrow into the banks above the high tide level (Watts and Aslin 1984).

Freshwater channels and lakes provide habitat to many of the birds that feed in estuarine areas as well as being more attractive to ducks and darters. Most of the planktonic production that drives freshwater aquatic production occurs in the surface waters. The open waters have low habitat values and hence only support more mobile species. In the lower Murray Lakes these are dominated by fish species including Bony Herring, Smelt and the introduced Carp (Hammer, pers. comm.). These areas are also utilised by one native mammal the Water Rat which dives to the bottom for crustaceans and molluscs. Tortoises also occur in these areas. The only species recorded during the survey was the Common Long-necked Tortoise, but the Murray Tortoise is also likely to be present.

Littoral Habitat: The shallower regions around the edge of open areas of water and channels support the majority of non-microscopic plants, both submerged and semi-aquatic species. In the lower Murray lakes bullrushes and reeds dominate the banks and rooted milfoil and free-floating azolla ferns dominate the deeper but sheltered waters. Most of the fauna of open water come in to feed at the edge of this zone but then risk predation from large birds such as egrets and herons that hunt for fish and frogs in the shallows. Rails, crakes and water hens spend much of their lives in the dense reedland that dominates the edge of this habitat. The study of the fish at Wyndgate highlighted the importance of these densely vegetated areas in providing refuge habitat for the small rarer fish species that would fall prey to the larger predators in the open waters. These habitats are also the domain of frogs, tortoises, Tiger Snakes and the Red-bellied Black Snake. The Water Rat is probably the only native mammal that uses this habitat extensively, though the Swamp Rat probably moves around in the dense vegetation above the water. Cattle are the dominant introduced mammals, and are comfortable feeding and wading through this habitat. Other introduced mammals that were found in this habitat were foxes and house mice.

TERRESTRIAL AND EPHEMERAL WETLAND HABITATS

The Murray Mouth Reserves Survey concentrated on sampling these habitats. The site data for the region identified nine floristic communities with significant native vegetation components. These were: three coastal dune communities and six on flats and swamps. Two vegetation communities were not sampled: the semi natural hermland on Lucerne Island because of access difficulties, and the agricultural pastures and crops because they were not considered a priority for survey. Hindmarsh Island also supports two other distinctive woodland habitats, a small area of Sheoak woodland (sampled by site WYN01201) and more extensive areas of the introduced Aleppo Pine. A very small and degraded area of mallee growing amongst an area of pine was too small to be considered by the survey.

The coastal dune vegetation communities are distinctive in both species composition and structure. These shrublands provide the largest most intact areas of habitat for many of the Passerine species of bush birds. This is also the case for reptiles, though only the Painted Dragons were restricted to these areas. This area represents the main habitat for Western Grey Kangaroos in the region. No small native mammals were recorded at survey sites, however the Silky Mouse was recorded at a monitoring site further towards the mouth a month after the survey and indicates their presence in this habitat type for the first time. Echidna tracks were also noted in this habitat, but not at the survey sites. The most frequently recorded feral mammals were House Mice, Rabbits, Foxes and Cats. The oceanic fore dunes are likely to support a depauperate assemblage of the species present in the dune field with the addition of beach breeding birds such as the Hooded Plover.

The plains, flats and sand-loam rises adjacent to the estuarine areas supported a low shrubland of samphires, Marsh Saltbush and native grasses. The Western Grey Kangaroo is probably the main native mammal species utilising this habitat. The Water Rat may burrow into this habitat where it meets waterways or swamps and was recorded at the edge of one site. Of the four introduced mammals noted the House Mouse was most common. This habitat may be important for Elegant and Rock Parrots, chats and Willie Wagtails in this region. The Eastern Brown Snake was recorded at two sites along with three species of skink.

The low shrubland communities of the higher elevated flats inland or adjacent to freshwater areas supported a mix of Salt Bluebush and or Marsh Saltbush over Bucks-horn Plantain and a mix of grasses and Sea Rush. At one site Swamp Paperbarks formed the overstorey (WYN01301) and at WYN01001 they had been recently planted by the previous landholder. Five introduced mammals were recorded at sites. The only native mammals likely to use this habitat are Western

Grey Kangaroos. Bats may use the mature paperbarks, where present, as roosts. This habitat was important for small bush birds such as the Superb Fairy-wren, Brown Thornbill and White-browed Scrubwren. Reptiles were sparse in this habitat, with more than half the species (Tiger Snake, Common Long-necked Tortoise and Common Froglet) only likely to be present where wetland areas are adjacent.

The more frequently inundated flats often adjacent to sandy soils supported a low shrubland dominated by Beaded Samphire and Creeping Brookweed. Lignum was present at some sites and shrubs from adjacent sandy areas such as Common Boobialla and Boxthorn were sometimes present. Water Rats and Swamp Rats and numerous waterbirds made use of this habitat as well as White-fronted Chats, Golden-headed Cisticola and Cape Barren Geese. Tiger Snakes were the only reptiles recorded.

Tidal flats in the Mundoo channel supported low sedge/shrub lands sometimes with an overstorey of Swamp Paperbark. These areas also supported the only native mammals recorded at sites on Hindmarsh Island. Feral House Mice, Black Rats and foxes also utilised these areas. A mix of waterbirds and passerines were recorded at these sites. The widespread Southern Grass Skink was the only reptile recorded in this habitat in which Tiger Snakes are also likely.

The tidal flats adjoining the dunefield around Tauwichee point supported dense tall shrub communities of Lignum and the Common Reed to the exclusion of almost all other species. The information for these sites was collected using a smaller quadrat size and this may have contributed to the lesser number of other species present, as this group is closely allied with the samphire Lignum group described above. These freshwater patches of vegetation in the estuarine situation are likely to be sustained by freshwater seepage from the adjacent dunefield as significant freshwater flood events are now rare. Swamp Rats and Water Rats as well as House Mice used the cover afforded by this habitat. Birds were not surveyed at these sites.

The bulrush and Common Reedland habitat that fringes and in some cases dominates the islands on the freshwater side of the barrages is continuous from infrequently inundated terrestrial habitat into the aquatic littoral habitat already described. Introduced herbs and grasses (particularly Salt-water Couch) dominated the more open areas. The fauna is similar to that already described with waterbirds dominating. However this habitat is particularly important to the Australian Reed Warbler, Little Grassbird and the Golden Headed Cisticola. Swamp Rats were the only native mammals recorded along with Tiger Snakes, Southern Grass Skinks and two species of frog.

The open hermland sedgeland habitat is very limited to areas on islands fringing the reedbeds. This habitat was to be sampled at WYN00201 and should be surveyed

when access becomes possible over summer. It is likely that grazing birds such as Cape Barren Geese and waterbirds as well as grassland birds make use of this habitat.

The cropping land, particularly on Wyndgate, is heavily used by a summer population of up to 1000 Cape Barren Geese. Australian Shelducks and Black Swans also make significant use of these areas.

The map in the back pocket of this report shows the distribution of the major habitat types of the Murray Mouth Islands mapped as 10 vegetation communities or combinations thereof.

SPECIES WITH CONSERVATION SIGNIFICANCE

The Biological Resources Assessment of the Murray Mouth (Edyvane *et al.* 1996) recorded one aquatic plant species that is rated as rare under the National Parks and Wildlife Act (*Ceratophyllum demersum* Hornwort). Murfet (1996) found five plant species that are listed as rare in the schedules of the National Parks and Wildlife Act on Hindmarsh Island. None were recorded at survey sites. Forty-six species with a Southern Lofty Regional rating were recorded at sites (Biological Survey SA flora database). All sites fell within the south-eastern corner of this herbarium region. Twenty-three of these species were also rated for the adjacent Murray Mallee and South East regions and were therefore considered to be of more significance than the other species which are rated because of the artifact of their inclusion in the Southern Lofty Ranges herbarium region.

Forty-three of the 243 bird species recorded for the Murray Mouth region have South Australian conservation ratings (22 vulnerable and 21 rare). Of these four are also of national conservation significance, however the study area is only significant to the Hooded Plover and possibly the Fairy Tern. The two albatross species are vagrants to the area.

No mammals reptiles or frogs with state or national conservation significance ratings have been recorded within the study area. However there are several interesting records for the area. The capture of a Silky Mouse near Godfrey's Landing on Younghusband Peninsula represents a significant westward extension of its known range. The most important reptile capture was of a Red-bellied Black Snake on the south-eastern end of Hindmarsh Island which confirms its presence in the area. The Tiger Snake population in the Murray Mouth area appears to be a mix of two distinct species, the Eastern and Black Tiger Snake. Only one of the two expected species of tortoise was captured during the survey, probably because the time of year was not suited to the sampling technique that required tortoises to investigate baited traps. Frogs were under sampled because of the timing of the survey and further work is required to determine the region's importance to frogs.

Four species of fish with conservation significance were recorded during the survey. Two species (Yarra Pygmy Perch and Yarra Hardyhead) are considered nationally Vulnerable, and the other two (Southern Pygmy Perch and Dwarf Flathead Gudgeon) have the regional ratings of Endangered and Rare respectively. The results of this study highlights our limited knowledge of fish distributions across the state and the importance of the wetlands of the Murray mouth islands to fish conservation in an ailing Murray River system.

GENERAL BIOLOGICAL SIGNIFICANCE OF THE AREA

The Murray Mouth region is the terminus for Australia's largest river system. In the 1930's the area was significantly altered by the installation of barrages which confined estuarine and saline conditions to the Coorong and Goolwa Channels and created one of the largest bodies of permanent freshwater in southern Australia, Lakes Alexandrina and Albert. The area has been declared a wetland of international importance (RAMSAR) for its value as a summer refuge for waders and is of national importance as a breeding ground for waterbirds and regularly supports a significant proportion of the Australian populations of some these. The islands of the Murray Mouth also represent an important non-breeding summer refuge for over 1000 Cape Barren Geese. The relatively inaccessible coastal scrub of the Younghusband Peninsula provides protected habitat for other vulnerable birds such as the Rufous Bristlebird and Southern Emu Wren. The exposed oceanic beach is an important breeding area for the Vulnerable Hooded Plover

The estuarine Coorong and Goolwa Channels make up the largest estuary in South Australia and are an important nursery ground for commercially valuable estuarine fish species such as Mulloway. The smaller freshwater channels networking the islands were found to be significant habitat for threatened fish species.

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APPENDIX I. Site locations, survey dates, floristic analysis group numbers and physical descriptions.

Numbers and letters in brackets behind vegetation species refers to cover abundance estimates (N=not many 1-10 plants, cover < 5%; T=sparingly distributed, cover < 5%); 1=plentiful, cover less than 5%, 2= cover 5-25%; 3=cover 25-50%; 4=cover 50-75%; 5=cover >75%).

Svy No.	Site ID	Patch ID	Visit Date	Easting MGA zone 54	Northing MGA zone 54	Plant Group	Land Unit	Landform	Soil	Vegetation Structure	Dominant Plant Species
4	BK00101	140	01-Mar-82	316822	6061078	8		swamp	clay loam	Shrubland	<i>Muehlenbeckia florulenta</i> (4), <i>Sarcocornia quinqueflora</i> (4)
4	BK00102	141	01-Mar-82	316822	6060978	10		stream channel	sandy clay loam	Closed sedgeland	<i>Phragmites australis</i> (5), <i>Bolboschoenus caldwellii</i> (5),
4	BK00201	142	03-Mar-82	316722	6060978	10		stream channel	clay loam	Closed shrubland	<i>Muehlenbeckia florulenta</i> (5),
4	BK00301	143	03-Mar-82	316922	6060978	10		swamp	sandy clay loam	Shrubland	<i>Muehlenbeckia florulenta</i> (2), <i>Phragmites australis</i> (5), <i>Bolboschoenus caldwellii</i> (5)
4	BK00401	144	03-Mar-82	317022	6060578	2	Dunefield	dune	sand	Open shrubland	<i>Leucopogon parviflorus</i> (2), <i>Olearia axillaris</i> (3),
4	BK00501	145	03-Mar-82	317122	6060678	2	Dunefield	dune	sand	Open shrubland	<i>Leucopogon parviflorus</i> (2), <i>Olearia axillaris</i> (3),
4	BK00601	146	03-Mar-82	317322	6060778	2	Dunefield	dune	sand	Open shrubland	<i>Leucopogon parviflorus</i> (2), <i>Olearia axillaris</i> (3),
4	BK00701	147	03-Mar-82	317322	6060878	6		swamp	clay loam	Low shrubland	<i>Atriplex paludosa</i> ssp. <i>paludosa</i> (4), <i>Sarcocornia quinqueflora</i> (2), <i>Frankenia pauciflora</i> (2), <i>Distichlis distichophylla</i> (4)
4	BK00702	148	04-Mar-82	317522	6060678	1	Dunefield	dune	sand	Open shrubland	<i>Leucopogon parviflorus</i> (2), <i>Olearia axillaris</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (2),
4	BK00703	149	04-Mar-82	317422	6060378	3	Dunefield	dune	sand	Open shrubland	<i>Leucopogon parviflorus</i> (2), <i>Alyxia buxifolia</i> (2), <i>Kunzea pomifera</i> (3)
4	BK00801	150	02-Mar-82	317522	6060378	8		swamp	sandy clay loam	Shrubland	<i>Muehlenbeckia florulenta</i> (2), <i>Bolboschoenus caldwellii</i> (5)
4	BK00901	151	03-Mar-82	317622	6060678	10		swamp	clay loam	Sedgeland	<i>Phragmites australis</i> (5), <i>Muehlenbeckia florulenta</i> (2),
42	PC800	6747	13-Jun-87	308282	6065368	9				low shrubland	<i>Sarcocornia</i> sp., <i>Atriplex paludosa</i> , <i>Stipa stipoides</i> ,
42	PC801	6748	13-Jun-87	308552	6063928	6				Low shrubland	<i>Stipa stipoides</i> (1), <i>Atriplex paludosa</i> (1), <i>Maireana oppositifolia</i> (1), <i>Sarcocornia blackiana</i> (1), <i>Sclerostegia arbuscula</i> (1),
42	PC802	6749	13-Jun-87	308562	6064028	6				Low shrubland	<i>Stipa stipoides</i> (1), <i>Atriplex paludosa</i> (1), <i>Maireana oppositifolia</i> (1), <i>Sarcocornia blackiana</i> (1), <i>Sclerostegia arbuscula</i> (1),
42	PC803	6750	13-Jun-87	302722	6065578	1	Dunefield			Open shrubland	<i>Olearia axillaris</i> , <i>Acacia longifolia</i> var. <i>sophorae</i> ,
42	PC804	6751	13-Jun-87	302782	6065538	2	Dunefield			Very open shrubland	<i>Olearia axillaris</i> , <i>*Ehrharta villosa</i> var. <i>maxima</i> , <i>Rhagodia candolleana</i> ssp. <i>candolleana</i>
42	PC817	6767	24-Jul-87	299562	6071648	4				Woodland	<i>Eucalyptus fasciculosa</i> , <i>Eucalyptus incrassata</i> , <i>Melaleuca uncinata</i> and introduced grasses
45	NAR0401	10101	07-May-92	327571	6058947	11		swamp	medium clay	Sedgeland	<i>Typha domingensis</i> (2), <i>*Paspalum distichum</i> (2), <i>*Pennisetum clandestinum</i> (2), <i>Phragmites australis</i> (1), <i>*Berula erecta</i> (1)
45	NAR0402	10102	07-May-92	328472	6058978	11		swamp	medium clay	Sedgeland	<i>Typha domingensis</i> (3), <i>*Paspalum distichum</i> (2), <i>Phragmites australis</i> (1), <i>*Berula erecta</i> (1)
45	NAR0403	10103	07-May-92	327522	6061078	11		swamp	clay loam	Sedgeland	<i>Typha domingensis</i> (2), <i>Isolepis nodosa</i> (1), <i>*Berula erecta</i> (1)
78	MUR00101	18005	28-Aug-95	303112	6066928	6	Tidal flat	flat		Low shrubland	<i>Sclerostegia arbuscula</i> (5), <i>Atriplex paludosa</i> (1), <i>Halosarcia</i> spp.(2),
78	MUR00102	18006	28-Aug-95	303222	6066818	8	Tidal flat	flat		Low closed shrubland	<i>Sarcocornia quinqueflora</i> (5),
78	MUR00103	18007	29-Aug-95	308712	6064058	6	Tidal flat	flat		Low shrubland	<i>Stipa stipoides</i> (4), <i>Atriplex paludosa</i> (2), <i>Maireana oppositifolia</i> (2), <i>Sarcocornia blackiana</i> (2), <i>Sclerostegia arbuscula</i> (2),
78	MUR00104	18008	29-Aug-95	309032	6064148	9	Tidal flat	flat		Low closed shrubland	<i>Sarcocornia quinqueflora</i> (5),
78	MUR00105	18009	29-Aug-95	310682	6063088	8	Tidal flat	flat		Low open shrubland	<i>Juncus kraussii</i> (4), <i>Sarcocornia quinqueflora</i> (2), <i>Suaeda australis</i> (2), <i>Distichlis distichophylla</i> (2),
78	MUR00106	18010	29-Aug-95	317832	6061218	7	Tidal flat	flat		Closed (tussock) grassland	<i>Sporobolus virginicus</i> (5),
78	MUR00107	18011	30-Aug-95	306492	6063888	6	Tidal flat	flat		Low shrubland	<i>Sarcocornia blackiana</i> (3), <i>Limonium binervosum</i> (2),
78	MUR00108	18012	30-Aug-95	309342	6063368	8	Tidal flat	flat		Low closed shrubland	<i>Sarcocornia quinqueflora</i> (5),
78	MUR00109	18013	31-Aug-95	312322	6062368	6	Tidal flat	flat		Low shrubland	<i>Sclerostegia arbuscula</i> (3), <i>Atriplex paludosa</i> (2), <i>Melilotus indica</i> (2)
82	GOO00101	15955	16-Oct-97	301412	6065488	5	Dunefield	fore dune	sand	(Tussock) grassland	<i>*Elymus farctus</i> (3),
82	GOO00102	15954	16-Oct-97	301262	6065668	1	Dunefield	fore dune	sand	Open shrubland	<i>Olearia axillaris</i> (2), <i>*Euphorbia paralias</i> (2), <i>*Ehrharta longifolia</i> (2), <i>Spinifex sericeus</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2)
82	GOO00103	15956	16-Oct-97	301552	6065668	1	dunefield	dune crest	sand	Open shrubland	<i>Olearia axillaris</i> (2), <i>*Ehrharta longifolia</i> (3), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (T), <i>Threlkeldia diffusa</i> (T), <i>Dianella brevicaulis</i> (T)
82	GOO00201	14756	23-Sep-96	309382	6062198	1	Dunefield	dune crest	sand	Low open shrubland	<i>Myoporum insulare</i> (2), <i>Olearia axillaris</i> (2), <i>Exocarpos syrticola</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2), <i>Isolepis nodosa</i> (2)
82	GOO00202	14757	23-Sep-96	309392	6062228	1	Dunefield	interdune corridor	sand	Open shrubland	<i>Myoporum insulare</i> (2), <i>Billardiera cymosa</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2), <i>Exocarpos syrticola</i> (2)
82	GOO00203	14758	23-Sep-96	309422	6062238	1	Dunefield	dune crest	sand	Low open shrubland	<i>Myoporum insulare</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Exocarpos syrticola</i> (2)
82	GOO00204	14755	23-Sep-96	309222	6062278	1	Dunefield	dune crest	sand	Shrubland	<i>Myoporum insulare</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Spinifex sericeus</i> (2)
82	GOO00205	14754	23-Sep-96	309512	6062398	1	Dunefield	interdune low	sand	Tall shrubland	<i>Myoporum insulare</i> (3), <i>Acacia longifolia</i> var. <i>sophorae</i> (2), <i>Leucopogon parviflorus</i> (T), <i>Exocarpos syrticola</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Billardiera cymosa</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2)
82	GOO00301	14779	23-Sep-96	311062	6061198	5	Dunefield	fore dune	sand	(Tussock) grassland	<i>*Elymus farctus</i> (3), <i>Spinifex sericeus</i> (2),
82	GOO00302	14780	23-Sep-96	311352	6061338	1	Dunefield	dune slope	sand	Shrubland	<i>Myoporum insulare</i> (3), <i>Exocarpos syrticola</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Muehlenbeckia gunnii</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (2)
82	GOO00303	14781	23-Aug-96	311332	6061318	1	Dunefield	dune slope	sand	Shrubland	<i>Myoporum insulare</i> (3), <i>Acacia longifolia</i> var. <i>sophorae</i> (3), <i>Rhagodia candolleana</i> ssp.

