The State of Biological Resources in South Australia

COVER:

The tiny Feathertail Glider Acrobates pygmaeus is confined to well wooded areas in the State's South East. Active mostly at night, it is capable of gliding between trees up to 20 metres apart in search of its diet of nectar, blossoms, sap and small invertebrate animals.

ROBINSON
NORWOOD.

THE STATE OF BIOLOGICAL RESOURCES IN SOUTH AUSTRALIA

A contribution toward improving
our understanding of the
South Australian environment

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1986 (second printing 1988)

ISBN 7243 88397

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SUMMARY

The purpose of this report is to describe, evaluate and explain the current condition and conservation status of South Australia's indigenous biological resources. It forms part of a major study of the state of the South Australian environment.

It excludes introduced cultivated plants and domestic animals, other than those which now exist in the wild.

For practical purposes the report is divided into three sections, each dealing with the biota of a major habitat type. These are:

1. The terrestrial, or land environment.

2. The inland water environment, including saline and temporary water bodies, and

3. The marine environment.

The report examines each of these in terms of:

- the current state of knowledge

- the availability and applicability of data

- the current condition of each major habitat type, based on existing knowledge and data, and

- the conservation status of, and the legislative protection afforded to the State's biological resources.

1. TERRESTRIAL ENVIRONMENT

a) The State of Knowledge.

Two components of the terrestrial biota are well documented. These are the flowering plants, and the birds and mammals. All have been studied historically, with survey reports, specific and general accounts being widely available. Trends for species and communities generally can be discerned.

For the lower plants including mosses, liverworts, lichens and fungi, the reptiles, and invertebrate animals generally, there is a paucity of current information and an overall lack of historical data.

b) Availability and Application of Data.

Most information used is in published form. The existence of maps and aerial photographs over time sequences has allowed data to be compiled for the quantitative assessment of loss rates for native vegetation in the agricultural regions of the State. In the arid northern part of the State however, no such data base exists and inferences have been drawn from the small number of documented experimental case studies.

Data for the birds and mammals are from a variety of published and unpublished sources, comprising documented fact and the informed opinions of individuals actively researching particular groups in South Australia.

Where information on other groups is available, it is not yet possible to apply it because of incompleteness, a lack of historical perspective, or both.

c) State of the Terrestrial Environment Biota.

The information available indicates:

- That natural vegetation in the agricultural region has declined in area by approximately 80% since European settlement, and the trend towards further clearance is continuing.

- In the arid zone the standing crop of native vegetation has declined significantly.

- A combination of habitat loss, and the competition from introduced plants and animals has resulted in extinction for 28 native mammal and 5 bird species. In addition 6 flowering plant species are presumed to be extinct on a national level. Many more plants are extinct within South Australia, but no statistics are available to enable an accurate assessment to be made of the situation. Research in this area is vital to provide basic data upon which to base management of the State's flora.

- It is possible that less conspicuous components of the biota have already become extinct or are likely to do so without ever coming to the attention of either the general or scientific communities.

- The current system of national and conservation parks does not include examples of all the State's surviving biota.

- The occurrence of a plant or animal within a reserve does not necessarily guarantee a secure future for the species.

- Lack of basic research may be preventing the optimal management of existing parks and reserves, and leading to inefficient use of scarce resources and funds.

d) Legislative Provisions.

The welfare of indigenous flora and fauna is legislated for under the National Parks and Wildlife Act 1972-78, the new Native Vegetation Management Act 1985, Marginal Lands Act 1940-74, Pastoral Act 1936-76, and several Acts of less direct relevance.

Mineral exploration and production is permissible within certain National Parks, most notably those likely to yield rich mineral deposits because of their geological history, which is often the underlying reason for their conservation and amenity value.

The policing and enforcement of legislation designed to protect native plants and animals is particularly inadequate.

More resources are needed for the successful management of the State's parks and reserves, and for educational campaigns to further enlighten land managers and the public as to the value and desirability of native flora and fauna in areas of natural habitat outside the park and reserve system.

2. INLAND WATER ENVIRONMENT

a) The State of Knowledge.

The biota of South Australian inland waters is very poorly known. Recent advances have been made in researching several aspects of the biology of the River Murray and the Coorong, and preliminary survey work of several other significant wetland habitats is underway.

The Engineering and Water Supply Department (E&WS) hold biological sampling data for the State's water supply reservoirs and the River Murray, and macro-invertebrate data from streams in the Mount Lofty Ranges. Recent interest in the mound springs region has increased knowledge of their highly specialised fauna and flora.

Other inland water bodies remain largely unstudied.

b) Availability and Application of Data.

The Department of Fisheries holds data on fish and invertebrates of commercial importance, and publishes regular research bulletins in its widely available magazine SAFIC.

Much information is confined to specialist journals, is still in progress or remains unpublished in university theses. Several reports published by the Department of Environment and Planning (DEP) are available but not widely publicised. The results of several research projects being conducted in the DEP on aspects of inland water conservation will be available by the end of 1985. They include River Murray wetlands, wetlands of the South East, mound springs, Cooper Creek, biota and conservation significance of remaining wetlands in the agricultural regions, and the biota of estuaries.

Information from the E & WS Department is not in a readily accessible format. Availability is therefore limited to specialists in the relevant fields. As resources become available, assessment of this data is being performed by the State Water Laboratory staff.

c) State of the Inland Water Environment Biota.

The major points are:

- Hydrological management of the River Murray system has created an imbalance amongst its component organisms. Species once common have been replaced by others more suited to the changed conditions, and by exotic species.

- Drainage, reclamation, and damming of wetland areas in the settled regions of the State has brought about extensive changes to the composition, distribution, and abundance of their dependent plant and animal communities.

- One fish, one bird, and one mammal species have become extinct. Many more are seriously threatened.

- Invertebrates are poorly known, so it is not yet possible to establish how many may have become extinct or are currently threatened.

- Wetland biota are poorly represented in the State's park and reserve system.

d) Legislative Provisions.

The fate of wetland areas has been determined by the following Acts of Parliament: Fisheries Act 1971-82, Irrigation Act 1930-75, Mining Act 1971-82, National Parks and Wildlife Act 1972-78, Water Conservation Act 1936-72, Water Resources Act 1976-83, Waterworks Act 1932-84, South East Drainage Act 1931-80, Coast Protection Act 1972-85 and River Murray Waters Act 1983.

The majority of this legislation does not directly take into account the well-being of native plant and animal communities, although the Water Resources Act directly recognises the flora and fauna of aquatic environments as a resource in need of protection and management. Developments which entail significant social, economic or environmental change now require the production of an Environmental Impact Statement (Planning Act 1982-85 Section 49) which must take into consideration the conservation requirements of plants and animals.

3. MARINE ENVIRONMENT

a) The State of Knowledge.

Fish and invertebrates of commercial importance are the best known component of the marine biota. The benthic flora is also well known. Knowledge about the remainder is variable in extent, with some groups being known only from isolated specimens.

b) Availability and Application of Data.

The Department of Fisheries is continuing to build up a picture of population structure and seasonal movements of species of commercial importance. The research findings are freely available.

The DEP and E & WS are concerned largely with monitoring the effects of marine pollution. Their research findings are generally published in technical reports which are distributed to State and National Libraries. Restricted reports are not widely available.

Five popular accounts dealing with selected aspects of the local marine biota have been published in the last ten years.

c) State of the Marine Environment Biota.

It would appear that:

- From the limited information available, the South Australian marine environment is still in a relatively natural state.

- The various biological communities appear to be both diverse and healthy on the whole.

- There are no recorded instances of local extinction. However several species have been over exploited by commercial fisheries, the latest instances being the bluefin tuna, *Thunnus maccoyii* which had been reduced by the early 1980s to 20% of its original population level after only fifteen years of exploitation, and the western king-prawn *Peneaus latisulcatus* which has declined despite stringent fisheries management.

- Fifteen thousand hectares of what is considered to be the most significant coastal marine habitat, have been reserved in order to protect the areas from damaging developments. Problems of inadequate policing and law enforcement make the effectiveness of the more accessible reserves doubtful. In addition all of the State's coastal mangrove communities are protected because of their importance as breeding and nursery areas for economically important coastal fish species.

- Acute pollution incidents have so far been avoided, although chronic pollution of a lasting nature has occurred.

- Local pollution that may have adverse effects on marine plants and animals has been confined to effluent discharges from urban areas, and industrial sites at Port Stanvac, Port Adelaide, and in the Iron Triangle region of Spencer Gulf. Detailed accounts of composition and relationships within local marine ecosystems are still largely absent.

d) Legislative Provisions.

Relevant legislation includes the following: Fisheries Act 1971-82, Food and Drugs Act 1908-72, Coast Protection Act 1972-85, Sewerage Act 1929-74, Harbors Act 1936-78, Prevention of Pollution of Waters by Oil Act 1961-79, Boating Act 1974-78, Fibre and Sponges Act 1909-73 and National Parks and Wildlife Act 1972-78.

The Fisheries Act and National Parks and Wildlife Act control commercial fisheries, and identify and protect all marine mammals and some fish and invertebrates. The Fibre and Sponges Act exists to regulate two currently obsolete industries, and the remaining legislation seeks to control the extent of marine pollution and coastal development.

A co-ordinated approach to marine management is desirable, but does not exist in practice as yet.

CONCLUSIONS

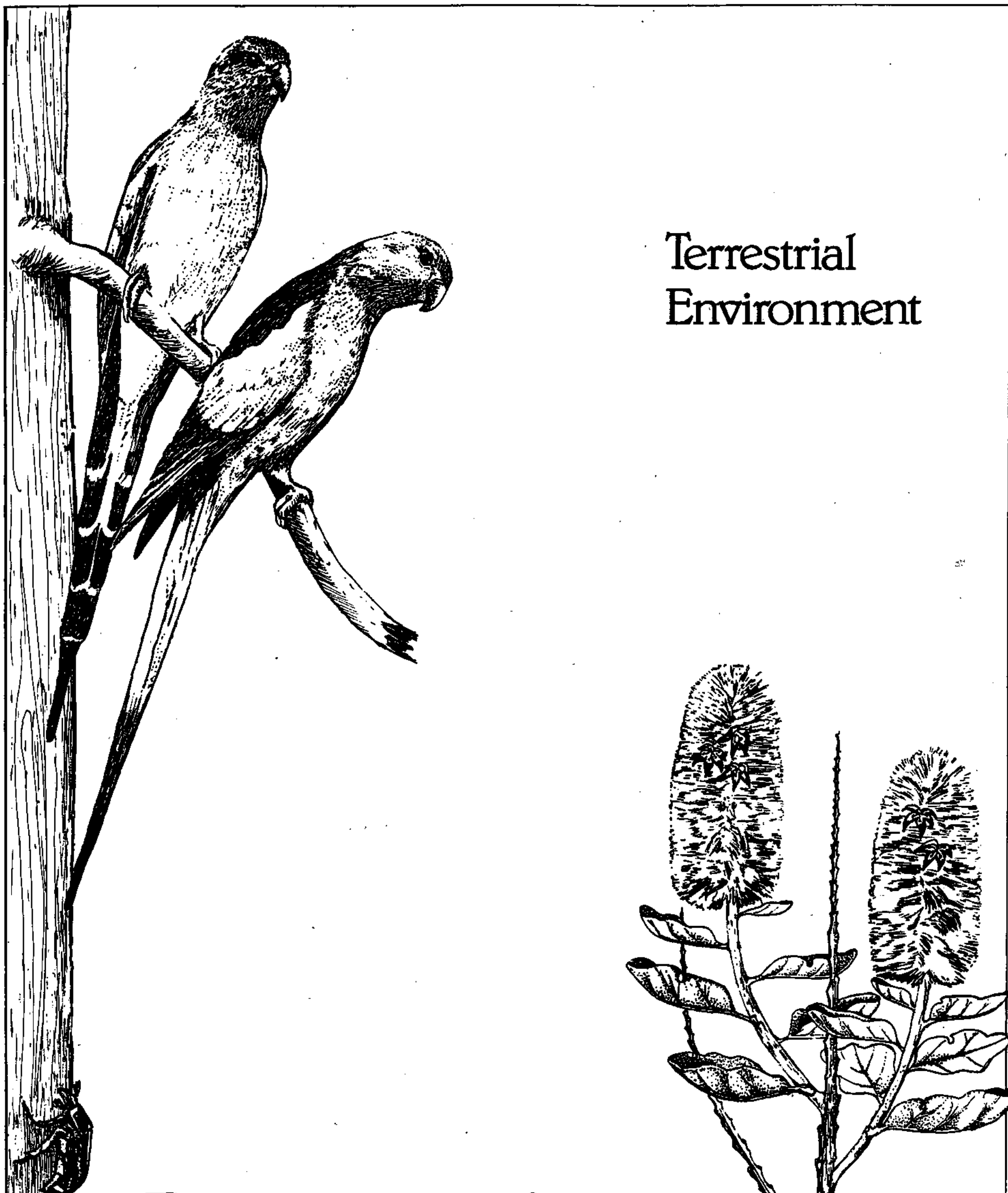
The plants and animals of the terrestrial and freshwater environments of South Australia have been considerably reduced in numbers, range, and diversity since the settlement of Europeans 150 years ago.

A point has now been reached where further pressures on what natural habitat remains could result in further acceleration of extinction rates and impoverishment of native flora and fauna. However, these pressures continue to exist, and public funds allocated to natural resource management are generally inadequate for the task. In addition there is still a lack of basic taxonomic and ecological knowledge in many areas. A sound understanding of these is necessary for the formulation of sound management plans for both public and other lands.

Adverse consequences of European occupation have been largely avoided in the marine environment.

In order for modern society to have a more balanced approach towards the natural environment, a greater awareness of, and empathy for our natural heritage will be necessary. A major public education campaign would be required in order to achieve what amounts to the reversal of 150 years of entrenched attitudes. It remains to be seen whether the political will to bring about such a change exists.

Terrestrial Environment



TERRESTRIAL ENVIRONMENT

The beautiful Alexandra's Parrot Polytelis alexandrae occurs only in the arid mulga and spinifex shrublands of the State's Far North. It is seldom seen owing partly to the remoteness of its habitat but also to its small population size.

The Fiddler Beetle Chlorobapta frontalis depends on the decaying heartwood of old blue gums Eucalyptus leucoxylon in which its larvae feed and mature. Stands of gum trees of mixed ages, including dead and dying ones, are of vital importance to this and many other South Australian animals.

The toadstool Amanita ochrophylla can grow up to a size of 25 cm across. It occurs in the wooded high rainfall areas of the South East and the Mt. Lofty Ranges. The toadstool is only the fruiting body emerging during wet weather to shed reproductive spores. The majority of the organism lives underground as a network of filaments and grows all year round.