Appendix I. (continued)

Svy No.	Site ID	Patch ID	Visit Date	Easting MGA zone 54	Northing MGA zone 54	Plant Group	Land Unit	Landform	Soil	Vegetation Structure	Dominant Plant Species
											<i>candolleana</i> (2), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2)
82	GOO00304	14783	23-Sep-96	311212	6061438	1	Dunefield	dune crest	sand	Shrubland	<i>Myoporum insulare</i> (3), <i>Acacia longifolia</i> var. <i>sophorae</i> (3), <i>Olearia axillaris</i> (2), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (2), <i>Tetragonia implexicoma</i> (2)
82	GOO00305	14782	23-Sep-96	311462	6061358	1	Dunefield	dune	sand	Shrubland	<i>Leucopogon parviflorus</i> (3), <i>Olearia axillaris</i> (3), <i>Myoporum insulare</i> (3), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (2)
82	GOO00401	14814	23-Sep-96	312612	6060468	2	Dunefield	fore dune	sand	Open (tussock) grassland	<i>Spinifex sericeus</i> (3), <i>*Elymus farctus</i> (3), <i>*Euphorbia paralias</i> (3), <i>Stackhousia spathulata</i> (T)
82	GOO00402	14816	23-Sep-96	312672	6060658	1	Dunefield	closed depression	sand	Tall shrubland	<i>Leucopogon parviflorus</i> (4), <i>Olearia axillaris</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (T), <i>Myoporum insulare</i> (T), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (T)
82	GOO00403	14822	23-Sep-96	312932	6060598	1	Parabolic dunefield	dune crest	sand	Shrubland	<i>Myoporum insulare</i> (2), <i>Leucopogon parviflorus</i> (2), <i>Olearia axillaris</i> (2), <i>Alyxia buxifolia</i> (T), <i>Exocarpos syrticola</i> (T)
82	GOO00404	14824	23-Sep-96	312662	6060498	1	Dunefield	closed depression	sand	Shrubland	<i>Myoporum insulare</i> (3), <i>Acacia longifolia</i> var. <i>sophorae</i> (2), <i>Olearia axillaris</i> (2), <i>Leucopogon parviflorus</i> (T)
82	GOO00405	14825	23-Sep-96	312622	6060418	1	Dunefield	fore dune	sand	Low shrubland	<i>Myoporum insulare</i> (2), <i>Olearia axillaris</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (2), <i>Spinifex sericeus</i> (2), <i>Exocarpos syrticola</i> (2), <i>Leucopogon parviflorus</i> (T)
82	GOO00601	15987	22-Oct-97	305042	6064178	1	dunefield	dune slope	sand	Very open shrubland	<i>Olearia axillaris</i> (2), <i>*Ehrharta villosa</i> var. <i>maxima</i> (4), <i>Carpobrotus rossii</i> (1), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (T), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (T), <i>Senecio lautus</i> (T)
82	GOO00602	15988	22-Oct-97	304962	6064458	1	dunefield	dune slope	sand	Open shrubland	<i>Olearia axillaris</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (T), <i>*Ehrharta villosa</i> var. <i>maxima</i> (4), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (T), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (T), <i>Carpobrotus rossii</i> (T)
82	GOO00603	15989	22-Oct-97	304952	6064448	1	dunefield	dune slope	sand	Very open shrubland	<i>Olearia axillaris</i> (2), <i>Acacia longifolia</i> var. <i>sophorae</i> (T), <i>*Ehrharta villosa</i> var. <i>maxima</i> (4), <i>Rhagodia candolleana</i> ssp. <i>candolleana</i> (T), <i>Threlkeldia diffusa</i> (T), <i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i> (T)
93	FRS01301	15687	16-Nov-96	308472	6064028	6	Plain	plain (incl undulating plain)	silty clay loam	(Tussock) grassland	<i>Stipa stipoides</i> (2), <i>Lawrenia squamata</i> (3), <i>Distichlis distichophylla</i> (2), <i>Sclerostegia arbuscula</i> (1), <i>Sarcocornia blackiana</i> (1)
93	FRS02701	15704	20-Dec-96	302572	6065828	8	Tidal flat	beach ridge	medium clay	Tall shrubland	<i>Muehlenbeckia florulenta</i> (2), <i>*Cynodon dactylon</i> (4), <i>Stipa stipoides</i> (2)
136	MUD00101	18264	19-Mar-02	317430	6060500	1	Dunefield	dune crest	sand	Shrubland	<i>Leucopogon parviflorus</i> (3), <i>Olearia axillaris</i> (2), <i>Myoporum insulare</i> (2), <i>Kunzea pomifera</i> (3), <i>Logania ovata</i> (1)
136	MUD00201	18265	19-Mar-02	317380	6060490	1	Dunefield	swale	sand	Sedgeland	<i>Lepidosperma gladiatum</i> (3), <i>Kunzea pomifera</i> (2)
136	MUD00301	18266	19-Mar-02	317270	6060810	6	Dunefield	closed depression	loamy sand	Low shrubland	<i>Atriplex paludosa</i> ssp. <i>cordata</i> (3), <i>Halosarcia indica</i> ssp. <i>leioestachya</i> (3), <i>Sarcocornia blackiana</i> (2), <i>*Paspalum vaginatum</i> (2)
136	MUD00401	18267	21-Mar-02	317020	6061000	10	Tidal flat	swamp	silty clay loam	Closed shrubland	<i>Muehlenbeckia florulenta</i> (5), <i>Kunzea pomifera</i> (3), <i>Logania ovata</i> (1)
136	MUD00402	18276	22-Mar-02	317030	6060900		Dunefield	dune	sand	Shrubland	<i>Leucopogon parviflorus</i> (1), <i>Olearia axillaris</i> (1), <i>Myoporum insulare</i> (1), <i>Kunzea pomifera</i> (1), <i>Logania ovata</i> (1)
136	MUD00501	18268	21-Mar-02	316725	6060990	6	Delta	swamp	heavy clay	Low closed shrubland	<i>Sarcocornia blackiana</i> (5), <i>Suaeda australis</i> (4), <i>Distichlis distichophylla</i> (2)
136	MUD00601	18269	20-Mar-02	317770	6060590	8	Delta	swamp	heavy clay	Closed shrubland	<i>Muehlenbeckia florulenta</i> (4), <i>Suaeda australis</i> (4), <i>Sarcocornia blackiana</i> (3)
136	MUD00701	18270	20-Mar-02	318160	6061950	11	Delta	swamp	heavy clay	Closed sedgeland	<i>Typha domingensis</i> (5), <i>Phragmites australis</i> (4), <i>*Paspalum vaginatum</i> (3), <i>*Berula erecta</i> (1), <i>Hydrocotyle verticillata</i> (1)
136	MUD00801	18271	20-Mar-02	318210	6061950	11	Delta	swamp	heavy clay	Closed sedgeland	<i>Typha domingensis</i> (5), <i>*Paspalum vaginatum</i> (5)
136	MUD00901	18272	20-Mar-02	317900	6061835	8	Delta	closed depression	heavy clay	Low shrubland	<i>Sarcocornia quinqueflora</i> (3), <i>Samolus repens</i> (2), <i>Mimulus repens</i> (T)
136	MUD01001	18273	21-Mar-02	317620	6061985	8	Delta	lunette	silty clay loam	Sedgeland	<i>Juncus sarophorus</i> (3), <i>Sarcocornia quinqueflora</i> (3)
136	MUD01101	18274	21-Mar-02	318650	6061760	11	Delta	swamp	heavy clay	Closed sedgeland	<i>Phragmites australis</i> (5), <i>Typha domingensis</i> (4), <i>*Paspalum vaginatum</i> (3)
136	MUD01201	18275	21-Mar-02	318780	6061845	11	Delta	swamp	heavy clay	Sedgeland	<i>Typha domingensis</i> (4), <i>Schoenoplectus validus</i> (4), <i>*Paspalum vaginatum</i> (4)
136	WYN00401	18255	21-Mar-02	312472	6065754	7	Plain	open depression	silty clay loam	Low shrubland	<i>Sarcocornia quinqueflora</i> (3), <i>Atriplex paludosa</i> ssp. <i>cordata</i> (1), <i>*Vulpia fasciculata</i> (2)
136	WYN00501	18256	19-Mar-02	308319	6065454	9	Plain	open depression	light medium clay	Low shrubland	<i>Halosarcia pergranulata</i> ssp. <i>pergranulata</i> (4), <i>Juncus kraussii</i> (3), <i>Threlkeldia diffusa</i> (3), <i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> (5), <i>Bolboschoenus caldwellii</i> (2), <i>Juncus kraussii</i>
136	WYN00601	18257	20-Mar-02	308437	6065464	9	Flood plain	swamp	medium clay	Very low woodland	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> (5), <i>Bolboschoenus caldwellii</i> (2), <i>Juncus kraussii</i>
136	WYN00701	18258	19-Mar-02	309197	6064250	9	Flood plain	open depression	light medium clay	Sedgeland	<i>Juncus kraussii</i> (3), <i>Muehlenbeckia florulenta</i> (N), <i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> (N), <i>Maireana oppositifolia</i> (2),
136	WYN00801	18259	19-Mar-02	308952	6064158	7	Plain	dune	loamy sand	(Tussock) grassland	
136	WYN00901	18260	20-Mar-02	309121	6066396	11	Flood plain	stream channel	silty clay loam	Sedgeland	<i>Typha domingensis</i> (3), <i>*Paspalum vaginatum</i> (3)
136	WYN01001	18261	21-Mar-02	308411	6067383	7	Plain	open depression	silty clay loam	Sedgeland	<i>Distichlis distichophylla</i> (4), <i>*Puccinellia distans</i> (T),
136	WYN01101	18262	19-Mar-02	309852	6067945	8	Flood plain	open depression	clay loam, sandy	Low shrubland	<i>Sarcocornia quinqueflora</i> (4), <i>Sclerostegia arbuscula</i> (T),
136	WYN01201	18263	20-Mar-02	306506	6069227	1	Rises	dune slope	loamy sand	Low woodland	<i>Allocasuarina verticillata</i> (4), <i>Eucalyptus porosa</i> (1), <i>*Ehrharta calycina</i> (3), <i>*Ammophila arenaria</i> (3), <i>Poa poiformis</i> (3)
136	WYN01301	18251	21-Mar-02	312942	6065753	7	Flood plain	swamp	silty clay loam	Low open forest	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> (3), <i>Triglochin striatum</i> (2), <i>*Paspalum vaginatum</i> (2), <i>*Trifolium fragiferum</i> var. <i>fragiferum</i> (1), <i>Juncus kraussii</i> (1), <i>*Berula erecta</i> (T)

APPENDIX II. Hindmarsh Island Plant List (D Murfett 1996 with subsequent updates to 2002).

FAMILY: Species SA status SL status	Area recorded+
ADIANTACEAE	
<i>Cheilanthes austrotenuifolia</i>	AW
AGAVACEAE	
* <i>Agave americana</i>	VA
AIZOACEAE	
<i>Carpobrotus rossii</i>	44 AP AW CT EC MM
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	44 58 60 CW MM R5 VA
* <i>Galenia pubescens</i> var. <i>pubescens</i>	EC VA
* <i>Mesembryanthemum crystallinum</i>	FR
<i>Tetragonia implexicoma</i>	AP AW C CT CW DA EC FR LH MM R5 VA
AMARANTHACEAE	
<i>Hemichroa pentandra</i> R	CW DA R5 VA
<i>Ptilotus spathulatus</i> forma <i>spathulatus</i> R	AW CW LH
AMARYLLIDACEAE	
<i>Calostemma purpureum</i>	GA VA
* <i>Narcissus jonquilla</i>	C
ASCLEPIADACEAE	
* <i>Gomphocarpus cancellatus</i>	AW CW EC
AVICENNIACEAE	
<i>Avicennia marina</i> var. <i>resinifera</i>	44 planted during the 1940's
AZOLLACEAE	
<i>Azolla filiculoides</i>	EW LR RF VA
<i>A. pinnata</i>	DA GA
BORAGINACEAE	
* <i>Buglossoides arvensis</i>	AP
<i>Cynoglossum australe</i> R	EC MM SS
* <i>Heliotropium europaeum</i>	44 GA VA
CAMPANULACEAE	
<i>Lobelia anceps</i>	DA FR RF
<i>Pratia concolor</i> T	
<i>P. irrigua</i> T	EW GA
<i>Wahlenbergia gracilentia</i>	AP
CARYOPHYLLACEAE	
* <i>Cerastium glomeratum</i>	AP EC
* <i>Minuartia mediterranea</i>	AP AW CT CW EC FR GA LH MM
* <i>Moenchia erecta</i>	AW
* <i>Petrorhagia velutina</i>	CW
* <i>Sagina maritima</i>	MM
* <i>Silene nocturna</i>	AP EC FR LH
* <i>Spergularia marina</i>	CW MM R5
* <i>S. media</i>	44 MM
* <i>Stellaria media</i>	AP AW EC
CASUARINACEAE	
<i>Allocasuarina verticillata</i>	AP AW C CT CW EC LH VA
CENTROLEPIDACEAE	
<i>Centrolepis polygyna</i>	AP CW MM
<i>C. strigosa</i>	AW
CERATOPHYLLACEAE	
<i>Ceratophyllum demersum</i> R K	VA
CHENOPODIACEAE	
<i>Atriplex australasica</i> R R	MM
<i>A. paludosa</i> ssp. <i>cordata</i>	44 MC MM R5 VA
* <i>A. prostrata</i>	EW R5 SW
<i>A. semibaccata</i>	44 60 CW MC SW VA
* <i>Chenopodium glaucum</i>	LR
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	44 57 60 AP AW C CT CW DA EC FR GA MC MM R5 SS SW VA
<i>Halosarcia halocnemoides</i> ssp. <i>halocnemoides</i>	46 57 60 R5
<i>H. indica</i> ssp. <i>bidens</i> K	MM R5 SW
<i>H. indica</i> ssp. <i>leiostachya</i>	60 CW MM R5
<i>H. pergranulata</i> ssp. <i>pergranulata</i>	46 57 58 60 CW MM R5 SW VA
<i>Maireana oppositifolia</i>	CW MC MM R5 VA
<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	44 AP AW C CT CW EC FR LH MM R9 SS VA
<i>Salsola kali</i>	60 CW FR LH MC R5 VA
<i>Sarcocornia blackiana</i>	CW MM
<i>S. quinqueflora</i>	44 58 60 CW DA FR MC MM R5 RF SS SW VA
<i>Sclerostegia arbuscula</i>	44 CW MC MM R5
<i>Suaeda australis</i>	44 46 57 58 60 CW DA FR GA LR MC MM R5 R9 RF SS SW VA
<i>Threlkeldia diffusa</i>	44 AP C CT CW EC FR LH MC MM R5 R9 RF SS VA
COMPOSITAE	
<i>Angianthus preissianus</i> R	CW MM R5
* <i>Arctotheca calendula</i>	AP AW C GA LH MC VA
* <i>Aster subulatus</i>	EW LR MM RF
<i>Brachycome ciliaris</i> var. <i>ciliaris</i>	AP CT EC
<i>B. lineariloba</i> V	EC
* <i>Centaurea aspera</i>	CW VA
* <i>C. calcitrapa</i>	AW CW MM VA
* <i>Chondrilla juncea</i>	AW CW VA
<i>Chrysocephalum apiculatum</i>	AW EC
* <i>Cirsium vulgare</i>	FR LR SS

Appendix II. (continued)

* <i>Conyza bonariensis</i>	SS
* <i>Cotula bipinnata</i>	60
* <i>C. coronopifolia</i>	AW EW GA LR
<i>C. vulgaris</i> var. <i>australasica</i> K	60 CW R5
* <i>Cynara cardunculus</i>	VA
* <i>Dittrichia graveolens</i>	VA
* <i>Gazania linearis</i>	FR VA
<i>Gnaphalium indutum</i> R	EC MM
* <i>Hedypnois rhagadioloides</i>	CT FR LH
<i>Helichrysum leucopsidium</i> U	AW CW LH VA
<i>H. scorpioides</i>	AW
* <i>Hypochaeris glabra</i>	AP AW CW EC LH
* <i>H. radicata</i>	AW CW FR GA LH MM R9 SS VA
* <i>Lactuca serriola</i>	44 SS VA
<i>Leptorhynchos squamatus</i>	AW FR LH VA
<i>Leucophyta brownii</i>	FR
<i>Millotia muelleri</i>	EC
<i>M. tenuifolia</i> var. <i>tenuifolia</i>	AP
<i>Minuria leptophylla</i>	LH
<i>Olearia axillaris</i>	44 AP CT CW EC FR LH MM SS VA
<i>O. ramulosa</i>	AP EC
<i>Ozothamnus turbinatus</i> V	FR
<i>Picris angustifolia</i> ssp. <i>angustifolia</i> K	MM
<i>P. squarrosa</i> R E	FR
* <i>Reichardia tingitana</i>	44 AP AW CW FR GA LH MC MM R5 SS VA
<i>Senecio glomeratus</i>	DA
<i>S. glossanthus</i>	44 60 AP CW EC MM R5
<i>S. lautus</i>	AP EC
<i>S. picridioides</i>	EC
* <i>S. pterophorus</i> var. <i>pterophorus</i>	AP EC SS
<i>S. tenuiflorus</i>	AP
* <i>Sonchus asper</i> ssp. <i>glaucescens</i>	44 GA MM VA
<i>S. hydrophilus</i>	44 EW FR GA LR R5 RF SS VA
* <i>S. oleraceus</i>	AP C EC FR GA LH MC R5 VA
* <i>Urospermum picroides</i>	CT FR
<i>Vittadinia australasica</i> var. <i>australasica</i> R	AP AW CT CW EC FR LH VA
<i>V. blackii</i> R	CW
<i>V. cervicalis</i> var. <i>cervicalis</i>	AW
<i>V. cuneata</i>	AW EC
<i>V. gracilis</i>	AW
<i>V. megacephala</i> R	EC VA
CONVOLVULACEAE	
<i>Calystegia sepium</i> U	DA FR GA LR RF VA
<i>Convolvulus erubescens</i>	FR LH VA
<i>C. remotus</i>	AW
<i>Wilsonia backhousei</i> V	44 46 57 58 60 MM R5 R9 SS SW
<i>W. humilis</i> var. <i>humilis</i> U	44 57 MM R5 VA
<i>W. rotundifolia</i> V	58
CRASSULACEAE	
* <i>Cotyledon orbiculata</i> var. <i>orbiculata</i>	C
<i>Crassula colorata</i> var. <i>acuminata</i>	AW CW
<i>C. decumbens</i> var. <i>decumbens</i>	44 60 AP AW CW GA SS
<i>C. helmsii</i> R	DA EW GA LR
* <i>C. natans</i> var. <i>minus</i>	AW
<i>C. sieberiana</i> ssp. <i>tetramera</i>	AP AW CW EC GA LH MM SS VA
CRUCIFERAE	
* <i>Brassica tournefortii</i>	44 AP AW C CT CW FR GA LH MC VA
* <i>Cakile maritima</i> ssp. <i>maritima</i>	MM R5 VA
* <i>Diplotaxis muralis</i> var. <i>muralis</i>	FR VA
* <i>D. tenuifolia</i>	GA LH VA
* <i>Hymenolobus procumbens</i>	CW R5
* <i>Lepidium africanum</i>	GA SW VA
* <i>Rapistrum rugosum</i> ssp. <i>rugosum</i>	VA
* <i>Rorippa palustris</i>	EW LR
CUPRESSACEAE	
<i>Callitris gracilis</i> U	VA
CYPERACEAE	
<i>Baumea juncea</i>	AW C LH VA
<i>Bolboschoenus caldwellii</i>	44 EW GA MM R5 VA
<i>B. medianus</i> R	FR LR
<i>Carex appressa</i>	RF
<i>C. fascicularis</i> U	LR
<i>Cyperus gymnocaulos</i>	DA EW FR GA LR VA
<i>Eleocharis acuta</i>	EW GA LR RF VA
<i>Gahnia deusta</i> R	AP AW CT CW EC FR LH VA
<i>G. filum</i> R	CW MM VA
<i>G. lanigera</i> R	AW FR LH
<i>Isolepis cernua</i>	DA EW LR
<i>I. inundata</i>	GA LR VA
<i>I. marginata</i>	AW

Appendix II. (continued)

<i>I. nodosa</i>	44 AP AW C CW EC FR LH MM R5 R9 RF SS VA
<i>Lepidosperma carphoides</i>	AW CW LH
<i>L. concavum</i>	AW
<i>L. congestum</i>	AP AW CT CW FR LH
<i>Schoenoplectus litoralis</i> U	RF
<i>S. pungens</i> U	EW FR GA RF SS VA
<i>S. validus</i>	FR GA LR RF VA
<i>Schoenus breviculmis</i>	AW
<i>S. nitens</i> R	C MM R9 SS
DILLENIACEAE	
<i>Hibbertia riparia</i>	AW
<i>H. sericea</i> R	AP CT CW EC FR LH
DIPSACACEAE	
* <i>Scabiosa atropurpurea</i>	AP AW C CT CW EC FR LH MM R5 RF VA
DROSERACEAE	
<i>Drosera glanduligera</i>	AW
<i>D. whittakeri</i> ssp. <i>whittakeri</i>	AW
DRYOPTERIDACEAE	
* <i>Cyrtomium falcatum</i>	FR
EPACRIDACEAE	
<i>Acrotriche affinis</i> R	FR
<i>Leucopogon parviflorus</i>	AP CT CW EC FR VA
EUPHORBIACEAE	
<i>Adriana quadripartita</i> U	AW C VA
* <i>Euphorbia terracina</i>	44 AP AW C CT CW EC FR GA LH MM R5 R9 RF SS VA
<i>Poranthera triandra</i> R	FR
FRANKENIACEAE	
<i>Frankenia pauciflora</i> var. <i>gunnii</i>	44 46 57 58 60 CW DA MC MM R5 R9 SS SW VA
GENTIANACEAE	
* <i>Centaurium erythraea</i>	AW EC
* <i>C. tenuiflorum</i>	AP FR
<i>Sebaea ovata</i>	FR
GERANIACEAE	
* <i>Erodium botrys</i>	AW CW GA
* <i>E. cicutarium</i>	CW
* <i>E. moschatum</i>	CW
* <i>Geranium molle</i> var. <i>molle</i>	EC
<i>G. potentilloides</i> var. <i>potentilloides</i> K	AP C CW FR LH MM SS VA
<i>Pelargonium australe</i> U	AW R9 SS VA
<i>P. littorale</i>	AW
GOODENIACEAE	
<i>Goodenia geniculata</i>	AW
<i>G. varia</i> K	AP FR LH
<i>Scaevola aemula</i> E	LH
<i>Selliera radicans</i> R	GA R5
<i>Velleia arguta</i> R	FR LH
GRAMINEAE	
<i>Agrostis avenacea</i>	EW FR LR RF VA
<i>A. billardieri</i> var. <i>billardieri</i>	FR SS
* <i>Aira cupaniana</i>	AP AW EC
* <i>Ammophila arenaria</i>	VA
<i>Amphipogon caricinus</i> var. <i>caricinus</i> U	AW
<i>Austrodanthonia auriculata</i>	AW
<i>A. caespitosa</i>	AW C CT CW EC FR GA LH MM R5 SS VA
<i>A. geniculata</i>	AW
<i>A. setacea</i>	AP AW FR
<i>Austrostipa acrociliata</i> R	AW CW LH
<i>A. drummondii</i>	AW CW EC MM VA
<i>A. echinata</i> R T	FR LH
<i>A. elegantissima</i> U	AP AW C EC
<i>A. flavescens</i>	44 46 57 AP AW C CT CW EC FR GA MC MM R5 SS VA
<i>A. mollis</i>	AW CW EC LH
<i>A. mundula</i> R	CW EC
<i>A. nitida</i>	GA VA
<i>A. nodosa</i>	CT CW GA R5 VA
<i>A. puberula</i> R R	R5
<i>A. scabra</i> ssp. <i>falcata</i>	AP AW C CT LH
<i>A. stipoides</i> R	44 MC MM R9 SS
<i>A. tenuifolia</i> R V	AW CW EC LH
* <i>Avellinia michelii</i>	AW FR LH
* <i>Avena barbata</i>	44 AP C CT CW EC FR GA LH MC MM R5 RF VA
* <i>A. fatua</i>	C
* <i>Brachypodium distachyon</i>	AW CT LH
* <i>Briza maxima</i>	AP AW CT EC FR VA
* <i>B. minor</i>	AW FR VA
* <i>Bromus diandrus</i>	44 AW C CT CW FR GA LH MC MM R5 RF SS VA
* <i>B. hordeaceus</i> ssp. <i>hordeaceus</i>	C FR GA LR VA
* <i>B. rubens</i>	FR MM RF VA
* <i>Catapodium rigidum</i>	CT CW EC FR LH MM VA
* <i>Critesion maritimum</i>	44 AW CW GA LR MC MM R5 SW VA

Appendix II. (continued)

* <i>C. murinum</i> ssp. <i>leporinum</i>	AW FR GA R5 VA
* <i>Cynodon dactylon</i> var. <i>dactylon</i>	44 AW FR GA LH MC SS VA
* <i>Dactylis glomerata</i>	VA
* <i>Digitaria sanguinalis</i>	VA
<i>Distichlis distichophylla</i>	44 46 57 58 60 AW C CW DA EW FR GA LR MC MM R5 RF SS SW A
* <i>Ehrharta calycina</i>	AP AW C CT CW FR GA LH RF VA
* <i>E. longiflora</i>	AP AW EC
* <i>E. villosa</i> var. <i>maxima</i>	CW FR SS VA
<i>Elymus scaber</i> var. <i>scaber</i>	AP AW CT EC FR
<i>Enneapogon nigricans</i>	AW CW GA
* <i>Eragrostis cilianensis</i>	VA
* <i>Festuca arundinacea</i>	EW GA VA
* <i>Hainardia cylindrica</i>	AW
* <i>Holcus lanatus</i>	FR
* <i>Lagurus ovatus</i>	44 AP AW C CT CW EC FR GA LH MC MM R5 RF SS VA
* <i>Lolium rigidum</i>	AP AW C FR GA LH MC MM R5
* <i>Panicum capillare</i> var. <i>brevifolium</i>	VA
<i>P. effusum</i> var. <i>effusum</i> K	AW
* <i>Parapholis incurva</i>	CW FR GA MC MM R5
* <i>Paspalum dilatatum</i>	VA
* <i>P. distichum</i>	EW
* <i>P. vaginatum</i>	44 EW FR GA LR MM R5 RF
* <i>Pennisetum clandestinum</i>	C LR VA
* <i>P. villosum</i>	VA
* <i>Pentaschistis airoides</i>	AW
* <i>Phalaris aquatica</i>	VA
<i>Phragmites australis</i>	44 DA EW FR GA LR MM R5 RF VA
* <i>Piptatherum miliaceum</i>	VA
* <i>Poa annua</i>	VA
* <i>P. bulbosa</i>	AP CT CW LH
<i>P. labillardieri</i> var. <i>labillardieri</i>	AW
<i>P. poiformis</i>	AW C CW FR LH MM SS VA
* <i>Polypogon maritimus</i>	MM
* <i>P. monspeliensis</i>	EW GA LR
* <i>Puccinellia distans</i>	MM VA
<i>P. stricta</i> var. <i>perlaxa</i>	DA VA
<i>P. stricta</i> var. <i>stricta</i>	46 57 58 60 CW DA MC MM R5
* <i>Rostraria cristata</i>	CW EC FR LH MM VA
* <i>Setaria verticillata</i>	VA
<i>Spinifex sericeus</i>	MM
* <i>Sporobolus indicus</i> var. <i>capensis</i>	FR VA
<i>S. virginicus</i>	44 MC MM R5 R9 SW
* <i>Stenotaphrum secundatum</i>	44 C CT FR LH MM RF SS VA
<i>Themeda triandra</i>	AW
* <i>Thinopyrum junceiforme</i>	MM R5
<i>Triodia compacta</i> R	LH
* <i>Vulpia bromoides</i>	AW
* <i>V. fasciculata</i>	AW CW FR GA LH MM VA
* <i>V. myuros</i> forma <i>myuros</i>	AP AW CW EC FR LH MM
HALORAGACEAE	
<i>Gonocarpus tetragynus</i>	AW
<i>Haloragis acutangula</i>	VA
<i>Myriophyllum caput-medusae</i> R	DA EW GA LR RF VA
HYDROCHARITACEAE	
<i>Vallisneria spiralis</i> T	DA EW
HYPOXIDACEAE	
<i>Hypoxis glabella</i> var. <i>glabella</i>	AP AW C EC FR MM
IRIDACEAE	
* <i>Chasmanthe floribunda</i> var. <i>floribunda</i>	C
* <i>Ferraria crispa</i> ssp. <i>crispa</i>	C
* <i>Gladiolus carneus</i>	C
* <i>Gynandris setifolia</i>	AP AW CW MC MM
* <i>Homeria flaccida</i>	AW
* <i>Romulea minutiflora</i>	AW C
* <i>R. rosea</i> var. <i>australis</i>	AW
* <i>Tritonia lineata</i>	C
* <i>Watsonia meriana</i> cv. <i>Bulbillifera</i>	C
JUNCACEAE	
* <i>Juncus acutus</i>	EW
<i>J. bufonius</i>	60 CW MM R5
<i>J. kraussii</i>	44 DA EW FR GA LR MC MM R5 R9 RF SS SW VA
<i>J. sarophorus</i>	DA FR LR
<i>Luzula meridionalis</i>	AW
JUNCAGINACEAE	
<i>Triglochin centrocarpum</i>	AW CW MM R5
<i>T. mucronatum</i> K	60 CW MM R5
<i>T. procerum</i> U	DA EW FR GA LR VA
<i>T. striatum</i>	44 57 58 DA EW FR GA LR MC MM R5 R9 RF SS SW VA
LABIATAE	
<i>Lycopus australis</i> R	DA FR GA LR RF VA

Appendix II. (continued)