There are 27 species of Pussy's Tail or Mulla Mulla known to grow in South Australia. This one Ptilotus exaltus is particularly common in rocky areas of the Flinders Ranges after good rains.

1 TERRESTRIAL ENVIRONMENT

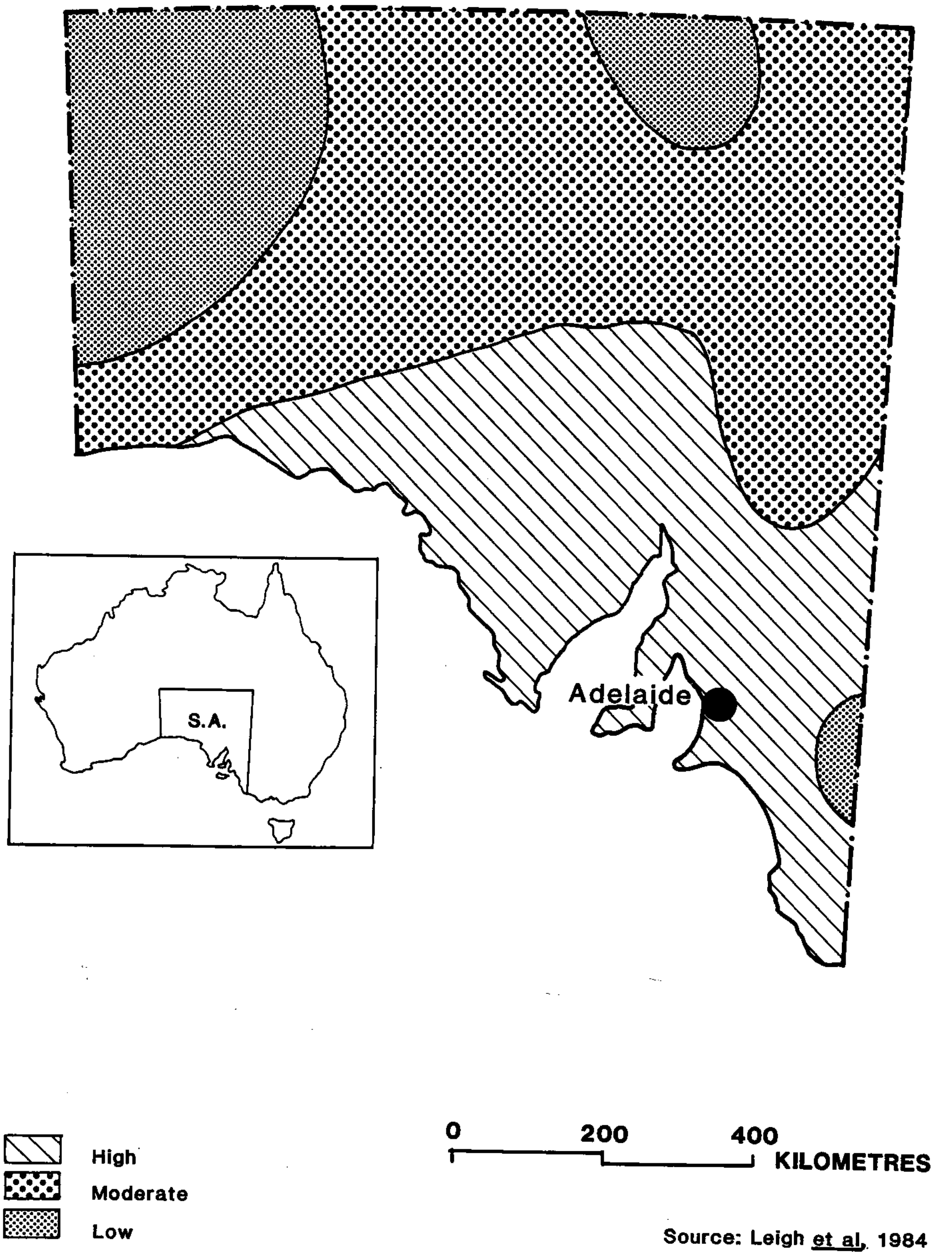
1.1 BACKGROUND

European settlement in South Australia over the past 150 years has led to dramatic changes in the composition and distribution of vegetation and wildlife, and consequently upon the appearance of the landscape. It is now generally accepted that Aboriginal people have occupied the Australian continent for at least 40,000 years and that they modified the landscape with their technology of 'fire-stick' farming (Jones, 1969) and to some extent the cultivation of certain plants (Hallam, 1975). Fire is still an important tool in shaping the landscape, but European settlement has introduced a much wider range of activities including intensive agriculture, forestry, grazing, indiscriminate hunting, trapping and poisoning, urbanisation and industrial development, mining and quarrying, transport networks, the use of chemicals, horticultural collections, and competing exotic plants now established in the wild. (Leigh et al, 1984). Figure 1.1 shows the level of disturbance resulting from European settlement.

It has been estimated that by the mid-1970s only 34% of South Australian vegetation present at the time of European settlement remained unmodified (Department of Home Affairs and Environment, 1981). Table 1.1 shows the degree of modification to the natural vegetation coverage of South Australia compared to that of Australia as a whole. Changes in species composition have been brought about by the grazing of domestic stock, selective harvesting of timber trees, and replacement of native species by introduced food crops, pasture grasses and coniferous timber plantations. (Leigh et al 1984).

Because South Australia is so arid, it is essential to retain as much permanent vegetation cover as possible and to encourage the revegetation of key areas in order to maintain resource productivity and reduce the occurrence and effects of land degradation. Research on revegetation techniques is being carried out in the Department of Environment and Planning (DEP). Basically these fall into two categories: natural methods of regeneration in areas protected from grazing animals and where weed competition has been minimised; and the more economical means of direct seeding. Results from direct seeding trials are proving encouraging (Venning, 1985).

FIGURE 1.1 LEVEL OF DISTURBANCE RESULTING FROM EUROPEAN SETTLEMENT



Source: Leigh et al, 1984

TABLE 1.1: MODIFICATION TO NATURAL VEGETATION

DEGREE OF MODIFICATION	% AREA SOUTH AUSTRALIA	AUSTRALIA
Unmodified natural vegetation - no apparent use by Europeans	34	30
Natural vegetation altered by extensive grazing or forestry and/or recreation activities	52	47
Natural vegetation modified by grazing and partly replaced by introduced species	3	7
Clearing or partial clearing of upper stratum and widespread modification and replacement of lower stratum with introduced species	4	6
Cultural vegetation only	7	10
No continuous vegetation (includes urban and commercial areas, open cut mining and man-made lakes)	less than 0.5	less than 0.5
TOTAL	100	100

Sources: Leigh et al, 1984; Dept. Home Affairs and Environment, 1981.

1.1.1 The Agricultural Area

In South Australia the arid zone is considered to comprise the 82% of the State receiving less than 250 mm average annual rainfall. (Vickery, 1978).

The remaining area is generally suitable for the growth of crops and pasture and has come to be termed the agricultural region (see Fig. 1.2). Consequently most of this area has been intensively developed in the time since settlement to a point where further clearance of native vegetation on privately owned farm land has become a widely debated and contentious political issue. Table 1.2. illustrates the extent of vegetation clearance in the agricultural areas from data collected in 1974 and 1985.

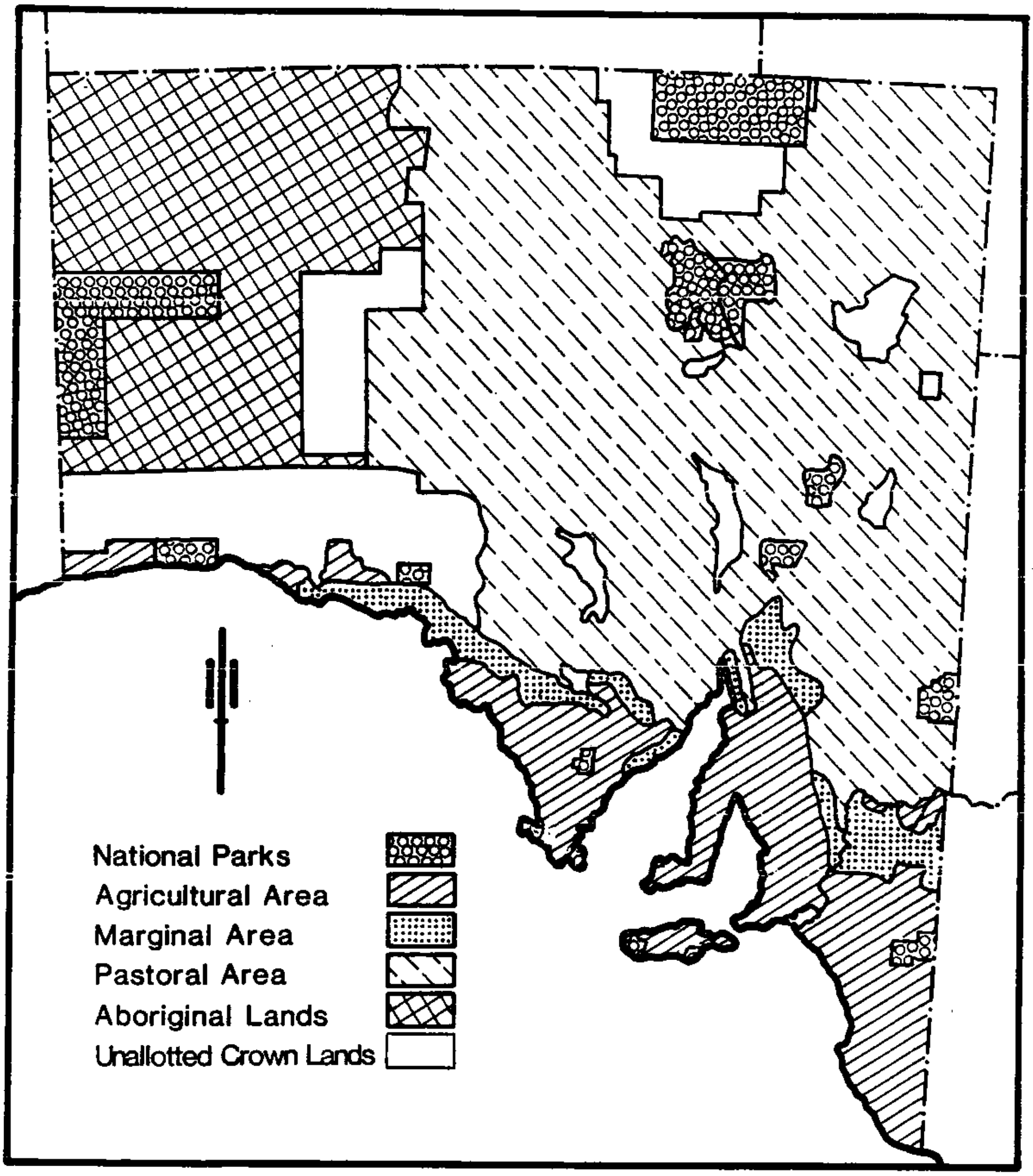
TABLE 1.2: EXTENT OF NATIVE VEGETATION CLEARANCE IN SOUTH AUSTRALIA'S AGRICULTURAL AREAS IN 1974 AND 1985

Region	Total Area (ha)	Area Cleared 1974 Ha	Area Cleared 1974 %	Area Cleared 1985(est) Ha	Area Cleared 1985(est) %	% reduction
Lower South East	1,037,552	964,157	92.92	999,154	96.30	3.38
Upper South East	2,049,160	1,502,366	73.32	1,630,066	79.55	6.23
Murray Mallee and Plains	2,787,037	2,265,582	81.28	2,453,296	88.03	6.75
Kangaroo Island	405,274	229,309	56.68	237,443	58.59	1.91
*Mt Lofty Ranges & Adelaide Plains	1,015,264	961,995	94.75	N/A	N/A	N/A
*Mid & Upper North	2,522,005	1,925,701	76.35	N/A	N/A	N/A
*Yorke Peninsula	907,205	833,370	91.86	N/A	N/A	N/A
Eyre Peninsula	3,011,129	1,927,427	64.01	1,966,381	65.30	1.29
West Coast	1,782,375	1,048,755	58.84	1,097,156	61.56	2.72
TOTAL	15,517,001	11,658,662	75.13	#12,233,604	#78.84	#3.71
TOTAL EXCLUDING REGIONS MARKED *	11,072,527	7,937,596	71.18	8,383,496	74.89	3.71

Source: Harris, 1976; Vegetation Retention Unit, 1985.

N.B. 1985 figures are not available for regions marked with *.
These figures are weighted averages derived from the regions for which data are available, and extrapolated to include the regions for which 1985 data are not available.