* <i>Marrubium vulgare</i>	AW CW FR LH MC VA
* <i>Mentha x piperita</i>	FR VA
* <i>Salvia verbenaca</i> var. <i>verbenaca</i> 44	AW CT CW EC FR GA MC VA
LEGUMINOSAE	
<i>Acacia cupularis</i> R	44 AP AW C CT CW EC FR LH RF SS VA
* <i>A. cyclops</i>	44 AP CW EC FR MM VA
<i>A. dodonaeifolia</i> R R	AW EC VA
<i>A. longifolia</i> ssp. <i>sophorae</i>	44 AP CT CW EC FR MM R9 RF SS VA
<i>A. paradoxa</i>	CT CW VA
<i>A. pycnantha</i>	AP AW CT CW EC VA
* <i>A. saligna</i>	CW FR MM VA
<i>A. spinescens</i>	AW CW
<i>Daviesia arenaria</i> K	AW CW VA
<i>Dillwynia hispida</i>	AW
* <i>Dipogon lignosus</i>	AP CT
<i>Glycine clandestina</i> var. <i>sericea</i>	AW CW VA
<i>Kennedia prostrata</i>	44 AP AW CT CW EC FR LH MM SS VA
<i>Lotus australis</i> U	AP SS
* <i>Lupinus cosentinii</i>	AW
* <i>Medicago littoralis</i>	FR
* <i>M. minima</i> var. <i>minima</i>	AP EC
* <i>M. polymorpha</i> var. <i>polymorpha</i>	C CW FR GA LH MC MM R5 VA
* <i>M. sativa</i> ssp. <i>sativa</i>	AW CT CW MC VA
* <i>M. truncatula</i>	C CT EC MM
* <i>Melilotus indica</i>	44 AP EC EW FR MC MM R5 VA
<i>Pultenaea densifolia</i> V	FR LH
<i>P. tenuifolia</i> R	AP AW CT CW EC FR LH VA
* <i>Retama raetam</i>	VA
* <i>Trifolium angustifolium</i>	AW
* <i>T. arvense</i> var. <i>arvense</i>	AP AW CW GA
* <i>T. campestre</i>	AP AW C CT EC FR VA
* <i>T. fragiferum</i> var. <i>fragiferum</i>	EW LR
* <i>T. repens</i>	FR GA
* <i>T. scabrum</i>	AW CT CW EC FR GA LH VA
* <i>Vicia sativa</i> ssp. <i>nigra</i>	EC FR
LEMNACEAE	
<i>Lemna disperma</i>	EW
<i>L. trisulca</i>	EW VA
<i>Spirodela punctata</i> R	EW VA
<i>Wolffia australiana</i>	EW VA
LILIACEAE	
* <i>Aloe saponaria</i>	AP C CT FR
<i>Arthropodium fimbriatum</i>	AW GA
<i>A. strictum</i>	AW CW LH
* <i>Asparagus asparagoides</i>	AP AW C CT EC
* <i>A. officinalis</i>	AW
* <i>Asphodelus fistulosus</i>	AP AW CT CW EC FR LH R5 SS VA
<i>Caesia calliantha</i>	AW
<i>Dianella brevicaulis</i>	44 AP AW C CT CW EC FR LH MM R5 SS VA
<i>D. revoluta</i> var. <i>revoluta</i>	CW
* <i>Ipheion uniflorum</i>	VA
<i>Lomandra collina</i> R	CW FR LH
<i>L. densiflora</i>	AW CW LH
<i>L. effusa</i> R	AW FR LH MM
<i>L. juncea</i> U	AW CW
<i>L. micrantha</i> ssp. <i>micrantha</i>	AP AW CW EC FR LH
<i>L. micrantha</i> ssp. <i>tuberculata</i>	AW
<i>L. nana</i>	AW
<i>L. sororia</i> U	AW CW
* <i>Ornithogalum arabicum</i>	C FR
* <i>Scilla hyacinthoides</i>	C
<i>Thysanotus patersonii</i>	AW
<i>Tricoryne tenella</i>	AP AW CT CW EC LH
<i>Wurmbea dioica</i> ssp. <i>dioica</i>	44 AP EC
<i>Xanthorrhoea semiplana</i> ssp. <i>sempi plana</i>	AW
LIMONIACEAE	
* <i>Limonium binervosum</i>	44 MC MM R9 SS VA
* <i>L. companyonis</i>	MM VA
LINACEAE	
<i>Linum marginale</i>	AP EC FR
LOGANIACEAE	
<i>Logania linifolia</i> R	AP EC LH
<i>L. minor</i> T	FR
LORANTHACEAE	
<i>Amyema melaleuca</i> K	VA
<i>Lysiana exocarpi</i> ssp. <i>exocarpi</i>	AW
LYTHRACEAE	
<i>Lythrum hyssopifolia</i>	FR LR
MALVACEAE	
* <i>Lagunaria patersonii</i>	EC FR

Appendix II. (continued)

* <i>Lavatera arborea</i>	44 C
<i>L. plebeia</i> U	VA
<i>Lawrenzia spicata</i> K	VA
<i>L. squamata</i> K	44 58 60 CW MM R5 R9 SS SW VA
* <i>Malva parviflora</i>	VA
MYOPORACEAE	
<i>Myoporum insulare</i>	44 AP CT EC MM R5 SS VA
<i>M. parvifolium</i> R V	C
MYRTACEAE	
<i>Calytrix tetragona</i>	AW
* <i>Eucalyptus gomphocephala</i>	AP C CT VA
<i>E. incrassata</i> U	CW EC
<i>E. porosa</i> U	AW CW EC
<i>Kunzea pomifera</i> U	AW C CW
<i>Leptospermum lanigerum</i> U	VA
<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> V	44 58 DA LR MM VA
<i>M. lanceolata</i> ssp. <i>lanceolata</i> U	AW C DA VA
OLEACEAE	
* <i>Olea europaea</i> ssp. <i>europaea</i>	AP AW C CT EC FR LH R5 VA
ONAGRACEAE	
<i>Epilobium billardierianum</i> ssp. <i>billardierianum</i>	DA RF VA
<i>E. billardierianum</i> ssp. <i>cinereum</i> U	RF
<i>E. pallidiflorum</i> U	EW FR GA LR
* <i>Ludwigia peploides</i> ssp. <i>montevidensis</i>	EW GA LR
* <i>Oenothera stricta</i> ssp. <i>stricta</i>	AW CW GA SS VA
<i>Ophioglossum lusitanicum</i> U	AW
ORCHIDACEAE	
<i>Caladenia latifolia</i> U	AP
<i>Corybas diemenicus</i>	AP
<i>C. expansus</i> E	AP CT EC VA
<i>Cyrtostylis robusta</i>	AP CT EC VA
<i>Eriochilus cucullatus</i>	AP
<i>Microtis arenaria</i>	AP EC VA
<i>Pterostylis curta</i> R R	EC
<i>P. nana</i>	EC
<i>P. nutans</i>	AP
<i>Thelymitra luteocilium</i>	AP
<i>T. pauciflora</i>	AP
<i>T. rubra</i>	AP
OXALIDACEAE	
* <i>Oxalis hirta</i>	C
<i>O. perennans</i>	AP AW EC FR LH
* <i>O. pes-caprae</i>	AP AW C CT CW FR MM R9 SS VA
PINACEAE	
* <i>Pinus halepensis</i>	44 AP C CT CW EC FR LH VA
* <i>P. radiata</i>	VA
PITTOSPORACEAE	
<i>Billardiera cymosa</i>	AP AW CW EC LH
<i>Bursaria spinosa</i> ssp. <i>spinosa</i>	AW C CW FR LH VA
PLANTAGINACEAE	
* <i>Plantago bellardii</i>	AW CT CW EC
* <i>P. coronopus</i>	44 CW EW FR GA LH LR MC MM R5 R9 SS SW VA
* <i>P. lanceolata</i> var. <i>lanceolata</i>	C CT CW VA
POLYGALACEAE	
<i>Comesperma volubile</i>	AW CW FR LH
* <i>Polygala myrtifolia</i>	AP
POLYGONACEAE	
* <i>Acetosella vulgaris</i>	GA
* <i>Emex australis</i>	VA
<i>Muehlenbeckia florulenta</i> R	44 DA EW FR LR MM R5 R9 RF SS
<i>M. gunnii</i>	44 AP AW C CT CW DA EC FR LH MM R5 RF SS
<i>Persicaria decipiens</i>	EW FR GA LR
* <i>Polygonum aviculare</i>	GA
<i>Rumex bidens</i> K	FR
* <i>R. conglomeratus</i>	EW LR
* <i>R. crispus</i>	EW FR GA VA
PORTULACACEAE	
<i>Calandrinia calypttrata</i> U	AW
<i>C. eremaea</i> U	AW
POTAMOGETONACEAE	
* <i>Potamogeton pectinatus</i>	EW
<i>Ruppia tuberosa</i>	60
PRIMULACEAE	
* <i>Anagallis arvensis</i>	AW CT FR VA
<i>Samolus repens</i> U	44 57 58 60 DA EW FR GA LR MC MM R5 R9 RF SS SW VA
PROTEACEAE	
<i>Hakea mitchellii</i> R	AP VA
<i>H. vittata</i> K	AW CW
RANUNCULACEAE	
<i>Clematis microphylla</i>	AP AW C CT CW EC FR LH MM SS

Appendix II. (continued)

<i>Ranunculus amphitrichus</i> R	DA EW FR GA LR
RHAMNACEAE	
<i>Cryptandra tomentosa</i>	AW
<i>Pomaderris paniculosa</i> ssp. <i>paniculosa</i> U	AW CW FR LH
* <i>Rhamnus alaternus</i>	AP CT EC LH VA
ROSACEAE	
<i>Acaena echinata</i>	AP AW CW EC LH MM SS
* <i>Rosa canina</i>	EC
RUBIACEAE	
* <i>Coprosma repens</i>	FR MM VA
<i>Galium compactum</i>	FR LH
<i>G. gaudichaudii</i>	EC LH
<i>G. migrans</i>	AP
* <i>G. murale</i>	AP AW CT EC FR
<i>Opercularia turpis</i>	AP FR LH
* <i>Sherardia arvensis</i>	CW FR VA
RUTACEAE	
<i>Correa alba</i> var. <i>pannosa</i> R R	AP CW VA
SALICACEAE	
* <i>Salix babylonica</i>	FR VA
SANTALACEAE	
<i>Exocarpos sparteus</i> R	AW
<i>E. syrticola</i> K	FR MM VA
SAPINDACEAE	
<i>Dodonaea viscosa</i> ssp. <i>spatulata</i>	AP AW C CT EC
SCROPHULARIACEAE	
<i>Mimulus repens</i> R	57 EW R5 RF VA
<i>Veronica hillebrandii</i> K	FR
* <i>Zaluzianskya divaricata</i>	AW
SOLANACEAE	
* <i>Lycium ferocissimum</i>	44 AP AW C CT CW EC FR LH MM R5 VA
* <i>Nicotiana glauca</i>	VA
* <i>Solanum linnaeanum</i>	AW CW VA
STACKHOUSIACEAE	
<i>Stackhousia aspericocca</i> ssp. "One-sided inflorescence" (W.R.Barker 697)	LH
STYLIDIACEAE	
<i>Levenhookia dubia</i>	AP AW
THYMELAEACEAE	
<i>Pimelea glauca</i>	44 AW C CW FR LH SS
<i>P. serpyllifolia</i> ssp. <i>serpyllifolia</i>	44 AP AW C CT CW EC FR GA LH MM R5 R9 RF SS VA
TYPHACEAE	
<i>Typha domingensis</i>	DA EW FR GA LR RF VA
<i>T. orientalis</i> R	GA
UMBELLIFERAE	
<i>Apium annuum</i> R	MM R5
<i>A. prostratum</i> ssp. <i>prostratum</i>	44 MC MM R5 SS
* <i>Berula erecta</i>	EW FR GA LR RF
* <i>Bupleurum semicompositum</i>	FR LH MM
<i>Centella asiatica</i> U	FR RF
<i>Daucus glochidiatus</i>	AP EC FR VA
<i>Hydrocotyle capillaris</i> R	AP MM
<i>H. medicaginoides</i> E	MM R5
<i>H. verticillata</i> K	DA EW FR GA LR
<i>Lilaeopsis polyantha</i> V	EW
URTICACEAE	
<i>Parietaria debilis</i>	AW EC VA
<i>Urtica incisa</i> R	EW New SL Record
ZANNICHELLIACEAE	
<i>Lepilaena cylindrocarpa</i>	57 CW MM R5 SW
ZYGOPHYLLACEAE	
<i>Nitraria billardierei</i>	44 FR R5 VA
* <i>Tribulus terrestris</i>	VA
<i>Zygophyllum billardierei</i> R	44 FR LH

+ Cat.	Name	Indigenous sp.	Alien sp.	Total
44	Section 44	43	22	65
46	Section 46	8	-	8
57	Section 57	14	-	14
58	Section 58	13	-	13
60	Section 60	21	-	21
AP	Another Pine Block	68	41	109
AW	Allocasuarina Woodland	106	59	165
C	Cemetery	28	37	65
CT	Central Pines Track	33	34	67
CW	Central Woodland	86	48	134
DA	The Dairy	33	-	33
EC	East Central Pines	64	39	103
EW	Eastern Wetlands	31	17	48

Appendix II. (continued)

FR	Ferrymans Reserve	85	67	152
GA	Galifrey	38	39	77
LH	Limestone Hill	59	36	95
LR	Lucas Road Reserve	30	15	45
MC	Mundoo Channel Reserve	19	19	38
MM	Murray Mouth Cons. area	67	41	108
R5	Res. 5, sec 18 & 23	51	23	74
R9	Reserve No 9	17	5	22
RF	River Frontage	31	11	42
SS	Southern Scrubland	40	17	57
SW	Southern Wetland	15	4	19
VA	Misc Locations eg. rd sides	95	89	184
TOTAL		279	182	461

Summary:

SA Conservation Status

R 10

Regional Conservation Status

SL

E 4

K 17

R 46

T 5

U 30

V 9

Surveyor/Source: **D.E. Murfet**

Survey dates: 11/2/96 30/5/96 15/6/96 24/8/96 12/10/96 23/11/96 21/12/96 27/12/96 16/8/97 29/12/97 21/3/98 9/9/99 5/3/00 23/9/00 4/8/01
6/11/01 12/9/02

Regional Conservation Status¹

X Presumed extinct: not recorded for more than 50 years

E Endangered: rare and in danger of becoming extinct

V Vulnerable: rare and at risk from potential threats in the long term

T Threatened: rare and likely to become either endangered or vulnerable

R Rare: having a low overall frequency, confined to a restricted range or scattered sparsely over a wider area

K Uncertain: either threatened or rare but insufficient data for a more precise assessment

U Uncommon: less common species but not rare

Q Not yet assessed but flagged as being of possible significance

N Not of particular significance

¹ Lang, P.J. & Kraehenbuehl, D.N. *Plants of Particular Conservation Significance in South Australia's Agricultural Regions: Interim Report* S.A. Department of Environment & Planning June 1987 (January 2000 updated ratings)

APPENDIX III. Aquatic flora list for Hindmarsh Island (Renfrey *et al.* 1989).

Family	Species
Aizoaceae	<i>Carpobrotus rossii</i> <i>Disphyma crassifolium</i>
Amaranthaceae	<i>Hemichroa pentandra</i>
Avicenniaceae	<i>Avicenna marina</i>
Azollaceae	<i>Azolla filiculoides</i>
Campanulaceae	<i>Pratia platycalyx</i>
Ceratophyllaceae	<i>Ceratophyllum demersum</i>
Characeae	<i>Lamprothamnium papulosum</i>
Chenopodiaceae	<i>Atriplex paludosa</i> <i>A. semibaccata</i> <i>Enchylaena tomentosa</i> <i>Halosarcia sp.</i> <i>Maireana oppositifolia</i> <i>Rhagodia candolleana</i> <i>Sarcocornia quinqueflora</i> <i>Suaeda australis</i> <i>Threlkeldia diffuses</i>
Compositae	* <i>Aster subulatus</i> * <i>Cotula coronipifolia</i>
Convolvulaceae	<i>Calystegia sepium</i> <i>Wilsonia backhousei</i> <i>W. humilis</i> <i>W. rotundifolia</i>
Crassulaceae	<i>Crassula helmsii</i>
Cruciferae	* <i>Cakile maritima</i>
Cyperaceae	<i>Baumea juncea</i> <i>Bolboschoenus medianus</i> <i>Cyperus gymnocaulos</i> <i>Eleocharis acuta</i> <i>Gahnia trifida</i> <i>Isolepis nodosa</i> <i>I. platycarpa</i> <i>I. sp.</i> <i>Schoenoplectus litoralis</i> <i>S. pungens</i>
Euphorbiaceae	* <i>Euphorbia terracina</i>
Frankeniaceae	<i>Frankenia sp.</i>
Goodeniaceae	<i>Scaevola calendulacea</i> <i>Selliera radicans</i>
Gramineae	<i>Agrostis avenaceae</i> * <i>Cynodon dactylon</i> <i>Distichlis distichophylla</i> * <i>Festuca arundinacea</i> * <i>Hordeum marinum</i> * <i>Lolium perenne</i> * <i>Parapholis incurva</i> * <i>Paspalum distichum</i> * <i>Pennisetum clandestinum</i> <i>Phragmites australis</i> * <i>Polypogon monspeliensis</i> * <i>Puccinella fasciculata</i>
Haloragaceae	<i>Myriophyllum sp.</i>
Juncaceae	* <i>Juncus articulatus</i> <i>J. continuus</i> <i>J. holoschoenus</i> <i>J. pallidus</i> <i>Vallisneria spiralis</i>
Juncaginaceae	<i>Triglochin procerum</i> <i>T. striatum</i>

Appendix III. (continued)

Labiatae	<i>Mentha australis</i> <i>Mentha</i> * <i>piperita</i> * <i>Marrubium vulgare</i>
Limoniaceae	* <i>Limonium binervosum</i>
Leguminosae	* <i>Medicago sativa</i> * <i>M. sp.</i>
Lythraceae	<i>Lythrum hyssopifolia</i> * <i>L. junceum</i>
Myrtaceae	<i>Melaleuca halmaturorum</i>
Onagraceae	<i>Epilobium billardieranum</i> <i>E. hirtigerum</i> <i>E. pallidiflorum</i> * <i>Ludwigia peploides</i>
Polygonaceae	* <i>Polygonum salicifolium</i> <i>Muehlenbeckia cunninghamii</i> * <i>Rumex conglomeratus</i> * <i>R. crispus</i>
Primulaceae	<i>Samolus repens</i>
Ranunculaceae	<i>Ranunculus rivularis</i>
Ruppiaceae	<i>Ruppia sp</i>
Scrophulariaceae	<i>Mimulus repens</i> <i>Limosella australis</i>
Typhaceae	<i>Typha domingensis</i>
Umbelliferae	* <i>Apium graveolens</i> * <i>Berula erecta</i> <i>Hydrocotyle verticillata</i>

APPENDIX IV. Brief Description of habitats available to birds on Hindmarsh Island (Paton *et al.* 1989).

AGRTICULTURAL AREAS: consist mainly of open paddocks with natural pastures, cereal crops, dryland and irrigated lucerne. Few natural trees and shrubs remain but there are scattered plantings of trees and shelter belts both in open paddocks and in close proximity to farm buildings.

WOODLAND HABITATS: exist in a limited area on Hindmarsh Island on higher ground north of Randell and Grundy Roads. The main areas are of naturalized Aleppo Pine (*Pinus halapensis*) with little or no associated understorey. A small remnant Drooping Sheoak (*Allocasuarina verticillata*) woodland occurs near Canowindra and this too has a sparse understorey.

FRESHWATER HABITATS: on Hindmarsh Island are associated with the shallow open waters of the lower Murray River. They are characterised by areas of reedbeds of variable width that line the channels and areas of open water. The reedbeds consist of *Typha* sp. With variable amounts of smaller rushes and sedges. In some places tea-tree (*Melaleuca*) and lignum are interspersed with reeds. A zone of sedges and samphire occurs on the landward side of the reedbeds in many areas. These freshwater habitats occur around the western, northern and eastern shores of the island and also line the natural channels and shallow swamps that infiltrate the eastern half of the island. Water levels in these freshwater habitats are controlled by the barrages and therefore do not vary greatly. Amongst the housing on the northern shore many of the reedbeds have been fragmented by access channels and private jetties or replaced with lawn or grassy verges.

ESTUARINE MUDFLATS AND ROCKY OUTCROPS: occur along the southern shore of Hindmarsh Island below the Barrages and are exposed at low tide. Immediately landward of these mudflats is fringing vegetation of sedges, rushes, samphire and scattered lignum clumps. Away from the land the water levels deepen and become suitable for birds that take fish or dive for food.

SAMPHIRE DEPRESSIONS: and dry clay pans occur in all low-lying areas of the island. These are usually dry but may fill with water following heavy winter rains or be flooded by man.

SEMI-URBAN AREAS: include the gardens and buildings associated with houses along the northern shore on the western third of the island and on the south-eastern corner of the island. The buildings and associated plantings of shrubs and trees provide terrestrial habitats for a variety of birds commonly associated with urban developments.

APPENDIX V. Reptile and frog species detected by the South Australian Herpetology Group on Hindmarsh Island (Milne and Matejcic 2001).

Species	Common Name	Location and number observed			
		1	2	3	4
<i>Pogona barbatus</i>	Coastal Bearded Dragon	2			
<i>Christinus marmoratus</i>	Marble Gecko	3			
<i>Aprasia striolata</i>	Striped Worm Lizard	6			
<i>Ctenotus robustus</i>	Eastern Striped Skink				1
<i>Hemiergis peronii</i>	Four-toed Earless Skink	2	1		1
<i>Lerista bougainvillii</i>	Bougainville's Skink	2			1
<i>Lerista dorsalis</i>	Southern Four-toed Slider	1			
<i>Menetia greyii</i>	Dwarf Skink	1			
<i>Tiliqua rugosa</i>	Sleepy Lizard	2			
<i>Pseudonaja textilis</i>	Eastern Brown Snake	3	1		
<i>Crinia signifera</i>	Common Froglet				1
<i>Litoria ewingii</i>	Brown Tree Frog	1 call			

1=Tarni Wara, 2= Ann Swan's, 3=Paula Horbelt, 4=opportunistic capture at other locations

APPENDIX VI. All plant taxa recorded at sites in alphabetical order by family and species. Numbers relate to the number of sites at which each species was recorded for each survey. Survey numbers: 4 = SE coast Survey, 42 = Mt Lofty - Private Collectors (Murfett) 1987, 45 = Western Murray Flats 1992, 78 = Tidal and Saltmarsh Communities 1995, 93 = Fleurieu Roadsides (M Hyde) 1993, 136 = Murray Mouth Reserves 2002. Species marked "#" were not recorded on Hindmarsh Island by Murfett (1995) or Renfrey et al (1989).

Family	SPECIES	Common Name	Native	4	42	45	78	82	93	136
AIZOACEAE	<i>Carpobrotus rossii</i>	Native Pigface	*	2	1			20		6
	<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	Round-leaf Pigface	*	1			3		1	1
	<i>Tetragonia implexicoma</i>	Bower Spinach	*	1	2			15	1	4
AMARANTHACEAE	<i>Hemichroa pentandra</i>	Trailing Hemichroa	*		1		1			1
APOCYNACEAE	<i>Alyxia buxifolia</i>	Sea Box	*	1				2		2
ASCLEPIADACEAE	<i>Asclepias rotundifolia</i>	Broad-leaf Cotton-bush								1
AZOLLACEAE	<i>Azolla pinnata</i> #	Ferny Azolla	*							1
CAMPANULACEAE	<i>Lobelia alata</i>	Angled Lobelia	*							1
CARYOPHYLLACEAE	<i>Cerastium balearicum</i>	Chickweed						1		
	<i>Cerastium glomeratum</i>	Common Mouse-ear Chickweed						1		
	<i>Sagina maritima</i>	Sea Pearlwort					2	11		
	<i>Stellaria media</i>	Chickweed						3		
	<i>Allocastrum verticillata</i>	Drooping Sheoak	*							1
CENTROLEPIDACEAE	<i>Centrolepis polygyna</i>	Wiry Centrolepis	*					1		
CHENOPODIACEAE	<i>Atriplex cinerea</i>	Coast Saltbush	*						1	
	<i>Atriplex paludosa</i> ssp.	Marsh Saltbush	*		2					
	<i>Atriplex prostrata</i>	Creeping Saltbush		1						
	<i>Chenopodium glaucum</i>	Glaucous Goosefoot								1
	<i>Einadia nutans</i> ssp. #	Climbing Saltbush	*		1					
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	Ruby Saltbush	*							3
	<i>Halosarcia indica</i> ssp.	Brown-head Samphire	*				1			
	<i>Halosarcia pergranulata</i> ssp.	Black-seed Samphire	*				1			
	<i>Maireana oppositifolia</i>	Salt Bluebush	*		1		1		1	4
	<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry Saltbush	*	1				19		5
	<i>Rhagodia parabolica</i>	Mealy Saltbush	*							3
	<i>Sarcocornia blackiana</i>	Thick-head Samphire	*		2		3		1	3
	<i>Sarcocornia quinqueflora</i>	Beaded Samphire	*	2	3		5		1	5
	<i>Sclerostegia arbuscula</i>	Shrubby Samphire	*		2		3		1	1
	<i>Suaeda australis</i>	Austral Seablite	*	2	3		4		1	5
	<i>Threlkeldia diffusa</i>	Coast Bonefruit	*					9	1	6
COMPOSITAE	<i>Aster subulatus</i>	Aster-weed				3				4
	<i>Brachycome exilis</i>	Slender Daisy	*				1			
	<i>Chryscephalum apiculatum</i>	Common Everlasting	*							1
	<i>Cirsium vulgare</i>	Spear Thistle			1					
	<i>Conyza albida</i>	Tall Fleabane			1					
	<i>Conyza bonariensis</i>	Flax-leaf Fleabane								1
	<i>Cotula coronopifolia</i>	Water Buttons					1			4
	<i>Cotula vulgaris</i> var. <i>australasica</i>	Slender Cotula	*				2			
	<i>Dimorphotheca pluvialis</i>	Cape Marigold						1		
	<i>Hypochaeris glabra</i>	Smooth Cat's ear						3		
	<i>Hypochaeris radicata</i>	Rough Cat's ear			1			2		
	<i>Olearia axillaris</i>	Coast Daisy-bush	*	4	2			19		2
	<i>Ozothamnus turbatus</i>	Coast Bush-everlasting	*					1		
	<i>Podotheca angustifolia</i>	Sticky Long-heads	*		1					
	<i>Reichardia tingitana</i>	False Sowthistle						6		
	<i>Senecio glossanthus</i>	Annual Groundsel	*				2			
	<i>Senecio lautus</i>	Variable Groundsel	*		1			7		
	<i>Senecio quadridentatus</i>	Cotton Groundsel	*		1					
	<i>Sonchus asper</i> ssp. <i>glaucescens</i>	Rough Sow-thistle								2
	<i>Sonchus megalocarpus</i>	Coast Sow-thistle	*					4		
	<i>Sonchus oleraceus</i>	Common Sow-thistle					2	16		2
	<i>Urospermum picroides</i>	False Hawkbit						2		
	<i>Vittadinia condyloides</i>	Club-hair New Holland Daisy	*		1					
	<i>Vittadinia cuneata</i> var. <i>cuneata</i> forma <i>cuneata</i>	Fuzzy New Holland Daisy	*							1
CONVOLVULACEAE	<i>Calystegia sepium</i>	Large Bindweed	*			2				1
	<i>Convolvulus remotus</i>	Grassy Bindweed	*							1
	<i>Wilsonia backhousei</i>	Narrow-leaf Wilsonia	*						1	
	<i>Wilsonia humilis</i> var. <i>humilis</i>	Silky Wilsonia	*		2					
CRASSULACEAE	<i>Crassula closiana</i>	Stalked Crassula	*					4		
CRASSULACEAE	<i>Crassula decumbens</i> var. <i>decumbens</i>	Spreading Crassula	*					5		
	<i>Crassula helmsii</i>	Swamp Crassula	*							1
	<i>Crassula sieberiana</i> ssp. <i>tetramera</i>	Australian Stonecrop	*					8		
CRUCIFERAE	<i>Cakile maritima</i> ssp. <i>maritima</i>	Two-horned Sea rocket						3		
CRUCIFERAE	<i>Hymenolobus procumbens</i>	Oval Purse					2			
CYPERACEAE	<i>Bolboschoenus caldwellii</i>	Salt Club-rush	*	3	1				1	5
	<i>Carex appressa</i>	Tall Sedge	*							1
	<i>Eleocharis acuta</i>	Common Spike-rush	*							1

Appendix VI. (continued)

Family	SPECIES	Common Name	Native	4	42	45	78	82	93	136
CYPERACEAE	<i>Isolepis cernua</i>	Nodding Club-rush	*							1
	<i>Isolepis marginata</i>	Little Club-rush	*					3		
	<i>Isolepis nodosa</i>	Knobby Club-rush	*	3	1	1		15	1	3
	<i>Lepidosperma concavum</i>	Spreading Sword-sedge	*							1
	<i>Lepidosperma congestum</i>	Clustered Sword-sedge	*		1					
	<i>Lepidosperma gladiatum</i>	Coast Sword-sedge	*	3				1		1
	<i>Schoenoplectus pungens</i>	Spiky Club-rush	*			2				
	<i>Schoenoplectus validus</i>	River Club-rush	*			2				3
	<i>Drosera macrantha ssp. planchonii</i>	Climbing Sundew	*		1					
DROSERACEAE	<i>Drosera whittakeri</i> (NC)	Scented Sundew	*		1					
EPACRIDACEAE	<i>Leucopogon parviflorus</i>	Coast Beard-heath	*	5				9		2
EUPHORBIACEAE	<i>Euphorbia paralias</i>	Sea Spurge						7		
	<i>Euphorbia terracina</i>	False Caper						1		1
FRANKENIACEAE	<i>Frankenia pauciflora</i> var.	Southern Sea-heath	*		2		3			
GERANIACEAE	<i>Geranium potentilloides</i> var. <i>potentilloides</i>	Downy Geranium	*					1		
	<i>Geranium retrorsum</i> #	Grassland Geranium	*							1
	<i>Pelargonium australe</i>	Australian Pelargonium	*		1			7		
GRAMINEAE	<i>Agrostis billardieri</i> var.	Blown-grass	*		1					
	<i>Ammophila arenaria</i>	Marram grass						4		1
	<i>Amphipogon caricinus</i> var. <i>caricinus</i>	Long Grey-beard Grass	*							1
	<i>Avellinia michelii</i>	Avellinia						1		
	<i>Avena barbata</i>	Bearded Oat						1		1
	<i>Avena fatua</i>	Wild Oat								2
	<i>Briza maxima</i>	Large Quaking-grass			1					1
	<i>Bromus diandrus</i>	Great Brome						5		
	<i>Bromus madritensis</i>	Compact Brome						1		
	<i>Criteston maritimum</i>	Sea Barley-grass			2	1	1			3
	<i>Cynodon dactylon</i>	Couch							1	
	<i>Danthonia caespitosa</i>	Common Wallaby-grass	*					1		
	<i>Danthonia setacea</i> var. <i>setacea</i>	Small-flower Wallaby-grass	*							1
	<i>Distichlis distichophylla</i>	Emu-grass	*	2	2		2		1	5
	<i>Ehrharta calycina</i>	Perennial Veldt Grass								1
	<i>Ehrharta longiflora</i>	Annual Veldt Grass						2		
	<i>Ehrharta villosa</i> var. <i>maxima</i>	Pyp Grass			2			3		
	<i>Elymus farctus</i>	Sea Wheat-grass						3		
	<i>Holcus lanatus</i>	Yorkshire Fog				1				
	<i>Lagurus ovatus</i>	Hare's tail Grass			2			4	1	1
	<i>Parapholis incurva</i>	Curly Ryegrass						2	1	
	<i>Paspalum distichum</i>	Water Couch				3				
	<i>Paspalum vaginatum</i>	Salt-water Couch								10
	<i>Pennisetum clandestinum</i>	Kikuyu				1				
	<i>Phragmites australis</i>	Common Reed	*	3		3				7
	<i>Poa poiformis</i>	Coast Tussock-grass	*					1		4
	<i>Polypogon maritimus</i>	Coast Beard-grass								1
	<i>Polypogon monspeliensis</i>	Annual Beard-grass								2
	<i>Polypogon viridis</i> #	Water Bent								1
	<i>Puccinellia distans</i>	Reflexed Poa			2					1
	<i>Puccinellia stricta</i> var. <i>stricta</i>	Australian Saltmarsh-grass	*				1			1
	<i>Rostraria cristata</i>	Annual Cat's-tail						1		
	<i>Spinifex sericeus</i>	Rolling Spinifex	*					13		
	<i>Sporobolus virginicus</i>	Salt Couch	*				1	3		
	<i>Stipa flavescens</i>	Coast Spear-grass	*					2		
	<i>Stipa stipoides</i>	Coast Spear-grass	*		2		1		2	1
	<i>Themeda triandra</i>	Kangaroo Grass	*							1
	<i>Vulpia fasciculata</i>	Sand Fescue						2		3
HALORAGACEAE	<i>Gonocarpus meianus</i>	Broad-leaf Raspwort	*		1					
	<i>Myriophyllum caput-medusae</i>	Coarse Milfoil	*							1
	<i>Myriophyllum salsugineum</i> #	Lake Milfoil	*							1
JUNCACEAE	<i>Juncus kraussii</i>	Sea Rush	*	2	3		3	1		6
	<i>Juncus pauciflorus</i>	Loose-flower Rush	*						2	
	<i>Juncus sarophorus</i>		*							2
	<i>Juncus usitatus</i>	Common Rush	*							1
JUNCAGINACEAE	<i>Triglochin centrocarpum</i>	Dwarf Arrowgrass	*				1			
	<i>Triglochin striatum</i>	Streaked Arrowgrass	*				5			3
LABIATAE	<i>Lycopus australis</i>	Australian Gipsywort	*			1				
	<i>Mentha x piperita</i> var.	Peppermint				2				
	<i>Prunella vulgaris</i> #	Self-heal	*							3
LAURACEAE	<i>Cassytha glabella</i> forma <i>dispar</i>	Slender Dodder-laurel	*							2
	<i>Cassytha pubescens</i>	Downy Dodder-laurel	*							2
LEGUMINOSAE	<i>Acacia cupularis</i>	Cup Wattle	*					1		1
	<i>Acacia longifolia</i> var. <i>sophorae</i>	Coastal Wattle	*	1	1			17		2
	<i>Acacia pycnantha</i>	Golden Wattle	*							1
	<i>Acacia saligna</i>	Golden Wreath Wattle								1

Appendix VI. (continued)