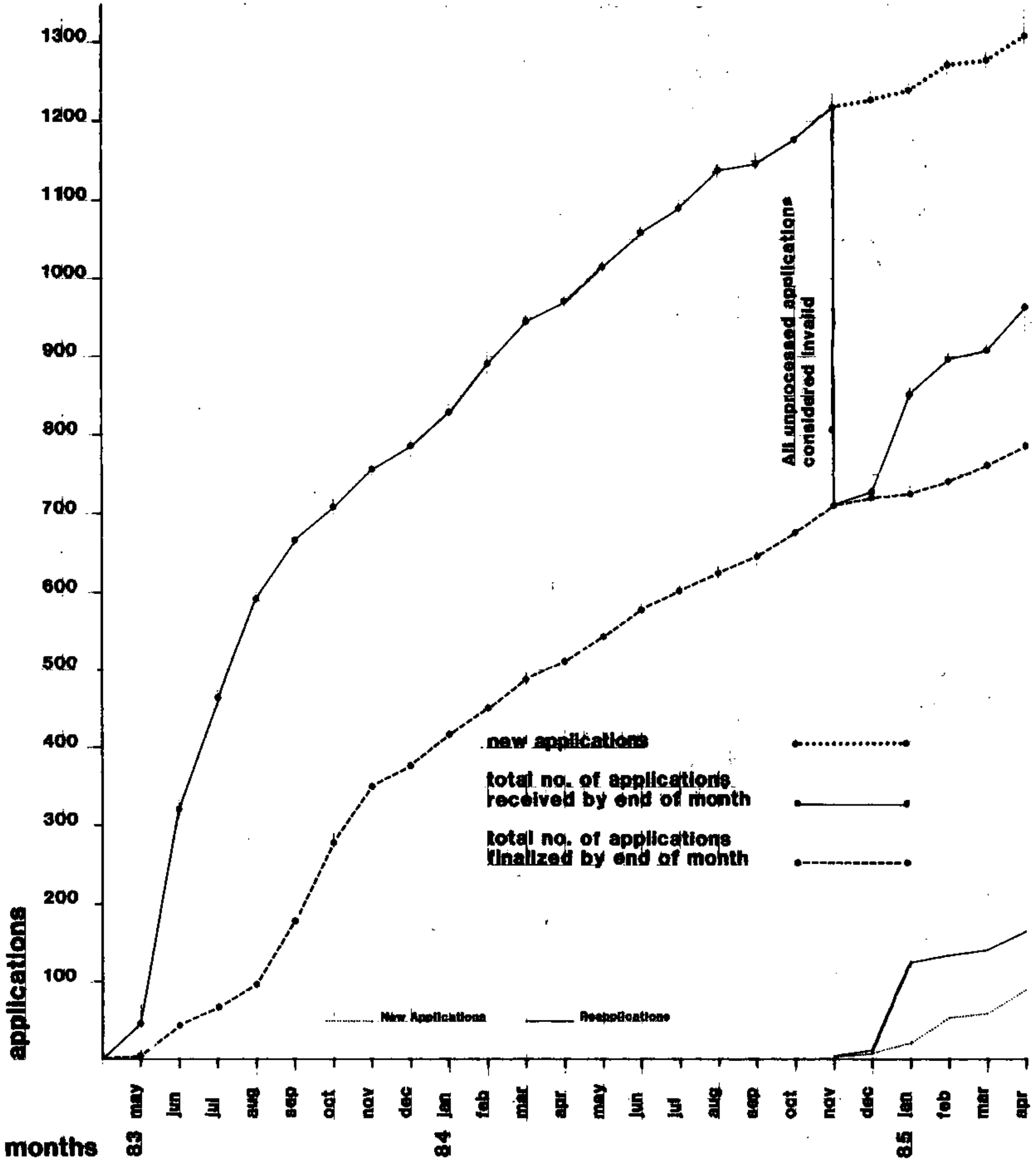
FIGURE 1.2 CURRENT LAND OCCUPATION OF SOUTH AUSTRALIA



Clearance constitutes a continuing pressure upon an ever diminishing and essentially non-renewable natural resource. It has become the focus of land use conflict between a significant proportion of the farming community on the one hand, who commonly view such areas as undeveloped agricultural potential, vermin reservoirs (Craig et al, 1983), or fire hazards, and State Government departments responsible for conservation of natural resources on the other, who view the same areas as being essential contributors to the viability of the State's park and reserve system. The parks are essentially small islands of natural habitat isolated from one another in a sea of agricultural land usually inhospitable to native flora and fauna. The continued existence of significant tracts of native vegetation outside national and conservation parks is the only realistic way in which the recognised consequences of isolation in the parks' plant and animal communities can be avoided. The habitat formed by the remnants of vegetation is needed to provide stepping stones and corridors along which animals and plants can disperse in order that their genetic material may be circulated and healthy and diverse populations maintained throughout their range. If this process can no longer be accomplished owing to increased isolation, it will very probably lead to genetic impoverishment and a rise in the rate of species extinction (MacArthur and Wilson, 1967; May, 1975). This situation would make the requirement of the National Parks and Wildlife Act 1972 very difficult to fulfil. Section 37(a) clearly identifies "the preservation and management of wildlife" as a primary objective.

The trend towards further clearance has continued in the two year period since such clearance was brought under the control of the Planning Act in May 1983 (Fig. 1.3). Until the end of April 1985, 1281 applications to clear native vegetation from rural properties had been received by the DEP, and while a significant proportion of these areas would probably not have been cleared in the immediate future, it is likely that all the land covered by the applications would have been cleared eventually. To the end of April 1985, 745 (58.2%) of the applications had been processed, and of these 138 (18.5%) had been refused (Vegetation Retention Unit, 1985). Consequently these few areas are now afforded a degree of legal protection which will help ensure the existence of at least some areas of natural habitat outside the park and reserve system. However such areas have not necessarily been provided with management assistance and are difficult to police, and thirteen instances of clearing without planning permission had come to light by the end of March 1985 (Vegetation Retention Unit, 1985). Taken together with the c. 15 000 ha now protected by voluntary agreement

FIGURE 1.3 VEGETATION CLEARANCE APPLICATIONS - MONTHLY STATUS



Source: Vegetation Retention Unit 1985

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with individual landholders under the South Australian Heritage Act 1978, remnant vegetation forms a small but valuable addition to habitat conserved in the park and reserve system in the agricultural regions of the state.

South Australia's first national park at Belair in the Adelaide Hills was proclaimed in 1891. The exertions of a small number of dedicated individuals succeeded in increasing this number to 19 by early 1962, against a background of wars, economic depression, public and political indifference, and outright opposition from a variety of vested interest groups. Land reserved for conservation purposes during this period had even been resumed for conversion to agriculture, notably sections of the Hambidge and Hincks Conservation Parks on Eyre Peninsula. Both these were dedicated in 1941, but between 1952 and 1962, their combined area was reduced by a total of 14,418 ha representing 12% of their original area. For the State as a whole during this period 15,641 ha were pared from the reserve system (6.2% of the total area at the time), most of it being resumed for farming purposes (Harris, 1974). The prevailing philosphy at the time had been to declare as reserves land for which no economically productive use was considered possible. Thus it was only amid soaring wheat and wool prices between the late 1940s and early 60s that substantial efforts were made to secure resumption of land from existing reserves in the drylands of Eyre Peninsula.

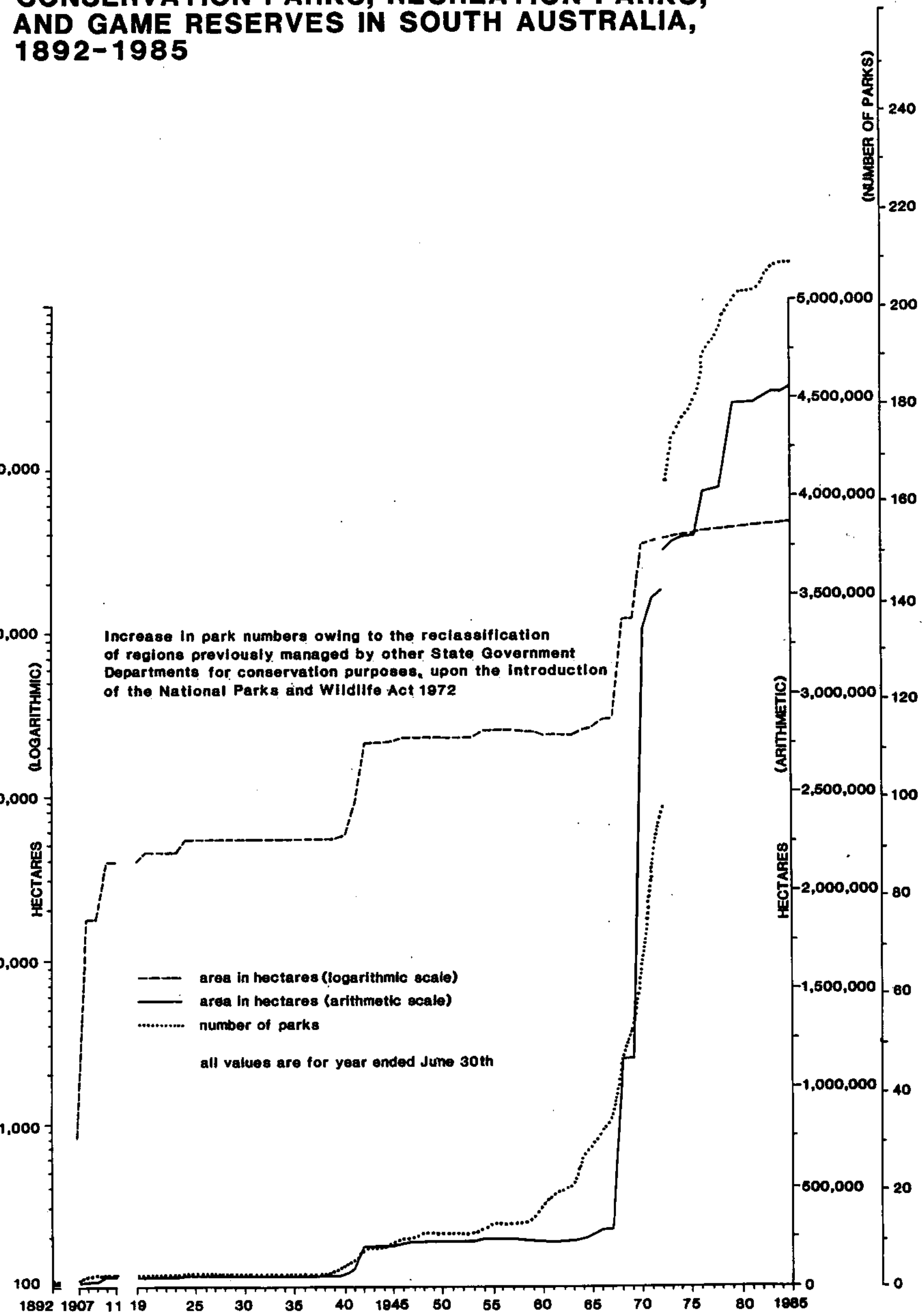
The most significant gains for the park system however were achieved in the decade 1962 to 1972, when a combination of social, economic, and legislative changes resulted in the addition of a further 80 parks and reserves to the system, bringing the total area to 3,546,564 ha by June 1972. It was during this period that the merits of conservation as a land use in its own right began to obtain popular recognition and acceptance. The National Parks Act of 1966 afforded reserves protection of more than a temporary nature for the first time. It was under this Act that major reserves were set up outside the agricultural regions also for the first time, notably the vast Unnamed Conservation Park in the far north west (2,132,600 ha), Simpson Desert Conservation Park in the far north (692,680 ha), and many of South Australia's 134 offshore islands.

When this Act was replaced in 1972 by the current National Parks and Wildlife Act, control of a further 66 areas previously under the jurisdiction of other government departments and totalling 218,343 ha was passed to the National Parks and Wildlife Service (NPWS). This set the scene for consolidation of the system which has continued ever since. Major additions since 1972 include the largest remaining uncleared area in the otherwise intensively farmed Murray Mallee region, Ngarkat (207,941 ha) Conservation Park, and the 253,230 ha Danggali Conservation Park on a comparatively lightly grazed area of the eastern pastoral area.

The 4,578,660 ha protected within the South Australian park system at the end of June 1985 comprises 209 separate areas (see Figure 1.4). Most are within the southern agricultural regions, where a reasonable percentage of the pre-settlement habitat types are represented (Davies, 1982). Habitats representative of the arid interior, and of the wide variety of wetland types known to occur there are not adequately represented however. These aspects are explored further in section 1.1.2 and 2.1. The other major omission is the marine environment. No sub-tidal region is represented, and there is no indication that NPWS interest will extend below the sea's surface in the foreseeable future. This issue is addressed in section 3.1.

The National Parks and Wildlife Act 1972 charges the NPWS with the establishment and management of reserves, intended amongst other things to contain representative areas of all natural ecological systems occurring in the State and to protect the flora and fauna they contain. In some instances, the NPWS has played an important role in the re-establishment of locally extinct or endangered native animals. These are discussed in sections 1.3.1 and 2.3.1. In addition certain plants and animals are specifically protected to varying degrees, and their destruction or damage can result in prosecutions being brought against apprehended offenders. The commercial kangaroo harvest administered by the Service falls into this category. The third area of activity for NPWS is the encouragement of practical conservation measures on non-reserve land. This is achieved largely through the avenues of information distribution and education. Unfortunately when funding for NPWS activities becomes excessively restricted, available resources become concentrated within the first two areas. The dangers inherent in relying solely upon reserves for practical conservation have already been indicated. A continuing emphasis upon environmental education aimed at the next generation of land-managers now passing through the education system would be the most effective conservation measure. It is important that this aspect of the publicly funded environmental programme be strengthened. The long term success of direct conservation action taken now in reserves and on isolated farm holdings, largely depends on the practical implementation of similar measures by a majority of well-informed, far-sighted, and sympathetic farmers in the near future.

FIGURE 1.4 INCREASE IN NATIONAL PARKS, CONSERVATION PARKS, RECREATION PARKS, AND GAME RESERVES IN SOUTH AUSTRALIA, 1892-1985



One notable shortcoming of the park and reserve system as it stands, is that of the 165 distinct vegetation association categories known to exist in the State, 39 (24%) are not conserved at all within the system, and 21 (13%) are only poorly conserved (for example in a weed infested or feral animal grazed condition) (Davies, 1982). Therefore, many important strongholds of these vegetation associations and the fauna that depends upon them are on either private property, or on public land not managed primarily for conservation such as unallotted crown lands and roadside reserves.

Overall however the parks and reserves of South Australia form an essential and relatively secure basis on which sound conservation management can build. With prudent land management on private land as well, the trend towards depleted populations and local extinctions could be halted and even reversed.

When the vegetation clearance regulations were introduced a considerable animosity between agricultural and conservation interests became evident. There is a prevalent view that habitat protection is designed largely for the esoteric requirements of those interested in its component plants and animals. While this end is no doubt served to some extent, the overriding importance relates to land and water conservation. Widespread and costly occurrences of soil erosion, soil salinity, watercourse and aquifer depletion and pollution can all be directly related to prevailing land management practices and the broadscale clearance of the natural vegetation which preceded it (E&WS 1985, Jayal 1985).

In order to reach a degree of consensus between the State Government and the farming community on this issue, financial compensation to individual landholders who have been refused permission to clear more land has been agreed to. It reflects the difference in market value between land which may be cleared and therefore made productive, and comparable land where the vegetation must be retained and which would attract a lower price on the open market. The Native Vegetation Management Act 1985, replaces the vegetation clearance regulations in the Planning Act, and gives responsibility for its implementation to a Native Vegetation Authority (NVA) established for the purpose. The Authority comprises representatives of conservation, farming, and government interests. Landholders must now make clearance applications to the NVA. Financial assistance will be available to landholders for expenses incurred in fencing and management of areas for which clearance applications have been refused. Significantly payments will be made only where the area in question is equivalent to 12½% or more of the property, with the land having been acquired by the applicant before 12 May 1983. In addition compensation will be paid only to those prepared to enter into a Heritage Agreement under the terms presently contained in the South Australian Heritage Act, 1978.