Family	SPECIES	Common Name	Native	4	42	45	78	82	93	136
	<i>Acacia spinescens</i>	Spiny Wattle	*							1
	<i>Daviesia arenaria</i>	Sand Bitter-pea	*							1
	<i>Dillwynia hispida</i>	Red Parrot-pea	*							1
	<i>Kennedia prostrata</i>	Scarlet Runner	*							1
	<i>Lotus australis</i>	Austral Trefoil	*					4		
	<i>Medicago polymorpha</i> var. <i>polymorpha</i>	Burr-Medic								1
	<i>Melilotus indica</i>	King Island Melilot					2	3		1
	<i>Trifolium fragiferum</i> var. <i>fragiferum</i>	Strawberry Clover								3
	<i>Trifolium striatum</i>	Knotted Clover								1
LILIACEAE	<i>Caesia calliantha</i>	Blue Grass-lily	*		1					
	<i>Dianella brevicaulis</i>	Short-stem Flax-lily	*					16		2
	<i>Dianella longifolia</i> var.	Pale Flax-lily	*						1	
	<i>Dianella revoluta</i> var. <i>revoluta</i>	Black-anther Flax-lily	*							2
	<i>Myrsiphyllum asparagoides</i>	Bridal Creeper			1					
	<i>Thysanotus patersonii</i>	Twining Fringe-lily	*		1					
	<i>Tricoryne tenella</i>	Tufted Yellow Rush-lily	*							1
	<i>Wurmbea dioica</i> ssp. <i>dioica</i> (NC)	Early Star-lily	*		1					
LIMONIACEAE	<i>Limonium binervosum</i>	Dwarf Sea-lavender			3		3			4
	<i>Limonium companyonis</i>	Sea-lavender							2	
LOGANIACEAE	<i>Logania ovata</i>	Oval-leaf Logania	*							1
LORANTHACEAE	<i>Amyema melaleucae</i>	Tea-tree Mistletoe	*		1					3
	<i>Lysiana exocarpi</i> ssp. <i>exocarpi</i>	Harlequin Mistletoe	*							1
MALVACEAE	<i>Lagunaria patersonii</i>	Pyramid Tree								1
	<i>Lawrenzia squamata</i>	Thorny Lawrenzia	*		2		2		1	2
MYOPORACEAE	<i>Myoporum insulare</i>	Common Boobialla	*					13		7
MYRTACEAE	<i>Eucalyptus fasciculosa</i>	Pink Gum	*		1					
	<i>Eucalyptus incrassata</i>	Ridge-fruited Mallee	*		1					
	<i>Eucalyptus porosa</i>	Mallee box	*							1
	<i>Kunzea pomifera</i>	Muntries	*	2				3		3
	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i>	Swamp Paper-bark	*		1					6
	<i>Melaleuca uncinata</i>	Broombush	*		1					
ONAGRACEAE	<i>Epilobium pallidiflorum</i>	Showy Willow-herb	*							1
ORCHIDACEAE	<i>Cyrtostylis reniformis</i>	Small Gnat-orchid	*		1					
	<i>Pterostylis dolichochila</i>	Mallee Shell-orchid	*		1					
	<i>Pterostylis nana</i>	Dwarf Greenhood	*		1					
	<i>Pyrorchis nigricans</i>	Black Fire-orchid	*		1					
OXALIDACEAE	<i>Oxalis pes-caprae</i>	Soursob						2		
PITTOSPORACEAE	<i>Billardiera cymosa</i>	Sweet Apple-berry	*					11		2
	<i>Billardiera sericophora</i>	Silky Apple-berry	*	1						
	<i>Bursaria spinosa</i>	Sweet Bursaria	*							1
PLANTAGINACEAE	<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-Horn plantain								5
	<i>Plantago major</i>	Greater Plantain								1
POLYGALACEAE	<i>Comesperma volubile</i>	Love Creeper	*							1
POLYGONACEAE	<i>Muehlenbeckia florulenta</i>	Lignum	*	5		1			1	4
	<i>Muehlenbeckia gunnii</i>	Coastal Climbing lignum	*		1			16		2
	<i>Persicaria decipiens</i>	Slender Knotweed	*							3
	<i>Persicaria lapathifolia</i>	Pale Knotweed	*			3				
	<i>Rumex conglomeratus</i>	Clustered Dock								1
	<i>Rumex crispus</i>	Curled Dock				1				
PRIMULACEAE	<i>Anagallis arvensis</i>	Pimpernel						2		
	<i>Samolus repens</i>	Creeping Brookweed	*	3	4		7		2	6
PROTEACEAE	<i>Hakea vittata</i>	Limestone Needlebush	*							1
RANUNCULACEAE	<i>Clematis microphylla</i>	Old Man's Beard	*		2			4		2
RUBIACEAE	<i>Galium murale</i>	Small Bedstraw						7		
SANTALACEAE	<i>Exocarpos syrticola</i>	Coast Cherry	*	1				14		1
SAPINDACEAE	<i>Dodonaea baueri</i>	Crinkled Hop-bush	*		1					
	<i>Dodonaea viscosa</i> ssp. <i>spatulata</i>	Sticky Hop-bush	*							1
SCROPHULARIACEAE	<i>Mimulus repens</i>	Creeping Monkey-flower	*							2
	<i>Parentucellia latifolia</i>	Red Bartsia					1			
	<i>Verbascum virgatum</i>	Twiggy Mullein								1
SOLANACEAE	<i>Lycium ferocissimum</i>	African Boxthorn						2		3
SOLANACEAE	<i>Nicotiana glauca</i>	Tree Tobacco								1
	<i>Solanum linnaeanum</i>	Apple of Sodom								1
STACKHOUSIACEAE	<i>Stackhousia spathulata</i>	Coast Candles	*					2		
STYLIDIACEAE	<i>Levenhookia dubia</i>	Hairy Stylewort	*		1					
THYMELAEACEAE	<i>Pimelea glauca</i>	Smooth Riceflower	*							1
	<i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i>	Thyme Riceflower	*	3	2			19	1	5
TYPHACEAE	<i>Typha domingensis</i>	Narrow-leaf Bulrush	*			3				5
UMBELLIFERAE	<i>Apium annuum</i>	Annual Celery	*				2			
	<i>Berula erecta</i>	Water Parsnip				3				4
	<i>Bupleurum semicompositum</i>	Hare's Ear			1					

Appendix VI. (continued)

Family	SPECIES	Common Name	Native	4	42	45	78	82	93	136
	<i>Centella asiatica</i>	Asian Centella	*							1
	<i>Daucus glochidiatus</i>	Native Carrot	*					14		
	<i>Hydrocotyle capillaris</i>	Thread Pennywort	*				1			
	<i>Hydrocotyle medicaginoides</i>	Medic Pennywort	*		1					
	<i>Hydrocotyle verticillata</i>	Shield Pennywort	*			2				3
URTICACEAE	<i>Urtica urens</i>	Small Nettle				1				

Total species	217	24	63	20	33	69	27	126
Total indigenous	144	23	51	10	24	38	22	90
Total exotic	73	1	12	10	9	31	5	36

APPENDIX VII. Plant species used for the cluster analysis and their occurrence in the 11 floristic groups.

Numbers are averages of the following cover abundance estimate codes: 0.1=small cover < 10 plants, 0.5=sparingly present, 1=numerous but cover < 5%, 2=cover 5-25%, 3=cover 25-50%, 4=cover 50-75%, 5=cover > 75%

Species	Common Name	1	2	3	4	5	6	7	8	9	10	11
<i>Acacia longifolia</i> var. <i>sophorae</i>	Coastal Wattle	1.12										
<i>Alyxia buxifolia</i>	Sea Box	1.13		2.00								
<i>Ammophila arenaria</i>	Marram Grass	1.17										
<i>Amyema melaleuca</i>	Tea-tree Mistletoe							0.50		2.37		
<i>Aster subulatus</i>	Aster-weed							2.00				0.45
<i>Atriplex paludosa</i> ssp.	Marsh Saltbush						1.75					
<i>Berula erecta</i>	Water Parsnip							2.00				1.25
<i>Billardiera cymosa</i>	Sweet Apple-berry	0.80										
<i>Bolboschoenus caldwellii</i>	Salt Club-rush	0.50						1.00	5.00	0.40	5.00	1.00
<i>Bromus diandrus</i>	Great Brome	1.10										
<i>Carpobrotus rossii</i>	Native Pigface	0.66	1.03	2.00		0.50	3.00	2.00				
<i>Clematis microphylla</i>	Old Man's Beard	1.20	0.50		0.50			0.10				
<i>Cotula coronopifolia</i>	Water Buttons							0.83	1.00			0.50
<i>Crassula closiana</i>	Stalked Crassula	0.75										
<i>Crassula decumbens</i> var. <i>decumbens</i>	Spreading Crassula	1.00										
<i>Crassula sieberiana</i> ssp. <i>tetramera</i>	Australian Stonecrop	0.66										
<i>Critesion maritimum</i>	Sea Barley-grass						0.65		0.75			0.50
<i>Daucus glochidiatus</i>	Native Carrot	0.63										
<i>Dianella brevicaulis</i>	Short-stem Flax-lily	1.02						0.50				
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	Round-leaf Pigface						1.63		2.00			
<i>Distichlis distichophylla</i>	Emu-grass						1.90	0.53	3.00	0.50		
<i>Ehrharta villosa</i> var. <i>maxima</i>	Pyp Grass	0.75	0.50									
<i>Euphorbia paralias</i>	Sea Spurge	0.75	1.00			0.50						
<i>Exocarpos syrticola</i>	Coast Cherry	0.85	2.50									
<i>Frankenia pauciflora</i> var.	Southern Sea-heath						1.72					
<i>Galium murale</i>	Small Bedstraw	0.94										
<i>Hydrocotyle verticillata</i>	Shield Pennywort											1.30
<i>Isolepis nodosa</i>	Knobby Club-rush	1.04	1.52									0.10
<i>Juncus kraussii</i>	Sea Rush	0.50	1.17				0.10	2.00	0.50	0.70		
<i>Kunzea pomifera</i>	Muntries	1.86		3.00								
<i>Lagurus ovatus</i>	Hare's Tail grass	1.50	0.50		0.10			0.10				
<i>Lawrenzia squamata</i>	Thorny Lawrenzia						0.90	0.75				
<i>Lepidosperma gladiatum</i>	Coast Sword-sedge	1.17	2.00									
<i>Leucopogon parviflorus</i>	Coast Beard-heath	0.91	2.00	2.00								
<i>Limonium binervosum</i>	Dwarf Sea-lavender		3.00				0.87	0.10		0.50		
<i>Lotus australis</i>	Austral Trefoil	0.75										
<i>Lycium ferocissimum</i>	African Boxthorn	1.75						0.50	0.50			
<i>Maireana oppositifolia</i>	Salt Bluebush						2.00	0.30				
<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i>	Swamp Paper-bark							1.70		1.02		
<i>Melilotus indica</i>	King Island Melilot	0.50					0.55	0.50				
<i>Muehlenbeckia florulenta</i>	Lignum							1.00	2.17	1.00	2.75	0.50
<i>Muehlenbeckia gunnii</i>	Coastal Climbing Lignum	1.08			0.50			2.00				
<i>Myoporum insulare</i>	Common Boobialla	1.22					0.50	2.25	0.50			
<i>Olearia axillaris</i>	Coast Daisy-bush	1.13	1.72									
<i>Paspalum vaginatum</i>	Salt-water Couch						2.00	0.50	2.50	0.50		1.20
<i>Pelargonium australe</i>	Australian Pelargonium	0.94	0.50									
<i>Phragmites australis</i>	Common Reed								0.50	0.50	3.88	0.64
<i>Pimelea serpyllifolia</i> ssp. <i>serpyllifolia</i>	Thyme Riceflower	1.40	1.38				0.50	0.10				
<i>Plantago coronopus</i> ssp. <i>coronopus</i>	Bucks-horn Plantain							2.00	1.00			
<i>Poa poiformis</i>	Coast Tussock-grass	1.63						0.50				
<i>Reichardia tingitana</i>	False Sowthistle	0.88										
<i>Rhagodia candolleana</i> ssp. <i>candolleana</i>	Sea-berry Saltbush	1.00	1.00				1.00	1.00				
<i>Sagina maritima</i>	Sea Pearlwort	1.01					1.50					
<i>Samolus repens</i>	Creeping Brookweed		2.00				1.30	2.00	1.57	1.05		
<i>Sarcocornia blackiana</i>	Thick-head Samphire						0.96		0.10			
<i>Sarcocornia quinqueflora</i>	Beaded Samphire						1.15	0.10	1.37	0.73		
<i>Schoenoplectus validus</i>	River Club-rush											2.20
<i>Sclerostegia arbuscula</i>	Shrubby Samphire						1.30		0.10			
<i>Senecio lautus</i>	Variable Groundsel	1.17			0.50							
<i>Sonchus megalocarpus</i>	Coast Sow-thistle	0.50				0.50						
<i>Sonchus oleraceus</i>	Common Sow-thistle	0.93					0.75	0.50				
<i>Spinifex sericeus</i>	Rolling Spinifex	1.44	1.00			1.00						
<i>Sporobolus virginicus</i>	Salt Couch	1.83						1.00				
<i>Stipa stipoides</i>	Coast Spear-grass						1.53	3.00				
<i>Suaeda australis</i>							0.78		1.50	1.50		
<i>Tetragonia implexicoma</i>	Bower Spinach	0.80	1.05		3.00						0.50	
<i>Threlkeldia diffusa</i>	Coast Bonefruit	1.19					0.50	0.50	5.00	1.50		
<i>Triglochin striatum</i>	Streaked Arrowgrass						1.00	2.05	0.63	0.10		
<i>Typha domingensis</i>	Narrow-leaf Bulrush											1.00

Appendix VII. (continued)

Species	Common Name	1	2	3	4	5	6	7	8	9	10	11
<i>Vulpia fasciculata</i>	Sand Fescue	1.00						2.17				

APPENDIX VIII. Mammal species recorded in the study area. Survey and Opportune data are held in the Biological Survey of South Australia databases (Dept. Environment & Heritage), South Australian Museum records represent specimens held in their collection.

Family	SPECIES	Common Name	Survey	Opportune	SA Museum
TACHYGLOSSIDAE	<i>Tachyglossus aculeatus</i>	Echidna			2
PSEUDOCHEIRIDAE	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum		2	
MACROPODIDAE	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	4	1	
MURIDAE	<i>Hydromys chrysogaster</i>	Water-rat	5	5	3
	* <i>Mus musculus</i>	House Mouse	92		3
	<i>Rattus lutreolus</i>	Swamp Rat	8		9
	* <i>Rattus rattus</i>	Black Rat	4		1
VESPERTILIONIDAE	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		1	1
	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		1	
	<i>Vespadelus darlingtoni</i>				1
CANIDAE	* <i>Canis lupus familiaris</i>	Dog (domestic or feral)	2		
	* <i>Vulpes vulpes</i>	Fox	7		
FELIDAE	* <i>Felis catus</i>	Cat	3	1	
BOVIDAE	* <i>Bos taurus</i>	Cattle	6		
	* <i>Ovis aries</i>	Sheep	1		
LEPORIDAE	* <i>Lepus capensis</i>	Brown Hare	1		
	* <i>Oryctolagus cuniculus</i>	Rabbit	5		

APPENDIX IX. Bird species recorded in the study area and the sources for these records.

ORDERNAME	Family_subfamily_name	Species	Common Name & Status	Murray Mouth Res	Opportune	Paton & Pedler 1989	Paton 1965-88	SA Museum	bird atlas 96-2001	bird atlas 77-81	bird atlas pre1977
STRUTHIONIFORMES	CASUARIIDAE	<i>Dromaius novaehollandiae</i>	Emu	*			*			*	*
GALLIFORMES	PHASIANIDAE	<i>Coturnix pectoralis</i>	Stubble Quail	*		*		*		*	*
ANSERIFORMES	ANATIDAE Oxyurinae	<i>Biziura lobata</i>	Musk Duck SA:R			*		*		*	*
		<i>Oxyura australis</i>	Blue-billed Duck SA:R				*	*		*	*
	ANATIDAE Stictonettinae	<i>Stictonetta naevosa</i>	Freckled Duck SA:V							*	
	ANATIDAE Anserinae	<i>Cereopsis novaehollandiae</i>	Cape Barren Goose SA:R	*	*	*			*	*	*
		<i>Cygnus atratus</i>	Black Swan	*	*	*		*	*	*	*
	ANATIDAE Tadorninae	<i>Tadorna radjah</i>	Radjah Shelduck SA:O								*
		<i>Tadorna tadornoides</i>	Australian Shelduck	*		*		*		*	*
	ANATIDAE Anatinae	<i>Anas castanea</i>	Chestnut Teal			*				*	*
		<i>Anas gracilis</i>	Grey Teal	*	*	*			*	*	*
		<i>Anas platyrhynchos</i>	Mallard *			*		*			*
		<i>Anas rhynchotis</i>	Australasian Shoveler SA:R			*		*	*	*	*
		<i>Anas superciliosa</i>	Pacific Black Duck	*	*	*			*	*	*
		<i>Aythya australis</i>	Hardhead (White-eyed Duck)				*			*	*
		<i>Chenonetta jubata</i>	Australian Wood Duck			*		*			*
		<i>Malacorhynchus membranaceus</i>	Pink-eared Duck				*	*		*	*
PODICIPEDIFORMES	PODICIPEDIDAE	<i>Podiceps cristatus</i>	Great Crested Grebe SA:R		*	*		*		*	*
		<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe	*		*			*	*	*
		<i>Tachybaptus novaehollandiae</i>	Australasian Grebe			*					*
SPHENISCIFORMES	SPHENISCIDAE	<i>Eudyptula minor</i>	Little Penguin				*			*	*
PROCELLARIIFORMES	PROCELLARIIDAE	<i>Daption capense</i>	Cape Petrel								*
		<i>Fulmarus glacialis</i>	Southern Fulmar					*			*
		<i>Halobaena caerulea</i>	Blue Petrel SA:V								*
		<i>Lugensa brevirostris</i>	Kerguelen Petrel								*
		<i>Macronectes giganteus</i>	Southern Giant-Petrel					*			*
		<i>Pachyptila belcheri</i>	Slender-billed Prion								*
		<i>Pachyptila desolata</i>	Antarctic Prion				*				*
		<i>Pachyptila salvini</i>	Salvin's Prion								*
		<i>Pachyptila turtur</i>	Fairy Prion					*			*
		<i>Pachyptila vittata</i>	Broad-billed Prion SA:R								*
		<i>Pterodroma lessonii</i>	White-headed Petrel					*			*
		<i>Puffinus carneipes</i>	Fleshy-footed Shearwater SA:R				*			*	*
		<i>Puffinus gavia</i>	Fluttering Shearwater				*	*			
		<i>Puffinus griseus</i>	Sooty Shearwater SA:O								*
		<i>Puffinus puffinus</i>	Manx Shearwater SA:O								*
		<i>Puffinus tenuirostris</i>	Short-tailed Shearwater				*				*
	DIOMEDEIDAE	<i>Diomedea cauta</i>	Shy Albatross SA:V Aus:VU					*		*	*
		<i>Diomedea chlororhynchos</i>	Yellow-nosed Albatross SA:V								*
		<i>Diomedea chrysostoma</i>	Grey-headed Albatross SA:V Aus:VU								*
		<i>Diomedea melanophris</i>	Black-browed Albatross SA:V								*
	HYDROBATIDAE	<i>Oceanites oceanicus</i>	Wilson's Storm-Petrel								*
		<i>Pelagodroma marina</i>	White-faced Storm-Petrel								*
PELECANIFORMES	SULIDAE	<i>Morus serrator</i>	Australasian Gannet				*				*
	ANHINGIDAE	<i>Anhinga melanogaster</i>	Darter		*		*			*	*
	PHALACROCORACIDAE	<i>Phalacrocorax carbo</i>	Great Cormorant	*	*	*			*	*	*
		<i>Phalacrocorax fuscescens</i>	Black-faced Cormorant			*					*
		<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	*	*	*		*	*	*	*
		<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	*		*		*	*	*	*
		<i>Phalacrocorax varius</i>	Pied Cormorant	*	*	*		*	*	*	*
	PELECANIDAE	<i>Pelecanus conspicillatus</i>	Australian Pelican	*	*	*		*	*	*	*
CICONIIFORMES	ARDEIDAE	<i>Ardea alba</i>	Great Egret	*	*	*	*		*		*
		<i>Ardea ibis</i>	Cattle Egret				*				
		<i>Botaurus poiciloptilus</i>	Australasian Bittern SA:V							*	*
		<i>Egretta garzetta</i>	Little Egret			*			*		
		<i>Egretta novaehollandiae</i>	White-faced Heron	*	*	*		*	*		
		<i>Egretta sacra</i>	Eastern Reef Egret SA:R							*	
		<i>Nycticorax caledonicus</i>	Nankeen Night Heron				*			*	*
	THRESKIORNITHIDAE	<i>Platalea flavipes</i>	Yellow-billed Spoonbill	*		*				*	*
		<i>Platalea regia</i>	Royal Spoonbill	*	*	*		*	*	*	*
		<i>Plegadis falcinellus</i>	Glossy Ibis SA:R				*	*		*	*
		<i>Threskiornis molucca</i>	Australian White Ibis	*	*	*		*	*		
		<i>Threskiornis spinicollis</i>	Straw-necked Ibis			*		*		*	*
FALCONIIFORMES	ACCIPITRIDAE Pandioninae	<i>Pandion haliaetus</i>	Osprey SA:R								*
		<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk			*				*	
		<i>Accipiter fasciatus</i>	Brown Goshawk			*			*		*
		<i>Aquila audax</i>	Wedge-tailed Eagle				*			*	*
		<i>Circus approximans</i>	Swamp Harrier	*		*		*	*	*	*
		<i>Circus assimilis</i>	Spotted Harrier	*			*				*
		<i>Elanus axillaris</i>	Black-shouldered Kite	*	*	*		*	*		
		<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle SA:V			*		*		*	*

Appendix IX. (continued)

ORDERNAME	Family_subfamily_name	Species	Common Name & Status	Murray Mouth Res	Opportunity	Paton & Pedler 1989	Paton 1965-88	SA Museum	bird atlas 96-2001	bird atlas 77-81	bird atlas pre1977
FALCONIFORMES	ACCIPITRIDAE Accipitrinae	<i>Haliastur spheurnus</i>	Whistling Kite	*	*		*		*	*	*
		<i>Hieraaetus morphnoides</i>	Little Eagle			*					*
		<i>Milvus migrans</i>	Black Kite				*				*
	FALCONIDAE	<i>Falco berigora</i>	Brown Falcon	*	*	*		*		*	*
		<i>Falco cenchroides</i>	Nankeen Kestrel	*		*		*	*	*	*
		<i>Falco longipennis</i>	Australian Hobby	*		*					*
		<i>Falco peregrinus</i>	Peregrine Falcon SA:R	*	*						*
		<i>Falco subniger</i>	Black Falcon			*				*	
GRUIFORMES	GRUIDAE	<i>Grus rubicunda</i>	Brolga SA:V								*
	RALLIDAE	<i>Fulica atra</i>	Eurasian Coot			*			*	*	*
		<i>Gallinula tenebrosa</i>	Dusky Moorhen			*		*		*	*
		<i>Gallinula ventralis</i>	Black-tailed Native-hen	*	*	*				*	*
		<i>Gallirallus philippensis</i>	Buff-banded Rail						*	*	*
		<i>Porphyrio porphyrio</i>	Purple Swampphen	*		*		*	*	*	*
		<i>Porzana fluminea</i>	Australian Spotted Crane		*	*		*		*	*
		<i>Porzana pusilla</i>	Baillon's Crane SA:R				*	*			
		<i>Porzana tabuensis</i>	Spotless Crane	*		*				*	*
		<i>Rallus pectoralis</i>	Lewin's Rail SA:V	*				*			*
	OTIDIDAE	<i>Ardeotis australis</i>	Australian Bustard SA:V								*
TURNICIFORMES	TURNICIDAE	<i>Turnix velox</i>	Little Button-quail								*
CHARADRIIFORMES	SCOLOPACIDAE Gallinagoninae	<i>Gallinago hardwickii</i>	Latham's Snipe SA:V		*		*	*		*	*
	SCOLOPACIDAE Tringinae	<i>Actitis hypoleucos</i>	Common Sandpiper							*	*
		<i>Limosa lapponica</i>	Bar-tailed Godwit			*				*	*
		<i>Limosa limosa</i>	Black-tailed Godwit				*	*		*	*
		<i>Numenius madagascariensis</i>	Eastern Curlew SA:V			*		*		*	*
		<i>Numenius minutus</i>	Little Curlew SA:O							*	*
		<i>Numenius phaeopus</i>	Whimbrel			*				*	*
		<i>Tringa glareola</i>	Wood Sandpiper			*				*	*
		<i>Tringa nebularia</i>	Common Greenshank	*	*	*		*	*	*	*
		<i>Tringa stagnatilis</i>	Marsh Sandpiper	*		*				*	*
		<i>Xenus cinereus</i>	Terek Sandpiper				*				
	SCOLOPACIDAE Arenariinae	<i>Arenaria interpres</i>	Ruddy Turnstone				*			*	*
	SCOLOPACIDAE Calidrinae	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	*	*	*		*	*	*	*
		<i>Calidris alba</i>	Sanderling			*				*	*
		<i>Calidris canutus</i>	Red Knot				*			*	*
		<i>Calidris ferruginea</i>	Curlew Sandpiper	*	*	*		*	*	*	*
		<i>Calidris melanotos</i>	Pectoral Sandpiper					*		*	*
		<i>Calidris ruficollis</i>	Red-necked Stint		*	*		*	*	*	*
		<i>Calidris subminuta</i>	Long-toed Stint							*	*
		<i>Calidris tenuirostris</i>	Great Knot				*			*	*
	BURHINIDAE	<i>Burhinus grallarius</i>	Bush Stone-curlew SA:V								*
	HAEMATOPODIDAE	<i>Haematopus fuliginosus</i>	Sooty Oystercatcher		*	*		*		*	*
		<i>Haematopus longirostris</i>	Pied Oystercatcher	*	*	*			*		*
	RECURVIROSTRIDAE	<i>Cladorhynchus leucocephalus</i>	Banded Stilt		*					*	*
		<i>Himantopus himantopus</i>	Black-winged Stilt	*	*	*		*	*		
		<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	*	*			*		*	*
	CHARADRIIDAE	<i>Charadrius bicinctus</i>	Double-banded Plover				*	*		*	*
		<i>Charadrius mongolus</i>	Lesser Sand Plover								*
		<i>Charadrius ruficapillus</i>	Red-capped Plover	*		*		*	*	*	*
		<i>Charadrius veredus</i>	Oriental Plover								*
		<i>Elseyonis melanops</i>	Black-fronted Dotterel				*			*	*
		<i>Erythronys cinctus</i>	Red-kneed Dotterel			*				*	*
		<i>Pluvialis fulva</i>	Pacific Golden Plover			*				*	*
		<i>Pluvialis squatarola</i>	Grey Plover							*	*
		<i>Thinornis rubricollis</i>	Hooded Plover SA:V Aus:VU				*				
		<i>Vanellus miles</i>	Masked Lapwing	*	*	*		*	*	*	*
		<i>Vanellus tricolor</i>	Banded Lapwing			*					
	GLAREOLIDAE	<i>Siltia isabella</i>	Australian Pratincole				*				
	LARIDAE Stercorariinae	<i>Catharacta maccormicki</i>	South Polar Skua SA:O				*				
		<i>Stercorarius parasiticus</i>	Arctic Jaeger, (Arctic Skua)								*
	LARIDAE Larinae	<i>Larus novaehollandiae</i>	Silver Gull	*	*	*			*	*	*
		<i>Larus pacificus</i>	Pacific Gull	*	*		*			*	*
	LARIDAE Sterninae	<i>Chlidonias hybridus</i>	Whiskered Tern			*			*	*	*
		<i>Chlidonias leucopterus</i>	White-winged Black Tern		*					*	*
		<i>Sterna albiglans</i>	Little Tern SA:V Aus:EN							*	*
		<i>Sterna bergii</i>	Crested Tern	*	*	*			*		
		<i>Sterna caspia</i>	Caspian Tern	*	*	*		*	*		
		<i>Sterna hirundo</i>	Common Tern SA:R			*				*	*
		<i>Sterna nereis</i>	Fairy Tern SA:V				*			*	*
		<i>Sterna nilotica</i>	Gull-billed Tern				*		*		
COLUMBIFORMES	COLUMBIDAE	<i>Columba livia</i>	Rock Dove *			*				*	*
		<i>Geopelia placida</i>	Peaceful Dove	*		*					*

Appendix IX. (continued)

ORDERNAME	Family_subfamily_name	Species	Common Name & Status	Murray Mouth Res	Opportune	Paton & Pedler 1989	Paton 1965-88	SA Museum	bird atlas 96-2001	bird atlas 77-81	bird atlas pre1977
COLUMBIFORMES	COLUMBIDAE	<i>Ocyphaps lophotes</i>	Crested Pigeon	*		*			*	*	*
		<i>Phaps chalcoptera</i>	Common Bronzewing				*			*	
		<i>Phaps elegans</i>	Brush Bronzewing	*		*		*		*	*
		<i>Streptopelia chinensis</i>	Spotted Turtle-dove *	*		*			*	*	*
PSITTACIFORMES	CACATUIDAE	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo								*
		<i>Cacatua roseicapilla</i>	Galah	*		*			*		
		<i>Nymphicus hollandicus</i>	Cockatiel								*
	PSITTACIDAE	<i>Glossopsitta concinna</i>	Musk Lorikeet				*		*		*
		<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet			*					*
		<i>Glossopsitta pusilla</i>	Little Lorikeet SA:V								*
		<i>Melopsittacus undulatus</i>	Budgerigar				*				*
		<i>Neophema chrysostoma</i>	Blue-winged Parrot SA:V	*	*						*
		<i>Neophema elegans</i>	Elegant Parrot	*		*		*		*	*
		<i>Neophema petrophila</i>	Rock Parrot SA:R	*	*				*	*	*
		<i>Northiella haematogaster</i>	Blue Bonnet							*	*
		<i>Platycercus elegans</i>	Crimson Rosella				*				*
		<i>Psephotus haematonotus</i>	Red-rumped Parrot				*			*	*
		<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		*	*				*	*
CUCULIFORMES	CUCULIDAE	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo			*					*
		<i>Chrysococcyx basalidis</i>	Horsfield's Bronze-cuckoo			*				*	*
		<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo SA:R			*					
		<i>Chrysococcyx osculans</i>	Black-eared Cuckoo							*	
		<i>Cuculus pallidus</i>	Pallid Cuckoo				*				*
STRIGIFORMES	STRIGIDAE	<i>Ninox novaeseelandiae</i>	Southern Boobook				*				*
	TYTONIDAE	<i>Tyto alba</i>	Barn Owl				*			*	*
CAPRIMULGIFORMES	PODARGIDAE	<i>Podargus strigoides</i>	Tawny Frogmouth								*
	CAPRIMULGIDAE	<i>Eurostopodus argus</i>	Spotted Nightjar							*	*
APODIFORMES	APODIDAE	<i>Apus pacificus</i>	Fork-tailed Swift			*					*
		<i>Hirundapus caudacutus</i>	White-throated Needle-tail								*
CORACIIFORMES	ALCEDINIDAE Halcyoninae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra				*				*
		<i>Todiramphus sancta</i>	Sacred Kingfisher				*				
	MEROPIDAE	<i>Merops ornatus</i>	Rainbow Bee-eater				*				
PASSERIFORMES	MALURIDAE Malurinae	<i>Malurus cyaneus</i>	Superb Fairy-wren	*		*			*	*	*
		<i>Malurus lamberti</i>	Variegated Fairy-wren							*	
		<i>Stipiturus malachurus</i>	Southern Emu-wren SA:R	*						*	
	PARDALOTIDAE	<i>Pardalotus punctatus</i>	Spotted Pardalote	*	*					*	*
		<i>Pardalotus striatus</i>	Striated Pardalote				*				
	ACANTHIZIDAE Dasyornithinae	<i>Dasyornis broadbenti</i>	Rufous Bristlebird SA:V	*						*	*
	ACANTHIZIDAE Acanthizinae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	*		*	*			*	*
		<i>Acanthiza nana</i>	Yellow Thornbill				*			*	*
		<i>Acanthiza pusilla</i>	Brown Thornbill	*		*		*		*	*
		<i>Calamanthus fuliginosus</i>	Striated Fieldwren								*
		<i>Sericornis frontalis</i>	White-browed Scrubwren	*		*				*	*
		<i>Smicronis brevirostris</i>	Weebill	*							
	MELIPHAGIDAE	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	*		*				*	*
		<i>Anthochaera carunculata</i>	Red Wattlebird	*		*			*	*	*
		<i>Anthochaera chrysoptera</i>	Little Wattlebird			*			*		*
		<i>Gliciphila melanops</i>	Tawny-crowned Honeyeater				*	*			
		<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater			*					
		<i>Lichenostomus virescens</i>	Singing Honeyeater	*		*		*	*		
		<i>Manorina melanocephala</i>	Noisy Miner	*							*
		<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater				*			*	
		<i>Melithreptus lunatus</i>	White-naped Honeyeater				*				
		<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	*	*	*		*	*	*	*
		<i>Plectorhyncha lanceolata</i>	Striped Honeyeater SA:R					*			*
	MELIPHAGIDAE Epthianurinae	<i>Epthianura albifrons</i>	White-fronted Chat	*		*			*	*	*
	PETROICIDAE	<i>Microeca fascians</i>	Jacky Winter				*				
		<i>Petroica multicolor</i>	Scarlet Robin				*				*
		<i>Petroica phoenicea</i>	Flame Robin SA:R								*
		<i>Petroica rosea</i>	Rose Robin SA:R				*				
	POMATOSTOMIDAE	<i>Pomatostomus superciliosus</i>	White-browed Babbler	*			*			*	*
NEOSITTIDAE		<i>Daphoenositta chrysoptera</i>	Varied Sittella					*			*
		<i>Daphoenositta chrysoptera</i>	Varied Sittella				*				
	PACHYCEPHALIDAE	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	*			*			*	*
		<i>Pachycephala pectoralis</i>	Golden Whistler			*				*	*
		<i>Pachycephala rufiventris</i>	Rufous Whistler	*		*				*	
	DICRURIDAE	<i>Grallina cyanoleuca</i>	Magpie-lark	*		*		*	*	*	*
		<i>Myiagra cyanoleuca</i>	Satin Flycatcher SA:V								*
		<i>Myiagra inquieta</i>	Restless Flycatcher							*	*
		<i>Rhipidura albiscapa</i>	Grey Fantail	*		*					
		<i>Rhipidura leucophrys</i>	Willie Wagtail	*		*			*	*	*

Appendix IX. (continued)