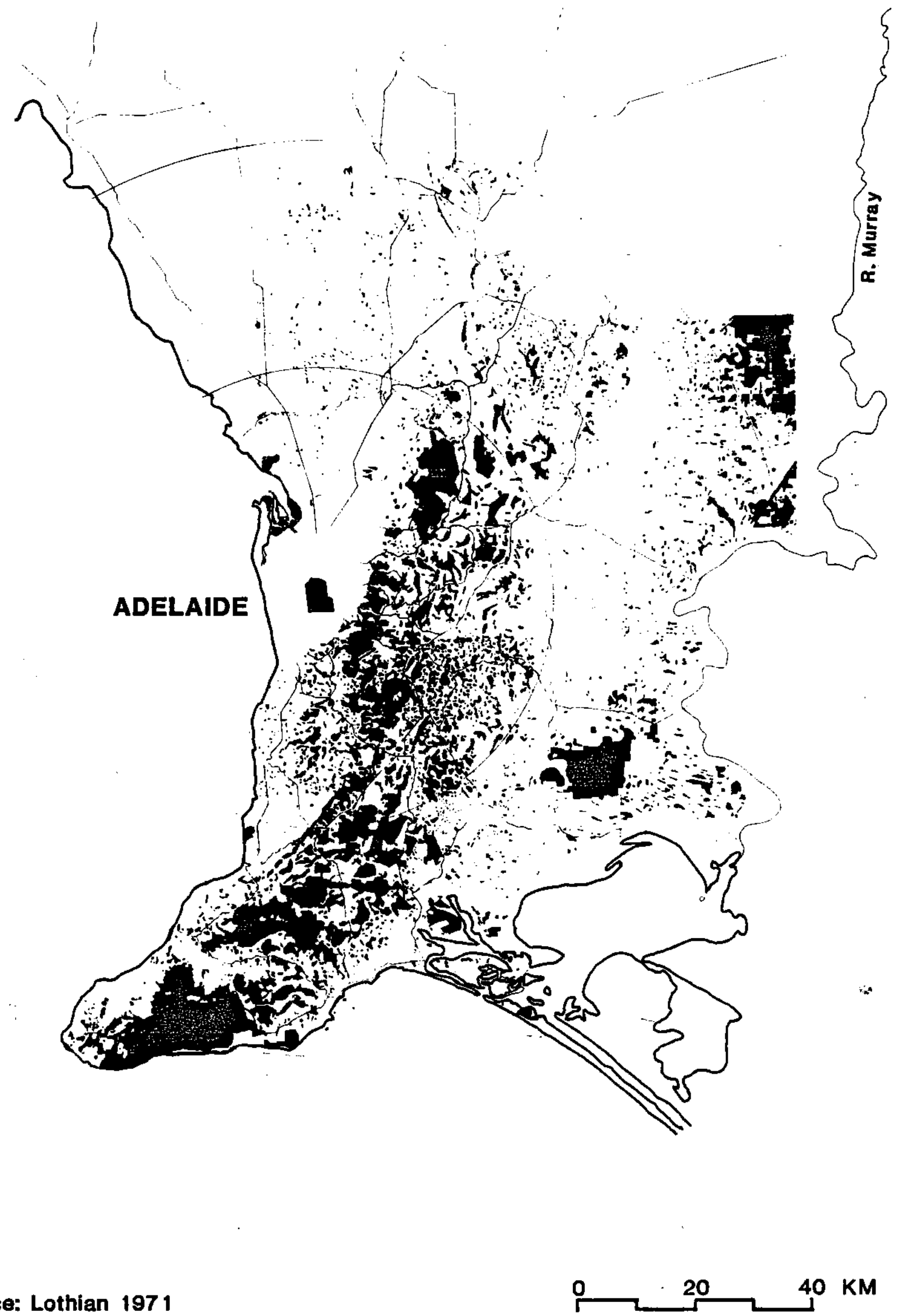
To illustrate the extent and rate of clearance two case studies are presented in map form which show changes to native vegetation over time. They are the Mount Lofty Ranges area and Kangaroo Island, which represent one of the most extensively cleared and the least cleared of the agricultural regions respectively (Figs. 1.5, 1.6 and 1.7).

The phenomenon of tree decline is an important contributing factor to decreasing vegetation cover. Work has been undertaken within the Department of Environment and Planning to determine the extent of the problem in the agricultural regions of the State. Most of the remaining native vegetation in the agricultural regions outside the parks and reserves system, is being modified to some extent by farm management practices. This results in a continuing loss of natural vegetation through permitted and illegal clearing, compounded by the death of aging trees and lack of natural regeneration. In many agricultural regions only isolated trees remain and many of these are dying. Without an active programme of replacement, such areas will inevitably become barren of perennial vegetation.

Factors contributing significantly to the loss of trees are natural senescence, secondary clearance, and premature death due to environmental stress. Variables contributing to environmental stress include fungal disease, insect infestations, and ringbarking and root trampling by stock. The continuing loss of remaining trees on farms brings into focus the value of remnant vegetation and the importance of its retention and even expansion. (Sullivan & Venning, 1982).

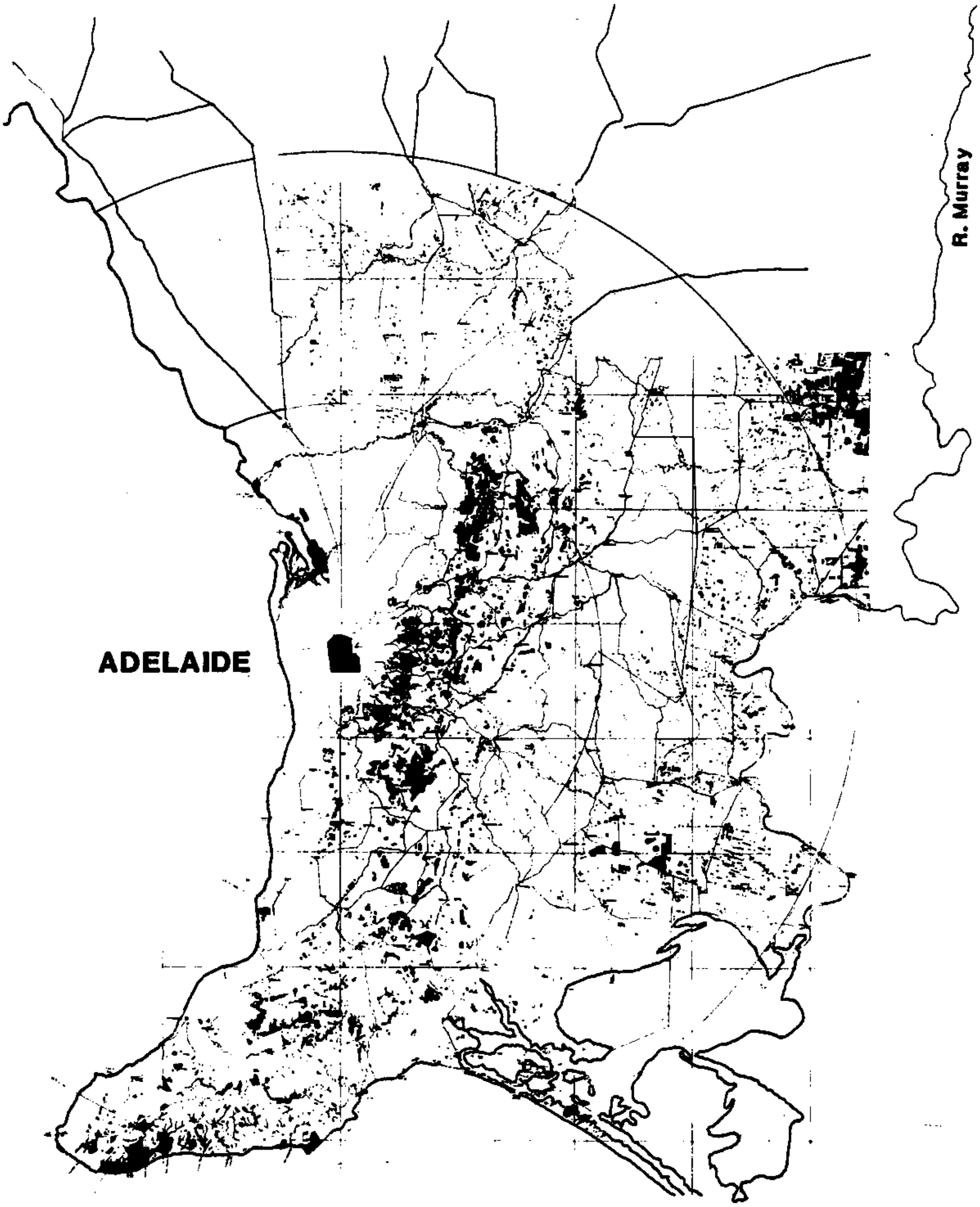
Another element in the demise of indigenous flora and fauna is the introduction of exotic species which compete for space and nutrients. Many introduced species find their new environment does not possess the array of predatory and parasitic organisms, or climatic factors which help constrain excessive population growth in their regions of origin, and hence can build up unusually large numbers. Agricultural and forestry practices are increasingly based upon monoculture crops and pastures grown with the assistance of fertilisers and pesticides. Such practices can create a hostile environment for indigenous plants and animals, and greatly reduce the availability of suitable habitat for many native species over extensive tracts of country.

FIGURE 1.5 NATIVE VEGETATION IN THE CENTRAL AND SOUTHERN MOUNT LOFTY RANGES IN 1945



Source: Lothian 1971

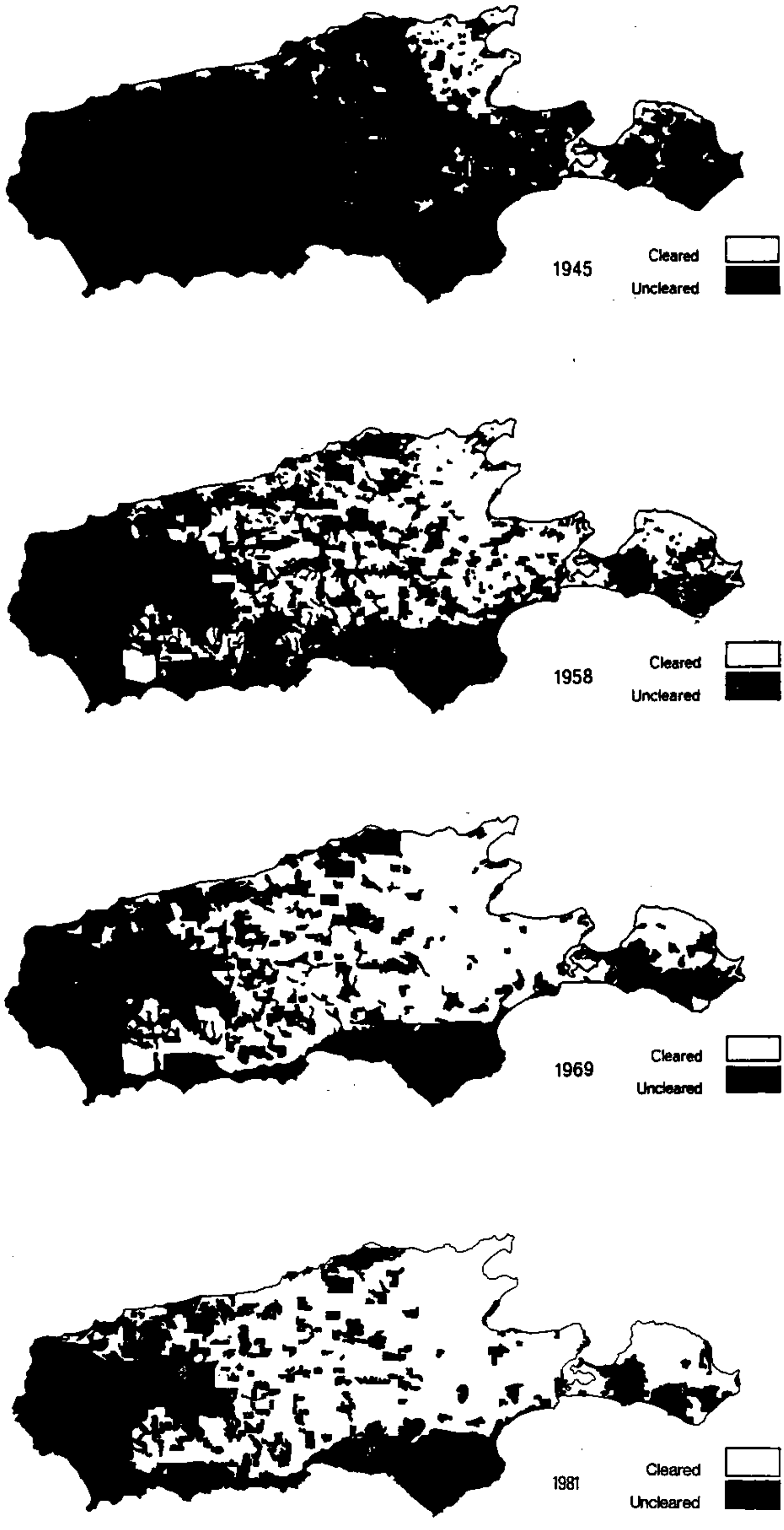
FIGURE 1.6 NATIVE VEGETATION IN THE CENTRAL AND SOUTHERN MOUNT LOFTY RANGES IN 1968



Source: Lothian 1971

0 20 40 KM

FIGURE 1.7 NATIVE VEGETATION ON KANGAROO ISLAND IN 1945, 1958, 1969, 1981.



Sources: 1 Maps for 1945, 1958 and 1969 – Harris, 1984

2 Map for 1981 – Mowling & Barritt, 1981

Many introduced weed plants have specialised dispersal and germination mechanisms which enable rapid colonisation of disturbed land such as tracks, firebreaks and cultivated areas. Seed dispersal is aided by the movement of vehicles which can transport trapped seed from one area to another. Once established they can compete with the native flora and rapidly move into areas vacated by dead plants. This has the effect of reducing available food supply, cover, and breeding sites for native animals many of which have evolved a close dependence on native plants for food and shelter. Exotic carnivourous animals often prey on native marsupials, rodents, reptiles, and birds. Indeed foxes and cats in particular have been cited as the main reason for the decline and even extinction of several of South Australia's native animals, such as the Western Barred Bandicoot Perameles bougainville, Brush-tailed Bettong Bettongia penicillata, Burrowing Bettong B. lesuer, and Greater and Lesser Stick-nest Rats Leporillus conditor and L. apicalis. All these species are either entirely extinct, or are confined to offshore islands free from feral animals (Strahan, 1983; Aslin, S.A. Museum, pers. comm.).