ORDERNAME	Family_subfamily_name	Species	Common Name & Status	Murrau Mouth Res	Opportune	Paton & Pedler 1989	Paton 1965-88	SA Museum	bird atlas 96-2001	bird atlas 77-81	bird atlas pre1977	
PASSERIFORMES	ARTAMIDAE	<i>Artamus cyanopterus</i>	Dusky Woodswallow				*			*	*	
		<i>Artamus personatus</i>	Masked Woodswallow								*	
		<i>Artamus superciliosus</i>	White-browed Woodswallow					*			*	
		<i>Cracticus torquatus</i>	Grey Butcherbird	*		*				*	*	
		<i>Gymnorhina tibicen</i>	Australian Magpie	*		*			*	*	*	
	CAMPEPHAGIDAE	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				*			*	*	
		<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike SA:R							*		
		<i>Lalage tricolor</i>	White-winged Triller								*	
	CORVIDAE	<i>Corvus coronoides</i>	Australian Raven	*						*		
		<i>Corvus mellori</i>	Little Raven	*	*	*			*	*	*	
	MUSCICAPIDAE	<i>Turdus merula</i>	Eurasian Blackbird *			*			*			
	STURNIDAE	<i>Sturnus vulgaris</i>	Common Starling *	*		*			*			
	HIRUNDINIDAE	<i>Hirundo neoxena</i>	Welcome Swallow	*		*			*	*	*	
		<i>Petrochelidon ariel</i>	Fairy Martin			*						
		<i>Petrochelidon nigricans</i>	Tree Martin	*		*			*	*	*	
	ZOSTEROPIDAE	<i>Zosterops lateralis</i>	Silvereye	*		*			*	*	*	
	SYLVIIDAE Acrocephalinae	<i>Acrocephalus australis</i>	Australian Reed Warbler, (Clamorous Reed-Warbler)	*		*				*	*	
	SYLVIIDAE Megalurinae	<i>Cincloramphus cruralis</i>	Brown Songlark	*		*		*	*			
		<i>Megalurus gramineus</i>	Little Grassbird	*		*		*	*	*	*	
	SYLVIIDAE Cisticolinae	<i>Cisticola exilis</i>	Golden-headed Cisticola SA:R	*		*			*	*	*	
	ALAUDIDAE	<i>Alauda arvensis</i>	Eurasian Skylark *	*		*			*	*	*	
		<i>Mirafrja javanica</i>	Horsfield's Bushlark			*		*		*	*	
	DICAEIDAE	<i>Dicaeum hirundinaceum</i>	Mistletoebird	*			*			*		
	PASSERIDAE	<i>Passer domesticus</i>	House Sparrow *			*			*			
	MOTACILLIDAE	<i>Anthus novaeseelandiae</i>	Richard's Pipit	*		*				*	*	
	ESTRILIDIDAE	<i>Neochmia temporalis</i>	Red-browed Finch				*		*			
		<i>Stagonopleura guttata</i>	Diamond Firetail SA:V				*					
	FRINGILLIDAE	<i>Carduelis carduelis</i>	European Goldfinch *	*		*				*	*	
		<i>Carduelis chloris</i>	European Greenfinch *			*						
		TOTAL		243	85	42	114	63	63	62	135	190

APPENDIX X. Frog and Reptile species recorded in the study area and the sources for these records.

Order	Family	Species	SA Museum 1964-2002	2001 SAHG	frog watch database	opportune database	Survey Database	
Anura	LEPTODACTYLIDAE	<i>Crinia signifera</i>	*	*	*		*	
		<i>Limnodynastes tasmaniensis</i>	*		*		*	
		<i>Limnodynastes fletcheri</i>			*			
		<i>Limnodynastes dumerilii</i>			*			
		<i>Crinia parinsignifera</i>			*			
	HYLIDAE	<i>Litoria ewingii</i>		*	*			
Reptilia	CHELIDAE	<i>Chelodina longicollis</i>	*				*	
	AGAMIDAE	<i>Ctenophorus pictus</i>	*			*	*	
		<i>Pogona barbata</i>	*	*			*	
	GEKKONIDAE	<i>Aprasia striolata</i>	*	*			*	
		<i>Christinus marmoratus</i>	*	*		*	*	
		<i>Nephruurus milii</i>	*					
	SCINCIDAE	<i>Ctenotus orientalis</i>	*				*	
		<i>Ctenotus robustus</i>	*	*			*	
		<i>Hemiergis peronii</i>	*	*			*	
		<i>Lerista bouganvillii</i>		*				
		<i>Lerista dorsalis</i>	*	*			*	
		<i>Menetia greyii</i>	*	*			*	
		<i>Morethia boulengeri</i>	*				*	
		<i>Morethia obscura</i>	*				*	
		<i>Pseudemoia entrecasteauxii</i>	*				*	
		<i>Tiliqua rugosa</i>		*				
		<i>Tiliqua scincoides</i>	*				*	
	ELAPIDAE	<i>Notechis cf ater</i>	*			*	*	
		<i>Notechis scutatus</i>	*				*	
		<i>Pseudonaja textilis</i>	*	*		*	*	
		# species	26	17	11	6	2	16

APPENDIX XI. Terrestrial invertebrate listed alphabetically by Order, Family and Species for each of the survey sites. Numbers indicate number of animals collected.

Order	Family	Species	MUD00101	MUD00201	MUD00301	MUD00601	MUD00801	MUD00901	MUD01101	MUD01201	WYN00401	WYN00701	WYN00801	WYN00901	WYN01001	WYN01101	WYN01201	WYN01301	MUDCAMP	Total	# sites
BLATTODEA	Blaberidae	<i>Calolampra sp.</i>															2			2	1
	Blattidae	<i>Platyzosteria sp.</i>																3		0	0
COLEOPTERA	Cantharidae	<i>Chauliognathus lugubris</i>							1									1		2	2
	Carabidae	<i>Craspedophorus sp.</i>													1					1	1
		<i>Gn sp</i>															2			2	1
		<i>Megacephala australis</i>						1						2		1				4	3
		<i>Rhytisternus sp.</i>																1		1	1
		<i>Simodontus sp.</i>												1						1	1
	Cerambycidae	<i>Phorocantha sp.</i>																	2	0	0
	Coccinellidae	<i>Micrapsis sp.</i>													3			1		4	2
	Curculionidae	<i>gn sp medium</i>																	1	0	0
	Dytiscidae	<i>Eretes australis</i>												1						1	1
	Scarabaeidae	<i>Metanestes sp.</i>																	1	0	0
	Silphidae	<i>Ptomaphila lachrymosa</i>																	1	0	0
	Staphylinidae	<i>Gn sp</i>																1		1	1
	Tenebrionidae	<i>Adelium brevicornis</i>														1				1	1
		<i>Adelium sp</i>								2							1			3	2
		<i>Celibe australis</i>	1																	1	1
		<i>Celibe brunnipes</i>			1															1	1
		<i>Ecnolagria rufescens</i>															5			5	1
		<i>helea sp small</i>																	1	0	0
		<i>Helea sp.</i>			1												1		12	2	2
		<i>Saragus interruptus</i>																	1	0	0
	Trogidae	<i>Trox sp.</i>																	2	0	0
COLLEMBOLA	Entomobryidae	<i>Gn sp</i>	1	1		1	1													4	4
DERMAPTERA	Family ?	<i>Gn sp</i>								1										1	1
	Forficulidae	<i>Forficula sp.</i>		1						1		3					2			7	4
	Labiduridae	<i>Labidura sp.</i>													1	1				2	2
DIPTERA	Cecidomyiidae	<i>Gn sp</i>		1																1	1
	Chloropidae	<i>Gn sp</i>			1													1		2	2
	Chironomidae	<i>Gn sp</i>																1		1	1
	Ephydriidae	<i>Gn sp</i>									1									1	1
	Lauxaniidae	<i>Gn sp</i>	1																	1	1
	Muscidae	<i>Gn sp</i>												1		1				2	2
	Phoridae	<i>Gn sp</i>		1		1	1			1				1						5	5
	Sciaridae	<i>Gn sp</i>					1			1										2	2
	Sepsidae	<i>Gn sp</i>														1				1	1
	Sphaeroceridae	<i>Gn sp</i>						1												1	1
	Syrphidae	<i>Melangyna sp</i>																1		1	1
	Tachinidae	<i>Gn sp</i>			1						1					1				3	3
HEMIPTERA	Belostomatidae	<i>Lethocerus sp.</i>												1							
	Cydnidae	<i>Aethus sp.</i>																	1	0	0
	Jassidae	<i>Gn sp</i>			1									1						2	2
	Notonectidae	<i>Anisops sp.</i>													1					1	1
	Pentatomidae	<i>Poecilometis sp.</i>															1			1	1
	Reduviidae	<i>Coranus distinctus</i>			1															1	1
	Reduviidae	<i>Gn sp</i>														1				1	1
HYMENOPTERA	Family ?	<i>Gn sp</i>													2	1				3	2

Appendix XI. (continued)

Order	Family	Species	MUD00101	MUD00201	MUD00301	MUD00601	MUD00801	MUD00901	MUD01101	MUD01201	WYN00401	WYN00701	WYN00801	WYN00901	WYN01001	WYN01101	WYN01201	WYN01301	MUDCAMP	Total	# sites
	Formicidae	<i>Camponotus sp.</i>																	10	0	0
		<i>Myrmecia sp.</i>																	9	0	0
	Mutillidae	<i>Gn sp</i>											1							1	1
	Pompilidae	<i>Gn sp</i>													1		1			2	2
	Tiphiidae	<i>Gn sp</i>												1						1	1
		<i>Thynninae Gn.sp.</i>																	1	1	1
MANTODEA	Mantidae	<i>Archimantis sp.</i>																	1	1	1
NEUROPTERA	Myrmeleontidae	<i>Acanthaclisis fundatus</i>																	2	0	0
ODONATA	Coenagrionidae	<i>Ischnura heterosticta</i>																	1	1	1
ORTHOPTERA	Acrididae	<i>Acrida sp.</i>													1					1	1
		<i>Ailopus sp.</i>																	4	4	1
		<i>Ailopus sp. near</i>													3				1	4	2
		<i>Gn sp</i>																	1	1	1
		<i>Oedalus australis</i>														1	3			4	2
ORTHOPTERA	Gryllacrididae	<i>Gn sp</i>											1						1	1	1
	Gryllidae	<i>Eneopterinae gn sp.</i>					1													1	1
		<i>Gn sp</i>								5										5	1
		<i>Phalangopsinae Gn.sp.</i>	1		1		3						1							6	4
		<i>Teleogryllus commodus</i>						2						2	1	1		1		7	5
	Gryllotalpidae	<i>Gryllotalpa sp.</i>													1					1	1
PSOCOPTERA	Psocidae	<i>Gn sp</i>					4													4	1
THYSANURA	Lepismatidae	<i>Ctenolepisma longicaudata</i>		1																1	1
TRICHOPTERA	Family ?	<i>Gn sp</i>											1							1	1
																				124	58

APPENDIX XII. Terrestrial invertebrate listed alphabetically by Order, Family and Species for occurrence within soil surface texture classes and floristic groups as described in the vegetation chapter.

		# sites	2	3	1	4	1	5	3	1	4	3	1	4
			Soil Surface Texture						Floristic group					
Order	Family	Species	Sand	Loamy Sand	Clay Loam Sandy	Zilty Clay Loam	Light Med Clay	Heavy Clay	1	6	7	8	9	11
BLATTODEA	Blaberidae	<i>Calolampra sp.</i>		2					1					
COLEOPTERA	Canthararidae	<i>Chauliognathus lugubris</i>				1		1			1			1
	Carabidae	<i>Craspedophorus sp.</i>				1					1			
		<i>Gn sp</i>		2					1					
		<i>Megacephala australis</i>			1	2		1				2		1
		<i>Rhytisternus sp.</i>				1					1			
		<i>Simodontus sp.</i>				1								1
	Coccinellidae	<i>Micrapsis sp.</i>				4					2			
	Dytiscidae	<i>Eretes australis</i>				1								1
	Staphylinidae	<i>Gn sp</i>				1					1			
	Tenebrionidae	<i>Adelium brevicornis</i>			1							1		
		<i>Adelium sp</i>		1		2			1		1			
		<i>Celibe australis</i>	1						1					
		<i>Celibe brunnipes</i>		1						1				
		<i>Ecnolagria rufescens</i>		5					1					
		<i>Helea sp.</i>		2					1	1				
COLLEMBOLA	Entomobryidae	<i>Gn sp</i>	2					2	2			1		1
DERMAPTERA	Family ?	<i>Gn sp</i>				1					1			
	Forficulidae	<i>Forficula sp.</i>	1	5		1			2		2			
	Labiduridae	<i>Labidura sp.</i>			1	1					1	1		
DIPTERA	Cecidomyiidae	<i>Gn sp</i>	1						1					
	Chloropidae	<i>Gn sp</i>		1		1				1	1			
	Chironomidae	<i>Gn sp</i>				1					1			
	Ephydriidae	<i>Gn sp</i>					1						1	
	Lauxaniidae	<i>Gn sp</i>	1						1					
	Muscidae	<i>Gn sp</i>			1	1						1		1
	Phoridae	<i>Gn sp</i>	1			1		3	1			1		3
	Sciaridae	<i>Gn sp</i>						2						2
	Sepsidae	<i>Gn sp</i>			1							1		
	Sphaeroceridae	<i>Gn sp</i>						1				1		
	Syrphidae	<i>Melangyna sp</i>				1					1			
	Tachinidae	<i>Gn sp</i>		1	1		1			1		1	1	
HEMIPTERA	Belostomatidae	<i>Lethocerus sp.</i>				1								
	Jassidae	<i>Gn sp</i>		1		1				1				1
	Notonectidae	<i>Anisops sp.</i>				1					1			
	Pentatomidae	<i>Poecilometis sp.</i>		1					1					
	Reduviidae	<i>Coranus distinctus</i>		1						1				
		<i>Gn sp</i>			1							1		
HYMENOPTERA	Family ?	<i>Gn sp</i>			1	2					1	1		
	Mutillidae	<i>Gn sp</i>		1							1			
	Pompilidae	<i>Gn sp</i>		1		1			1		1			
	Tiphiidae	<i>Gn sp</i>				1								1
		<i>Thynninae Gn.sp.</i>				1					1			
MANTODEA	Mantidae	<i>Archimantis sp.</i>				1					1			
ODONATA	Coenagrionidae	<i>Ischnura heterosticta</i>				1					1			
ORTHOPTERA	Acrididae	<i>Acrida sp.</i>				1					1			
		<i>Ailopus sp.</i>				4					1			
		<i>Ailopus sp. near</i>				4					2			
		<i>Gn sp</i>				1					1			
		<i>Oedalus australis</i>		3	1				1			1		

Appendix XII. (continued)

		# sites	2	3	1	4	1	5	3	1	4	3	1	4
			Soil Surface Texture					Floristic group						
Order	Family	Species	Sand	Loamy Sand	Clay Loam Sandy	Zilty Clay Loam	Light Med Clay	Heavy Clay	1	6	7	8	9	11
	Gryllacrididae	<i>Gn sp</i>		1							1			
	Gryllidae	<i>Eneopterinae gn sp.</i>						1						1
		<i>Gn sp</i>				5					1			
		<i>Phalangopsinae Gn.sp.</i>	1	2				3	1	1	1			1
		<i>Teleogryllus commodus</i>			1	4		2			2	2		1
	Gryllotalpidae	<i>Gryllotalpa sp.</i>				1					1			
PSOCOPTERA	Psocidae	<i>Gn sp</i>						4						1
THYSANURA	Lepismatidae	<i>Ctenolepisma longicaudata</i>	1						1					
TRICHOPTERA	Family ?	<i>Gn sp</i>		1							1			

APPENDIX XIII. Butterfly species that previously occurred in the study area (T= threatened in South Australia, R Grund pers. comm.)

Family	Species	Status
Hesperiidae	<i>Anisynta cynone</i>	T
(skippers)	<i>Antipodia atralba</i>	
	<i>Herimosa albovenata</i>	T
	<i>Hesperilla chrysotricha</i>	T
	<i>Hesperilla donnysa</i>	
	<i>Motasingha trimaculata</i>	
	<i>Ocybadistes walkeri</i>	
	<i>Taractrocera papyria</i>	
	<i>Trapezites lutea</i>	T
Papilionidae	<i>Papilio anactus</i>	
(swallowtails)	<i>Papilio demoleus</i>	
Pieridae	<i>Belenois java</i>	
(whites and yellows)	<i>Delias aganippe</i>	
	<i>Eurema smilax</i>	
	<i>Pieris rapae</i>	
Nymphalidae	<i>Danaus chrysippus</i>	
(brushfoot butterflies)	<i>Danaus plexippus</i>	
	<i>Geitoneura klugii</i>	
	<i>Heteronympha merope</i>	
	<i>Junonia villida</i>	
	<i>Vanessa itea</i>	
	<i>Vanessa kershawi</i>	
Lycaenidae	<i>Candalides heathi</i>	
(blues and coppers)	<i>Cyprotides cyprotus</i>	
	<i>Erina acasta</i>	
	<i>Erina hyacinthina form simplex</i>	
	<i>Hypochrysops ignita</i>	T
	<i>Jalmenus icilius</i>	
	<i>Lampides boeticus</i>	
	<i>Lucia limbaria</i>	
	<i>Nacaduba biocellata</i>	
	<i>Neolucia agricola</i>	
	<i>Ogyris amaryllis</i>	
	<i>Ogyris idmo</i>	T
	<i>Ogyris olane</i>	
	<i>Ogyris otanes</i>	T
	<i>Theclinesstes albocincta</i>	
	<i>Theclinesstes miskini</i>	
	<i>Theclinesstes serpentata</i>	
	<i>Zizina labradus</i>	