It is worth mentioning here that some commentators consider the decline and even extinction of many mammals and birds to be a result not of direct impact from Europeans, but to have been caused by a cessation in the traditional seasonal burning practices of Aboriginal people when they were finally forced to abandon their nomadic ways in the 1930's. The fact that many species declined drastically around that time tends to support the idea (Bottom et al 1975), especially for mammals in the arid zone.

The availability of plants as a food resource has progressively diminished because of agricultural, urban and other developments, and the grazing and browsing activities of introduced animals. These introduced herbivores and omnivores are an additional source of competition for native plant eaters. When good plant growing conditions prevail, the populations of species such as rabbits, goats and rats grow and exert increased pressures on the vegetation. As is often the case in Australia such conditions are short lived and once normal low plant productivity resumes, elevated feral animal populations largely unchecked by predation, are forced to feed on the vital parts of plants such as their roots and bark, often killing them in the process. Furthermore, the relatively benign climate of South Australia does not have the population suppressing influences of severe winters which introduced species generally suffered in their region of origin, thereby allowing their populations to remain vigorous and active for the whole year. Inevitably the balance between native plants and animals is put under strain and the picture of depleted populations and extinctions revealed in the appendices can be the end result. Conversely crop damage blamed on native and feral animals is often a consequence of insufficient natural feed for populations which are artificially boosted by the year round availability of stock or irrigation water. In this way drought has been effectively removed as a natural suppressant of animal populations over much of Australia. Unfortunately the native vegetation can suffer the effects of overgrazing alongside cultivated crops and pastures. At the same time it is seen as a refuge for offending animals, and its elimination a convenient means of pest control.

1.1.2 Marginal And Arid Lands

It appears that the pressures being exerted upon the vegetation of these extensive semi-arid and arid areas of the State (see Figure 1.2) are regarded by the general community as being less serious and requiring less immediate attention than those evident in the settled and agricultural regions. However the vulnerability of marginal and arid lands is evidenced by the activities of the Pastoral Board, which occasionally has cause to issue de-stocking orders for particular pastoral leases in instances where grazing pressure is at too high a level for the vegetation to support without incurring permanent damage (Department of Lands, 1981), a recent example being Nantawarrinna Station in the Flinders Ranges. Although legislation exists to prevent such a situation arising, it only has practical force through the regulations, that is, sensible stocking rates being recommended and monitored. It is of significance that no prosecutions have ever occurred under the Pastoral Act, even though instances of severe land degradation resulting from mismanagement are a common feature of the pastoral zone.

Marginal and arid areas have also been a source of concern because of their widespread susceptibility to soil erosion. This results from clearance for crop production in marginal lands, and in the arid zone by a combination of over-grazing and consequent reduction of vegetation cover and the damaging physical effects of livestock trampling on the soil surface. Both of these factors facilitate the erosive forces of wind and water, as well as reducing the recuperative potential of the vegetation which contributes substantially to the stability and productivity of arid zone soils (Harrington, et al 1984). Loss of vegetation is also thought to be a primary factor in the drastic reduction and extinction of many native mammals and ground dwelling birds who rely on it for shelter, nest building, and as a food source (Low, 1984).

The initial task of quantifying the state of biological resources in these areas is hampered by a lack of quantitative survey data. Four surveys (Hall et al, 1964; Fatchen, 1978; Lay, 1979; Lange et al, 1984) in the arid regions indicate a rapid rate of loss of vegetation under prevailing management practices, particularly at the density level (see Fig. 1.8 and Table 1.3).

Of all rangeland types, saltbush (regions where the dominant perennial shrubs belong to the drought adapted family Chenopodiaceae, particularly the genus *Atriplex*) is the most extensively documented in Australia (Graetz and Wilson, 1984). The available records have contributed to an understanding of how the landscape has altered under grazing pressure from domestic stock and feral animals, and what can be expected if grazing continues. Unfortunately, it does not appear that this information has automatically translated into enlightened land management practices. These lands are still subject to degradation.

Domestic stock have been grazing the arid lands for over 100 years. Substantial areas have incurred loss of shrubs, and to a lesser extent destruction and loss of topsoil. Historical records suggest that this mainly occurred during early settlement times and to a lesser degree, in later periods of economic depression (Graetz and Wilson, 1984). Nonetheless, overgrazing is still a problem.

There is an urgent need for regular and comprehensive records from pastoralists regarding stocking rates. The reports mentioned above indicate the incompleteness or absence of such information, which makes quantitative correlations between stocking rates and condition of vegetation impossible.

Records of vegetation succession on a section of the arid zone have been kept, albeit intermittently, over a period of 50 years. Koonamore Vegetation Reserve (now named T.G.B. Osborn Vegetation Reserve) was established on an overgrazed section of arid vegetation in the north-east of South Australia in July 1925 when the lease was transferred to the University of Adelaide. It covers an area of approximately 400 hectares and was fenced to exclude sheep and rabbits, although this was not always successful. Damage to fencing caused by kangaroos often allowed the entry of large numbers of rabbits, as well as the kangaroos themselves.

Perennial vegetation in the arid zone is significant for two reasons. First, as a soil stabiliser and secondly, as a subsistence diet for animals during periods of drought after the ephemeral herbage has been eaten. In this region, overstocking for even a short time may lead to destruction of the perennial flora and erosion of the land surface. Hall et al (1964) contend that when this has occurred, regeneration of most species has been poor, even after sheep have been excluded from the area for many years, and rabbit numbers reduced.

According to Hall et al (1964) regeneration is only possible if:

(1) there are source plants present in the area;

(2) the species flowers and fruits readily;

(3) the seeds remain viable until a season favourable for germination occurs, possibly many years later;

(4) the seeds have a high germination rate;

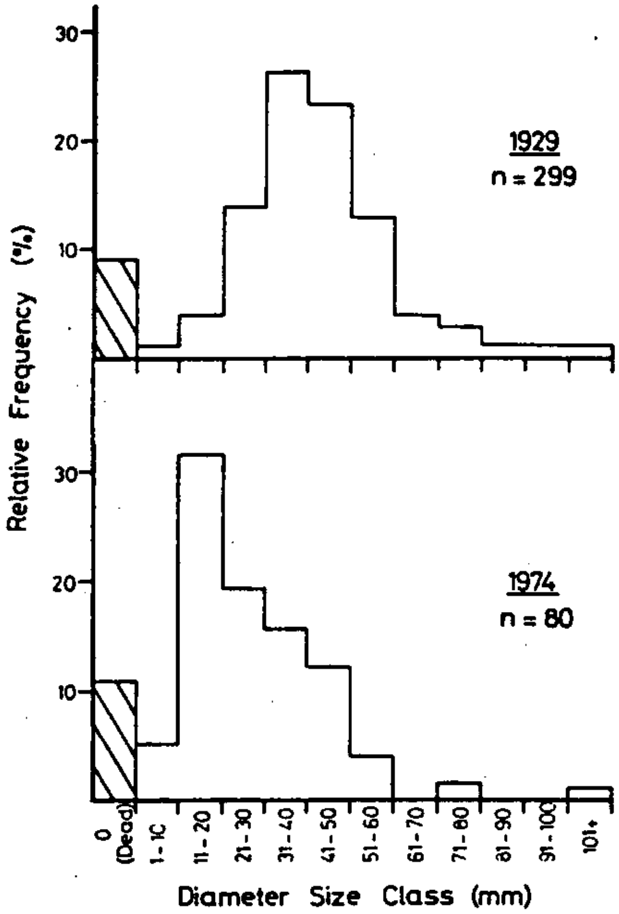
(5) there is a suitable seedbed for establishment; and

(6) the seedlings are relatively unpalatable to introduced animals such as sheep and rabbits.

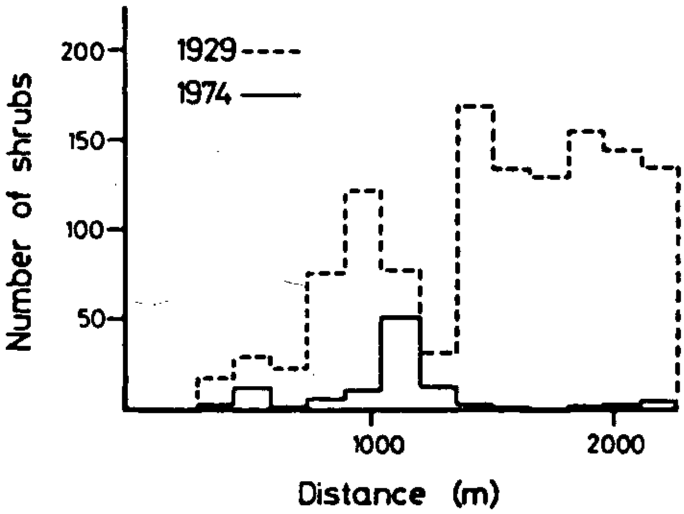
As these requirements are met by only a few species, changes in the composition, densities, and populations of plant species present on Koonamore Vegetation Reserve have become obvious (Figure 1.9).

Owing to the fact that Koonamore Vegetation Reserve has such a long recorded history, it is important that the work continues in order to further assess the long-term effects of pastoralism on the arid landscape. The work is complemented by studies being carried out at the Middleback Field Station, near Whyalla, where emphasis is placed on the dynamic responses of vegetation to current grazing pressure exerted by sheep. Both of these projects are run by the Botany Department, University of Adelaide (R. Sinclair, Uni. of Adelaide, written comm.).

FIGURE 1.8 CHANGES IN ARID LAND SHRUB DENSITY ON A 2140m TRANSE AT FROME DOWNS CATTLE STATION, SOUTH AUSTRALIA IN THE 45 YEAR PERI AFTER CATTLE GRAZING COMMENCED IN 1929



Relative frequency distribution of largest diameters of *Maireana astrotricha* canopies, 1929 and 1974

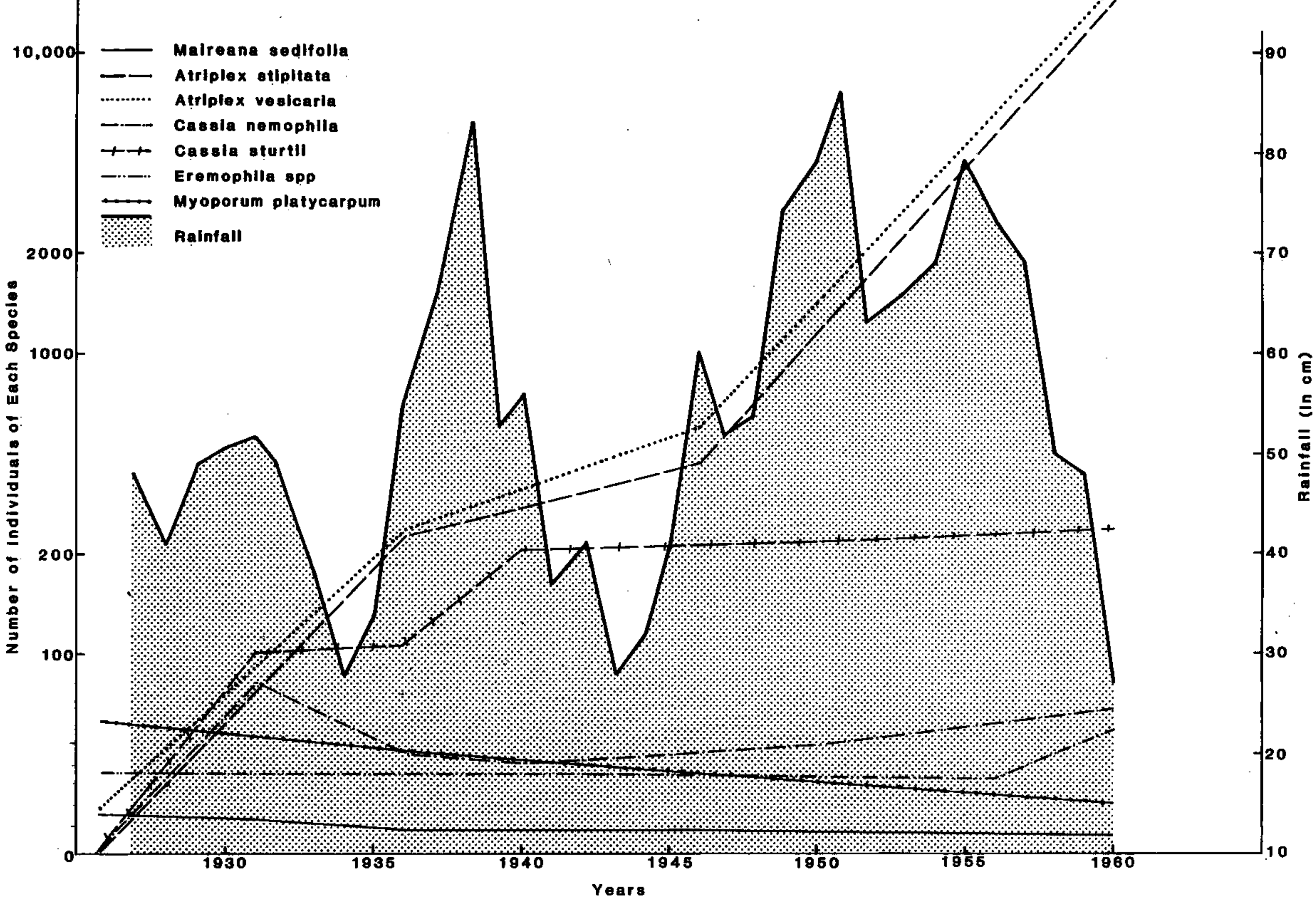


Distribution of all shrubs in the transect, 1929 and 1974

Source : T.J. Fatchen , 1978

FIGURE 1.9

CHANGES IN THE ABUNDANCE OF PERENNIAL PLANT SPECIES AT KOONAMORE VEGETATION RESERVE BETWEEN 1926 AND 1960 CORRELATED WITH RAINFALL FOR CONSECUTIVE THREE-YEARLY PERIODS PLOTTED AGAINST THE MIDDLE-YEAR FOR EACH CONSECUTIVE PERIOD.



Notice How only some species respond initially to removal of grazing pressure, increase in abundance is not directly dependant upon rainfall in all species; and some species, most noticably the larger shrubs and trees do not recover at all from grazing pressure. N.B. Data include seedlings, no attempt to account for survival rates has been made.

Source: Data from Hall et al 1964

TABLE 1.3: CHANGES IN NUMBERS OF ARID LAND SHRUBS ON A 2140M TRANSECT AT FROME DOWNS CATTLE STATION, SOUTH AUSTRALIA, IN THE 45 YEAR PERIOD AFTER CATTLE GRAZING COMMENCED IN 1929.

Shrub Species	Number of Individuals recorded on transect 1929	1974
Atriplex vesicaria	946	4
Maireana astrotricha	299	80
M. aphylla *	0	26
M. pyramidata *	0	9
Total Maireana spp.	299	115
Total Shrubs	1245	119

* It is not known whether these two species were unrecorded in the 1929 survey because they were not of interest to that particular study, or whether they were not growing on the site at that time.

Note: Rabbits were established in this area prior to 1929. Vegetation changes are therefore attributed to cattle grazing.

Source: Fatchen, 1978

Management regimes which permit a sustainable pastoral yield and allow for the maintenance of vegetation communities have been established in limited areas of the State's arid regions since 1896 (Waite, 1896; Lange et al, 1984). However, it would appear that a desire to maximise financial returns over the short term and/or inadequate availability of the information necessary for the development of sound management practices, has led to extensive depletion of the standing crop of natural vegetation over very large parts of the pastoral area.

The need for a vegetation condition monitoring programme is clearly spelt out in a recent overview of the management of Australia's pastoral lands (Harrington et al, 1984), which also highlights the difficulties faced by pastoralists in attempting to manage their properties for long-term viability. This is a consequence of the notorious unpredictability of rainfall and its effect on vegetation condition, which in turn determines carrying capacity for a given area of land. Because vegetation responds to the prevailing climatic conditions, good rainfalls allow new plants to replace those lost through old age and drought. Excessive grazing pressure at these times has the potential to suppress such natural regenerative processes, leading to deterioration of the vegetation and a decrease in its resilience to environmental stress in the long term. Of course it is these same times of rapid, verdant growth that offer the pastoralists rare opportunities to increase their profitability by increasing stocking rates, and perhaps recoup some of the losses incurred in previous drought seasons, thus providing the circumstances for the observed widespread deterioration in rangeland condition.

South Australian pastoralists often point to the valid observation that their industry is the most efficient and conservatively managed of any such enterprise in Australia. This position can only be maintained because pastoral lands in other States are generally at a more advanced stage of degradation (Harris, 1983) owing to various historic factors including less flexible land tenure systems and longer periods of exploitation.

It is perhaps opportune then that the South Australian Department of Lands, which has overall responsibility for administering the pastoral industry, has instigated a programme of Range Condition Assessment. Since 1983 a team of six rangeland officers (to be expanded to twelve by 1988) have been conducting 'Rangeland Resource Inventories' on a lease by lease basis. It is estimated that at least another eight years will be required before each of the 358 pastoral leases has been surveyed for the first time. (J. Vickery, Lands Dept., pers. comm.) The data gathered are stored on computer files and will form the basis of a monitoring programme which could eventually allow information to be provided to individual land managers enabling them to achieve optimum stocking rates and range conservation for given climatic conditions. To the end of February 1985 seven surveys had been commenced, with four published or in press. It is hoped that with improvements in remote sensing technology and the establishment of a ground verification index for the pastoral lands, the rate of survey will be increased to meet the objective. However trends can only be expected to begin to emerge and causative relationships identified in another decade or so. This makes the programme an unusually far-sighted one, although unfortunately it cannot influence short term management decisions. It has been met with a degree of scepticism, but it is hoped that the programme will yield practical data enabling the establishment and maintenance of sustainable pastoral management practices in a farming industry occupying over half of the State's area.

1.2 TERRESTRIAL FLORA

1.2.1 Vascular Plants

A list of the vascular plants of South Australia has been published by the Adelaide Botanic Gardens, State Herbarium and Department of Environment and Planning (Jessop, 1984). It records 4,200 species classified under 160 families. Of these, 989 are introduced species, leaving 3,211 species native to South Australia.

Information on distribution is also included in the list. The regions of South Australia adopted by the State Herbarium are shown in Appendix 1. It is envisaged that the Vascular Plants List will be updated regularly.

By March 1985, a total of 197 species recognised as being extinct, rare, or threatened were recorded in South Australia (Table 1.4). These species have been categorised to indicate various degrees of threat. Hartley and Leigh (1979) developed a binary coding system, the distribution category being indicated by numerals (1, 2, 3) and the conservation status by letters (X, E, V, R, K). Thus each species is coded with a number and a letter intended to be used in conjunction with each other. This system was retained by Leigh, Briggs and Hartley (1981) with some modifications to accord in part with the International Union for the Conservation of Nature and Natural Resources (IUCN) categories and further elaborated by Leigh _et al_ (1984).

A brief explanation of the coding system follows. (see Appendix 2 for elaboration).

Distribution Category

1. Species known only from the type collection.

2. Species with a very restricted distribution in Australia and with a maximum geographic range of less than 100 kilometres.

3. Species with a range over 100 kilometres in Australia but occurring only in small populations which are mainly restricted to highly specific habitats.

Conservation Status

'X' Species presumed extinct

'E' Endangered species in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate.

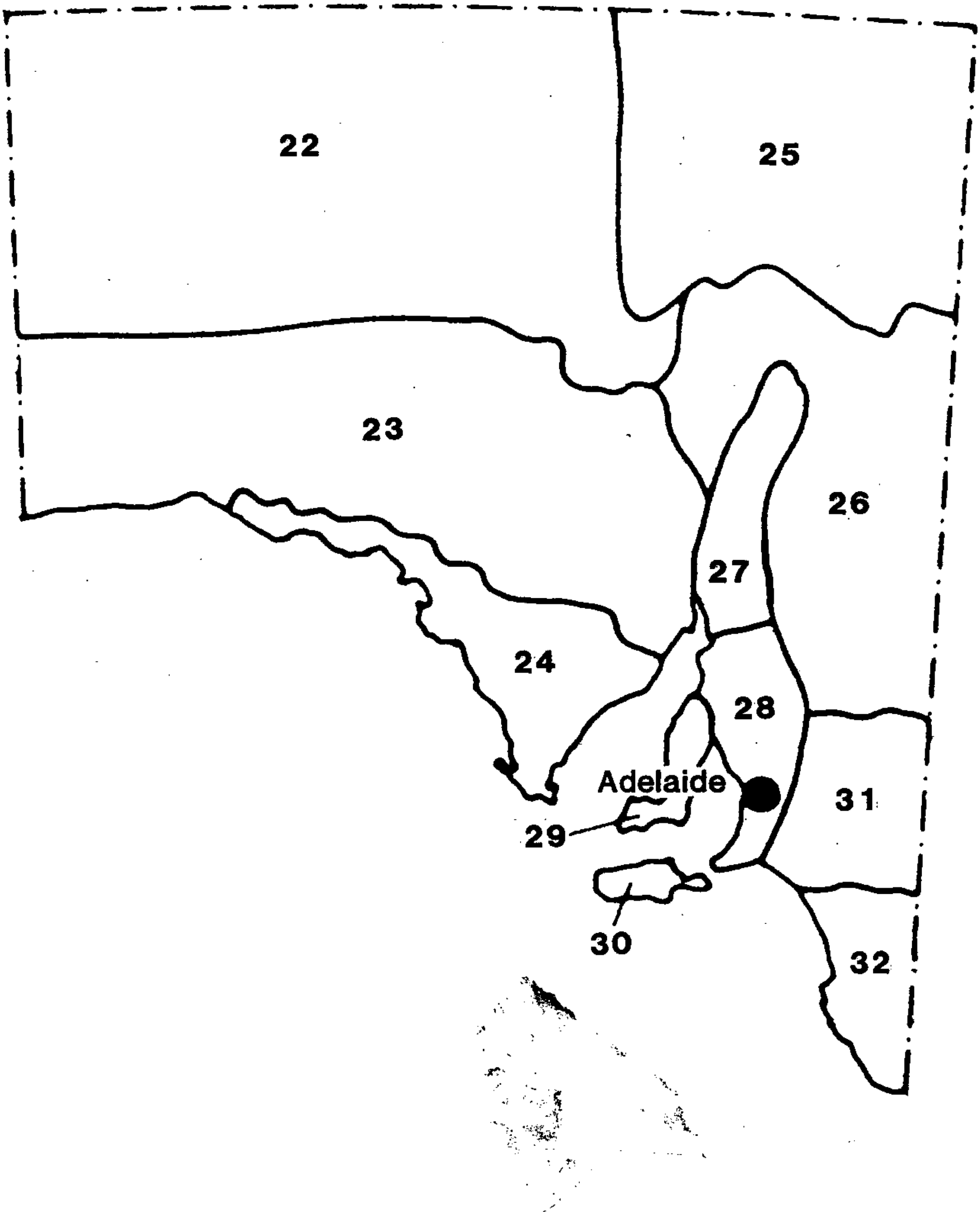
'V' Vulnerable species not presently endangered but at risk over a longer period through continued depletion, or species which largely occur on sites likely to experience changes in land use which would threaten the survival of the species in the wild.

'R' Species which are rare in Australia but which are not currently considered endangered or vulnerable.

'K' Poorly known species that are suspected, but not definitely known, to belong to any of the above categories.

The number of species within each conservation and distribution category in South Australia is listed in Table 1.4.

FIGURE 1.10 REFERENCE MAP OF REGIONS



Source: Leigh et al, 1984

0 200 400 KILOMETRES

TABLE 1.4: NUMBER OF PLANT SPECIES WITHIN EACH THREAT CATEGORY FOR SOUTH AUSTRALIA

	X	E	V	R	K	TOTAL
1	2	1	0	0	5	8
2	1	14	23	33	6	77
3	4	13	27	56	12	112
	7	28	50	89	23	197

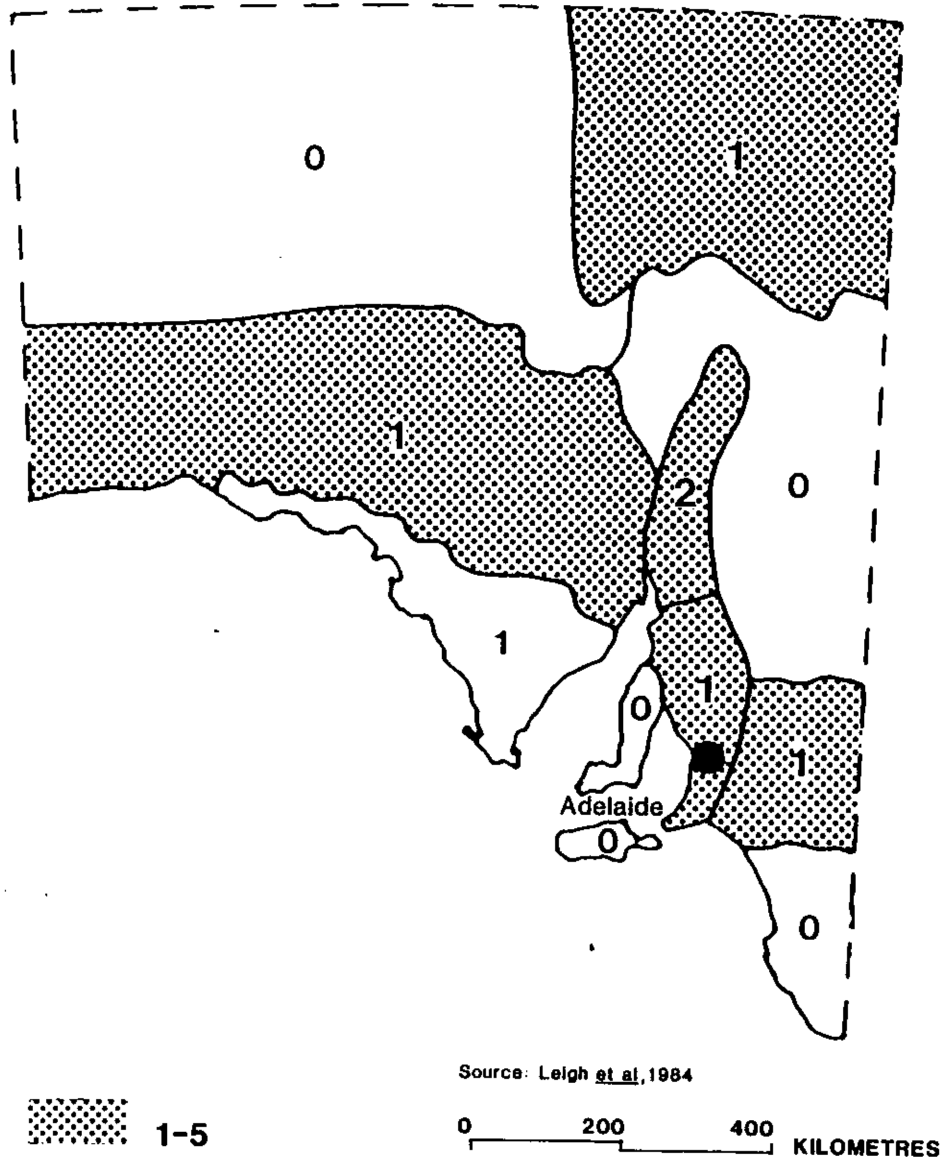
Source: Leigh, J., CSIRO unpublished

Separate lists of those species considered to be extinct or endangered are appended (Appendices 3 and 4). These also include information on distribution, vegetation type and reasons for their status. From this information, two maps have been produced to graphically display numbers of species considered extinct or endangered and their distributions (after Leigh et al, 1984). The regional division of South Australia adopted by Leigh et al is shown in Figure 1.10.

Figure 1.11 shows the number of plant species presumed extinct in each region. Region 27 (Flinders Ranges) is considered to have two species presumed extinct, and one each in Regions 23, 24, 25, 28 and 31 (Nullabor/Western Pastoral District, Eyre Peninsula, Lake Eyre Basin/Eastern Arid Zone, Mount Lofty Ranges and Murray Mallee respectively).

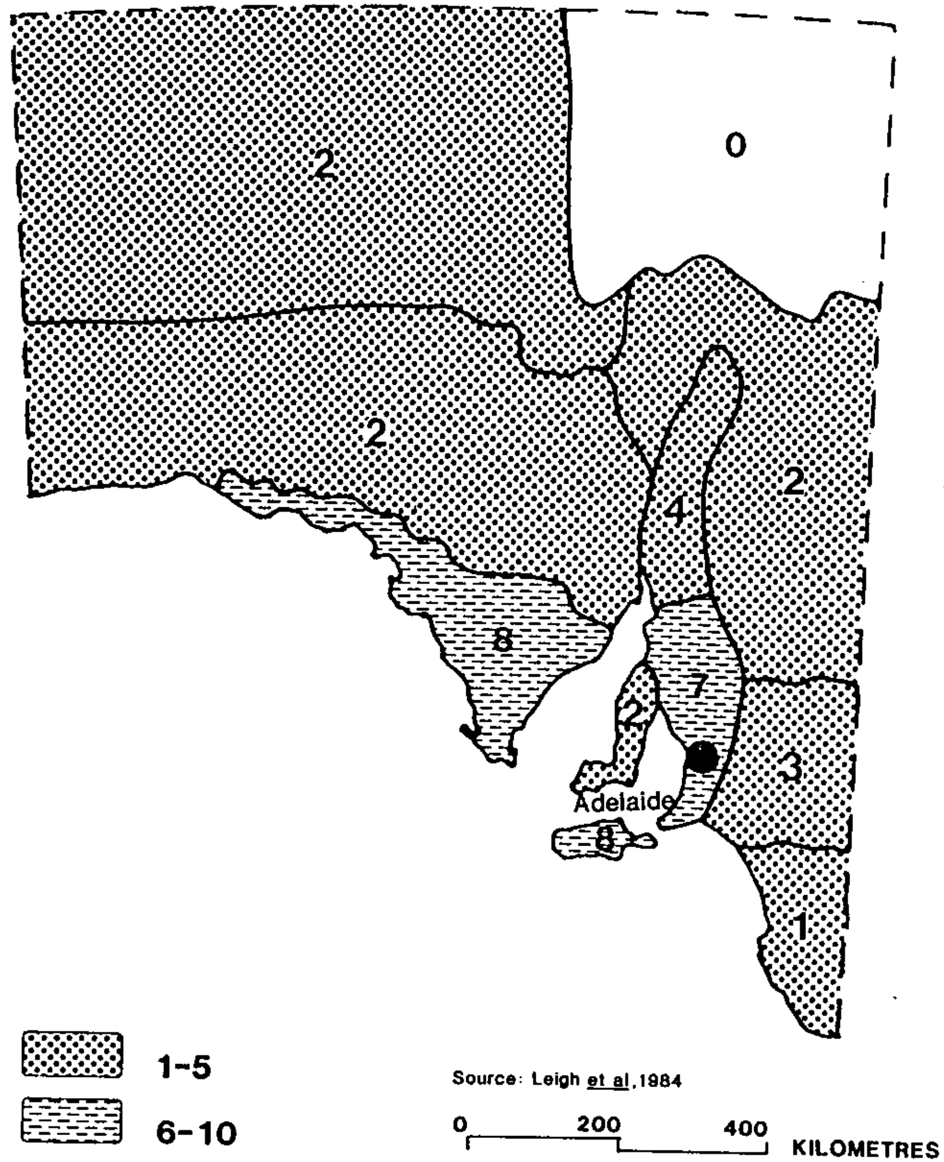
Figure 1.12 illustrates the numbers of endangered plant species. Regions 24 and 30 (Eyre Peninsula and Kangaroo Island) have the highest number with 8 species recorded as endangered, closely followed by Region 28 (Mount Lofty/Fleurieu Peninsula) with 7 endangered species. These three areas appear to be under most pressure: they are all located in the agricultural region of South Australia. Table 1.2 shows that the Mount Lofty Ranges areas has incurred the most extensive clearance of native vegetation. It is also an area which is subjected to many competing, and often conflicting land uses, all of which exert pressure on the environment. For example, alongside the predominant horticultural and agricultural activity it is also used for water catchment, recreation, conservation, and increasingly for residential purposes (E & WS, 1985). Kangaroo Island and Eyre Peninsula, by contrast, have undergone less clearance than other agricultural regions (see Table 1.2). In the past these areas have been considered as less suitable for agriculture owing to a poor climate and thin, or impoverished soils. In the last three decades,

FIGURE 1.11 NUMBERS OF PLANT SPECIES PRESUMED EXTINCT IN EACH REGION OF SOUTH AUSTRALIA



Source: Leigh et al, 1984

FIGURE 1.12 NUMBER OF ENDANGERED PLANT SPECIES IN EACH REGION OF SOUTH AUSTRALIA



Source: Leigh et al, 1984

both areas have come under mounting pressure as the agricultural community has sought to expand into increasingly marginal land which can now be made productive with the aid of fertilisers to correct soil nutrient deficiencies, and the latest farm technology.

It is expected that an updated list of species considered to be rare or threatened in South Australia will be available early in 1986 (J. Leigh, CSIRO, pers. comm.). However, in 1981, a list of rare or threatened plants in Australia was published by Leigh, Briggs and Hartley. In South Australia 209 species (48 families, 100 genera) were identified as rare or threatened. This list (with recent name changes) is attached at Appendix 5. Data from a recently completed survey (March, 1985) of threatened plant species of the Mount Lofty Ranges and Kangaroo Island regions are shown in Appendix 6. (Davies, 1985, in press).

Prevention of the decline and extinction of plant species has recently become one of the central themes in Botanic Gardens worldwide. It is recognised that this action is no substitute for preserving species by setting aside adequately large reserves of natural vegetation. However, Botanic Gardens can provide vital assistance in bringing rare and threatened species into cultivation and multiplying stocks. The Botanic Gardens of Adelaide has in cultivation 31 species of the rare and threatened species as identified by Leigh <u>et al</u>. (1981), (Haegi, 1984). A list of these species is also appended (Appendix 7). The propagation and cultivation of these South Australian species is being concentrated in Wittunga Gardens at Eden Hills.

Owing to constrained resources, the Botanic Gardens of Adelaide is unable to give the necessary attention to research into South Ausralia's rare and threatened plants. There is no co-ordinated effort to collect rare plant material. There is no South Australian section in the Botanic Gardens as such, although many South Australian plants are grown there. A plan has been proposed to recreate the pre-european Adelaide Plains vegetation in a section of the Botanic Gardens. (L. Haegi, Botanic Gardens, pers. comm.). An officer of DEP is currently researching the original vegetation of the Adelaide Plains (D. Kraehenbuehl, NPWS, pers. comm). There is no immediately accessible information as to which South Australian plants are grown in the Botanic Gardens. The information is available but is in the form of an index system which makes access tedious. The system needs to be computerised in order to facilitate easier access.

Work on propagation techniques and cultivation of rare and threatened South Australian plants is a prime function of the NPWS Black Hill Native Flora Park at Athelstone. A list of these species is appended (Appendix 8). A list of research projects dealing with rare or endangered native plants being undertaken at Black Hill Native Flora Research Unit is also appended (Appendix 9).

The number of plant species in each risk category that are conserved within South Australia's park and reserve system is shown in Table 1.5.

TABLE 1.5: PLANT SPECIES CONSERVED IN SOUTH AUSTRALIA

	X	E	V	R	K	TOTAL
1	0	0	0	0	0	0
2	0	1	8	28	1	38
3	0	7	13	32	2	54
	0	8	21	60	3	92

Source: Leigh, J., unpublished

A study by Davies (1982) determined that 37% of South Australia's 165 major plant association categories were either poorly conserved or not conserved at all. These 60 inadequately conserved associations were ranked into 16 priority categories according to the perceived degree of threat to their survival. A list of plant associations considered to be the most threatened is appended (Appendix 10).

The initial variable considered when ranking the association categories was whether they occur mainly in the agricultural or non-agricultural regions of the State. If they occur in the agricultural regions the risk is of total destruction through vegetation clearance, whereas in non-agricultural areas the risk is of degradation through overgrazing, a more long-term but equally detrimental threat.

Other variables considered by Davies were:

- the conservation status of association categories interstate;
- whether they are poorly or not at all conserved in South Australia;
- the number, size and condition of examples remaining outside reserves in South Australia;

- whether similar association categories are adequately conserved in South Australia.

A brief summary of results of Davies' work is tabled below.

TABLE 1.6: CONSERVATION STATUS OF PLANT ASSOCIATIONS IN SOUTH AUSTRALIA

CONSERVATION STATUS	NO. OF ASSOCIATION CATEGORIES	% OF TOTAL
Nil	39	24
Poor	21	13
Moderate	18	11
Reasonable	80	48
Excellent	7	4
TOTAL	165	100

Source: Davies, 1982

Table 1.7 illustrates the number of association categories in each environmental province which are either not conserved or only poorly conserved, and therefore considered to be the most threatened.

TABLE 1.7: MOST THREATENED PLANT ASSOCIATION CATEGORIES IN EACH ENVIRONMENTAL PROVINCE

ENVIRONMENTAL PROVINCE CONSERVED (AFTER LAUT 1977)	TOTAL NO. OF ASSOCIATION CATEGORIES RECORDED	NO. OF ASSOCIATION CATEGORIES NOT CONSERVED OR POORLY CONSERVED WITHIN THAT PROVINCE	NO. NOT CONSERVED OR POORLY CONSERVED AS % OF TOTAL
1. South East	54	19	35%
2. Murray Mallee	67	32	48%
3. Mount Lofty Block inc. Kangaroo Island	79	47	59%
4. Eyre & Yorke Peninsulas	65	24	37%
5. Eastern Pastoral	23	16	57%
6. Flinders Ranges	40	21	53%
7. Western Pastoral	51	41	80%
8. Northern Arid	49	29	59%

Source: Davies, 1982

Davies' work provides a useful summary of information on South Australia's plant associations, plant communities conserved in NPWS reserves in South Australia, and gives examples of inadequately conserved assocation categories still remaining in the agricultural regions of South Australia.

Currently, a 'plants of conservation significance' survey in the agricultural regions of the State is being undertaken by the Department of Environment and Planning. The data being collected are comprehensive and are in the process of being computerised. Conservative estimates have been put forward for three of the regions as follows:

- Southern Mount Lofty Ranges – 20% of plants of conservation significance (approx. 100 species)
- South-East – 25% of plants of conservation significance (approx. 150 species)
- Murray Mallee – 15% of plants of conservation significance (approx. 30 species)

(Source: D. Kraehenbuehl, NPWS pers. comm.)

This work will provide baseline information that can be used in a scheme currently being developed for evaluating potential areas for parks on the basis of their value as sites for the conservation of the State's flora and fauna. It is hoped that this valuable work will extend to the pastoral areas in the future.

A survey of roadside vegetation in the agricultural region is also being undertaken this year by the Department of Environment and Planning (Palmer, in prep), which will provide valuable information on some of the remaining native vegetation outside the park and reserve system and not on privately held land.

Most research work on native vegetation has been concentrated in the agricultural regions of the State and of these Eyre Peninsula, Yorke Peninsula, Mount Lofty Ranges area, and Kangaroo Island are the most comprehensively covered. The remaining areas of the South-East, Murray Mallee, Flinders Ranges and the arid pastoral zone require much more attention (R. Davies, pers. comm.).

1.2.2 Non-vascular Plants

Studies on vascular plants are far more numerous and extensive than those related to the lower or non-vascular plants.

In the terrestrial environment the representatives of the lower plants include the mosses, liverworts, lichens, and fungi.

Although progress has been made recently in the field of qualitative work on the mosses and lichens (Catcheside, 1980; Filson and Rogers, 1979) there are as yet no quantitative studies on any of these large and varied groups in South Australia. The current survey activities of the Department of Environment and Planning's Vegetation Retention Unit are focussed only on the vascular plants. This is unfortunate in that an opportunity to establish baseline information for the non-vascular plants is being lost, along with the possibility of establishing links between the plant community as a whole and the local climatic and chemical conditions for which many lower plants have specific requirements. Of particular interest is the ability of some moss, lichen and liverwort species to tolerate and even thrive on hostile substrates which other plants are unable to colonise. These include mine spoil heaps with high concentration of toxic heavy metals, saline anaerobic muds, inland and coastal sand dunes, and sites of urban and industrial dereliction (Rao et al., 1977; Catcheside, 1980; Moore and Scott, 1979). They have even been used to indicate the presence of orebodies (Brooks, 1971), and their important roles in protecting the surface of erosion-prone soils in arid regions and of enhancing soil formation and fertility have been recognised for some time (Filson and Rogers, 1979).

The most comprehensive and recent work dealing with South Australian mosses is published in the Flora and Fauna Handbook series (Catcheside, 1980). It is based largely on the collection of the author (now donated to the State Herbarium) and gives information on known distribution and where appropriate, estimates of status for each of the 179 recorded species. It is unlikely the total number of mass species in South Australia exceeds 200 owing to the prevailing arid climate - mosses require free water in order to reproduce. Accordingly most species are known from the South East and the Mount Lofty Ranges. Distribution is defined by a series of 21 geographical divisions developed by the author for practical field work purposes. Information on the collections held by the Herbarium is currently in the form of a card index, however it is hoped to transfer the information to a computerised retrieval system over the next two years, facilitating the use and application of data held in the collections.

More recent attention has been given to South Australian mosses by Dr Barbara Thiers from the New York Botanic Gardens, who used the collections as part of a research project on the taxonomy of mosses of the family Lejeuneaceae of mainland Australia and New Guinea sponsored by the Adelaide Botanic Gardens Research Fund. The results of the research should be published in 1985.

Similarly the lichens of South Australia have recently been dealt with in the Flora and Fauna Handbook series (Filson and Rogers, 1979). This work is the first of its kind in Australia and is intended to stimulate interest in the group to enable a second and more comprehensive edition to be produced in the future. Data and specimens are held at the Herbaria in Adelaide and Melbourne, and in various private collections. There are currently 191 species recorded in the State. Lichens are not single plants, but a symbiotic (mutually beneficial) relationship between an alga and a fungus. This is a unique combination, where the photosynthesising alga produces organic compounds, a proportion of which are utilised by the fungus in return for which it provides the alga with essential nutrients derived from the environment, shelter, and moisture. It allows them to survive and thrive in the harshest of environments, of which South Australia has an abundant supply. Therefore it seems likely that their diversity will eventually be found to be significantly larger than has been revealed to date. Computerisation of Herbarium records will enable this information to be utilised more effectively in future.

The familiar larger mushrooms and toadstools were dealt with in two volumes in the Handbook series, now available under a single cover (Cleland 1934, 1935). This was another pioneering work which is currently undergoing taxonomic review at the State Herbarium. However available funds will not permit information gathered since the original publication to be incorporated into the new edition, so the current effort can only be regarded as a stop-gap measure. There are 581 species described by Cleland, and he considers this to be a selective and incomplete treatment.

Professor D.G. Catcheside has begun work on a handbook of South Australia's liverworts since his retirement, but has expressed doubts about it being completed. To date there is no published information on the State's liverworts. Like the mosses, liverworts depend on freely available water in order to reproduce. They generally do not approach the mosses in their diversity of species, as it would be resonable to expect fewer than 100 species to occur in South Australia. Herbarium data will be transferred to the computer in due course.

The micro-fungi are a group of great economic importance whose existence is overlooked by most people. Published material resides in specialised scientific and industrial journals, but there has been no systematic study of the group to our knowledge. In South Australia there are two areas of local expertise; the Medical Pathology Laboratory based at the Adelaide Children's Hospital, and the Plant Pathology Laboratory based at the Waite Agricultural Institute. Precise data are kept on the occurrence of fungus related diseases, and probably form the most complete biological data bases in the State (D. Ellis, Adelaide Childrens Hospital written comm.). Only species with some medical or economic manifestation or those closely allied to them tend to be investigated. Of an estimated 3000 species of fungi occurring in South Australia, 175 cosmopolitan forms are human pathogens though only about 20 of these are responsible for causing systematic infections (D. Ellis, op. cit). In addition 670 species have been isolated and identified as pathogenic agents in diseased native and cultivated plants. Other destructive fungal effects include the spoilage of stored foods and the decomposition of structural timbers. To offset these losses we could consider the economic benefits we receive from them, including essential contribution to the production of foods such as bread, cheese, yoghurt and chocolate, the fermentation of alcoholic drinks, the production of rubber and tobacco, and the decomposition of organic waste materials.

To summarise, the state of knowledge of the non-vascular or 'lower' plants in South Australia is incomplete and in some areas almost totally lacking. The information that is available is currently not comprehensive enough or not in a format enabling its use as an environmental indicator or as a basis for establishing periodic monitoring of habitat condition, a task to which they have proved suitable in other parts of the world.

1.3 TERRESTRIAL FAUNA

1.3.1 Vertebrates

The vertebrates comprise only a small part of the total biota of any area, but because they are generally amongst the more conspicuous components of a region's wildlife or, like some fish, birds, or kangaroos, are of some economic importance to human activities, they have attracted most attention from collectors, taxonomists, and naturalists, and are accordingly the best known group of our fauna, as they are in every other part of the world.

The vertebrates fall into five major groups - mammals, birds, reptiles, amphibians, and fishes. Of these the mammals and birds are the most extensively documented in South Australia. Work is currently in hand on the revision and update of records for all vertebrate groups in the State by staff of the South Australian Museum and the Environmental Survey Branch of the Department of Environment and Planning. The initial results of this work have been published as 'A List of the Vertebrates of South Australia' (Aslin et al, 1985). It is hoped to regularly update the List as new information comes to light.

In the accompanying mammal, freshwater fish, and reptile and amphibian appendices, the most recent taxonomy and distributional data from the List is reproduced. The bird and marine fish appendices are based on other sources of recently published information as indicated at the end of each appendix. Status categories have been adapted from a variety of sources in order to correspond with the limits set by the present study. This needs to be borne in mind when making comparisons with other published accounts of the present status of vertebrates in South Australia.

The distribution data is based on Laut et al's Environments of South Australia (1977). These volumes are based on a wide array of biogeographical information and appear to be gaining favour for this purpose, a trend which should be fully publicised and encouraged as a logical first step towards establishing compatibility for natural resource data of different origins (Appendix 11). The State Herbarium uses a distribution system based on longitude and latitude which has also been adopted for the animal collections held by the State Museum. However the Laut system has been adopted for the published List.

Species nomenclature is the most recent available, but several groups (most notably the fish), are undergoing extensive taxonomic review and name changes are to be expected.

Conservation status is based on IUCN categories, modified slightly to suit Australian conditions (Leigh et al 1984), and the non-natural State boundaries defining the study area. An explanation of the coding system for vertebrates is provided in Appendix 2. Persons recognised as having expertise in particular areas have been consulted during the compilation of the vertebrate appendices, and draft copies were submitted for their scrutiny. They can be identified from the bibliography following each appendix.

As to the past and present status of the vertebrates, it is generally possible to extract information regarding the extinction of known taxa in historic times but the status of remaining species needs to be quantified in order for future trends in species and population status to be reliably deduced. This is an eventual aim of the Biological Survey Co-ordinating Committee whose members represent both the DEP and the State Museum. At present the work is still in the formative stages, and requires much more extensive and intensive field survey data in order to be of practical use.

Most of the presently assigned status categories therefore are informed estimates, and should not be viewed as definitive statements of a species' current conservation status.

The available information reveals the following about South Australia's terrestrial vertebrate fauna.

Mammals (see Appendix 12, Table 1.8 and Table 1.10)
There are a total of 102 species of native land-mammals recorded as having had breeding populations in South Australia at some time since European settlement. Of these, 28 are now regarded as being extinct (though some may still exist in areas outside the State).

Of the remaining 74 species, a further 36 are regarded as being rare, vulnerable, or endangered. It is difficult to determine which species are so positioned as a result of human influence and which might have always had small populations in South Australia, owing to the State's generally arid climatic conditions and sparseness of favourable habitat. A conservative figure is that 9 of the 36 species are under threat because of human actions and run some risk of joining the 28 already on the extinction list. The few remaining populations of two of these, the Southern Brown Bandicoot Isoodon obesulus and the Swamp Antechimus Antechinus minimum, are located in reserves or are planned to be included in reserves in the near future. The other seven species occur in the arid zone and are largely beyond the scope of conservation managemnt efforts. Of the remaining 38 species, 30 should be secure so long as prevailing conditions persist, and 8 are not sufficiently well known to establish their status. Table 1.8 summarises the status of terrestrial mammals in South Australia.

TABLE 1.8: STATUS OF TERRESTRIAL MAMMALS IN SOUTH AUSTRALIA

	Species Status[1]									
	X	E**	E*	V**	V*	R**	R*	K	C	Total
Species (n)	28	4	4	1	2	4	21	8	30	102
(%)	27.5	3.9	3.9	1.0	2.0	3.9	20.6	7.8	29.4	100
		7.8		3.0		24.5				

1 See Appendix 2 for explanation of coding system.

The National Parks and Wildlife Service has been instrumental in carrying out breeding programmes for rare mammals, and in some cases have worked towards the re-establishment of animals previously considered to be extinct in South Australia.

The last known population of the greater stick-nest rat Leporillus conditor in South Australia is found on the Franklin Islands forming park of the Nuyts Archipelago group south of Ceduna off the West Coast of Eyre Peninsula. Research sponsored by the World Wildlife Fund and Australian Heritage Commission is being undertaken to gain information about the rats' habitat and food requirements, reproduction, behaviour, and their competitors and predators which will form the basis for future conservation management decisions (Read, 1984). A further search for remaining populations on the mainland was conducted in the Gibson Desert of Western Australia and the North-West of South Australia in July 1985. Although many nests were identified, no indication of the recent presence of the rats was evident (Copley & Reid, in prep.). However a captive breeding programme is planned at special facilities within the Monarto Open Range Zoo complex (P. Copley, NPWS, pers. comm.).

The brush-tailed rat-kangaroo Bettongia penicillata once considered to be extinct in South Australia, has been successfully bred in captivity at Para Wirra Recreation Park near Adelaide since 1975. The original breeding stock of five animals were from Perth Zoo, Western Australia. Surplus animals from the captive breeding colony have been released on four uninhabited offshore islands since 1980. They are: St Francis Island, Nuyts Archipelago (40 individuals released, May 1980); Island 'A' Venus Bay Conservation Park (7 bettongs released May 1980); Baird's Bay Island Conservation Park (10 animals released May 1982); and Wedge Island off the tip of Yorke Peninsula (11 bettongs released in May 1983). All except the Wedge Island populations have been subsequently monitored by mark/recapture technique, and appear to have established with varying degrees of success (Delroy et al, in press). A more systematic monitoring programme for these and other threatened South Australian animals is inhibited by a lack of adequate funding. Of particular relevance to island populations is the fact that the South Australian National Parks and Wildlife Service do not have a suitable boat. The Service currently charter an appropriate vessel as and when they are able to obtain funds from external sources. These have included the Federal NPWS and Australian Heritage Commission grants in the recent past.

The Royal Zoological Society of South Australia has an established breeding colony of the Yellow-footed Rock Wallaby Petrogale xanthopus which is considered to be rare in the wild. Of seventeen species of kangaroo resident in South Australia at the time of settlement, only eight now remain. Of these, three form the basis of the State's commercial kangaroo harvesting industry (the composition of the 1983 kangaroo harvest was: Red Kangaroos Macropus rufus 80%; Western Grey Kangaroos M. fuliginosus 15%; and Euro M. robustus 5%, totalling 155,000 animals from a quota set at 300,000. The population for the three species was estimated to be 1,190,000 (NPWS figures for 1984). In order to regulate a cull of wild animals, the populations must be known and calculations made relating to the number of animals which may be taken, while at the same time not affecting the ability of the species to maintain a healthy and viable breeding population. This task is the responsibility of the NPWS. Each year aerial surveys of kangaroos are conducted in the defined areas where they may be hunted for commercial purposes. The techniques employed do not enable an accurate population census, but do allow for the magnitude and direction of change in the populations to be detected. It is then the responsibility of NPWS to issue licences and tags, collect returns from hunters, and police the commercial operations. The primary objective of the management programme is to conserve the larger kangaroo species. It is recognised that these are under no immediate threat nationally or in South Australia. However without a controlled approach to kangaroo culling administered by the NPWS, the stage would be set for a return to indiscriminate slaughter and poisoning. Kangaroos compete with domestic stock for often scarce food resources, and are therefore regarded and treated as pests. This presents something of a dilemma for the NPWS. They must direct considerable resources to the kangaroo conservation programme, while at the same time remain largely inactive in other fields, including aspects of park management and the establishment of conservation programmes for other clearly endangered plant and animal species, largely because of resource constraints. Clearly there is no simple solution unless extra funds can be found. The 35% of the NPWS budget currently spent on the kangaroo programme (Delroy, NPWS pers. comm.) is probably necessary, and only seems disproportionately large in the context of an overall inadequate budget.

Marine mammals are considered in section 3.3.1 under the marine environment section.

Birds (see Appendix 13, Table 1.9 and Table 1.10)
A total of 375 species of birds are currently regarded as being or having been either resident in or regular seasonal visitors to South Australia and its coastal waters in the time since European settlement.

There are a further 58 species that have been recorded from the State at least once. These are regarded as 'vagrant species' or 'occasional visitors', for whom South Australia forms part of a much larger range but not an essential part, for example regular breeding or feeding grounds. They are given an 'O' (for occasional) rating in the status category of the appendix.

Of the 375 'permanent' species, 5 are known to be extinct. An intensive breeding programme for one of these, the Magpie Goose Anseranas semipalmata, has been undertaken at Bool Lagoon Game Reserve. In 1984 300 eggs from the Northern Territory were incubated and hatched at the reserve, boosting the resident population to over 400 individuals. The NPWS rangers responsible for this programme are reasonably confident that the goose is capable of re-establishing itself in the wild in South Australia, although breeding success is generally low for the species (Blakers et al, 1984). Persecution by humans eliminated the entire south-eastern population by the turn of the century (Frith and Davies, 1961). Accordingly it is recorded here as extinct in South Australia, with a note on the re-introduction of a population from the Northern Territory.

Another bird thought to have become extinct was the Azure Kingfisher Ceyx azureus. However several individuals were reliably recorded from the Glenelg River in the south-east corner of the State in March 1985. The Glenelg is mainly a Victorian river which meanders briefly into South Australia. The birds are therefore likely to belong to a predominantly Victorian population. The species has completely disappeared from its original State stronghold in the Mount Lofty Ranges. The last reported sighting there was in 1965 (Blakers et al, ibid) although it was possibly extinct as early as the 1940s (Reid and Vincent, 1979). This illustrates one of the problems arising when a study is confined to artificial boundaries. During the course of writing, the Azure Kingfisher has changed from an extinct to an endangered species. This partly obscures the fact that the species is still extinct where it was once common. Such possibilities should be considered when making deductions from the information presented. Of the remaining 370 species, 119 are regarded as being rare, vulnerable, or endangered for a combination natural reasons such as scarcity of suitable habitat or climatic stress, and human influence, including modification of habitat, and predation by or competition from introduced animals.

In addition, South Australia is home to over 100 distinct sub-species of birds. Two are occasional visitors, and the remainder are regarded as being under no immediate threat or of unknown status.

Of the remaining 261 native species, 211 are still common (although this term implies that there is no immediate threat, rather than that the species is abundant), 47 species are uncommon (not sufficiently scarce to warrant rare status) with three species; the Fleshy-footed Shearwater Puffinus carnipes, Elegant Parrot Neophema elegans, and Grey-headed Honeyeater Meliphaga ornata not being sufficiently well known to be given a status category, though it is assumed they are not common (J. Reid, NPWS pers. comm.).

The Royal Zoological Society of South Australia has succeeded in establishing breeding colonies of five of the six species in the Neophema genus of parrots, these are Burke's Parrot N. bourkii, Blue-winged Parrot N. chrysostoma, Elegant Parrot N. elegans, Rock Parrot N. petrophila, and

Scarlet breasted Parrot N. splendida. The endangered Orange-bellied Parrot Neophema chrysogaster however has attempted to breed only once in captivity, and then without success (Lendon 1979). The last bird at the Adelaide Zoo died in 1978. It is so rare in the wild that attempts to capture more individuals for breeding purposes are considered to be imprudent. The vulnerable Australian Bustard Ardestis australis by contrast maintains a healthy breeding population at the zoo.

At least eleven species of exotic birds have established breeding colonies within the State.

The status of all South Australian birds is summarised in Table 1.9.

TABLE 1.9: STATUS OF BIRDS IN SOUTH AUSTRALIA

		Species Status[1]								
		X	E	V	R	C	U	K	O	Total
Resident	(n)	5	12	35	43	171	28	2	0	296
species	(%)	1.7	4.0	11.8	14.5	57.8	9.5	0.7		100
Seasonal	(n)	0	2	4	13	40	19	1	0	79
visitors	(%)		2.5	5.1	16.5	50.6	24.0	1.3		100
Occasional	(n)	0	0	0	0	0	0	0	58	58
visitors	(%)								100	100
Total	(n)	5	14	39	56	211	47	3	58	433
	(%)	1.2	3.3	9.0	12.9	48.7	10.8	0.7	13.4	100

1 See Appendix 2 for explanation of coding system.

Reptiles (see Appendix 15 and Table 1.10)

The Curator of Reptiles at the State Museum has pointed out that currently available data relating to the State's reptiles is not adequate to detect status on anything other than a local level. A recent survey of nine of South Australia's most experienced reptile collectors revealed a confidence level of only 60% of being able to predict status of a given species at a well known locality, and less than 30% if the same species were projected to the State level (T. Schwaner, S. Aust. Museum, pers. comm.). It has also been suggested that attempts to use inadequate information in order to make estimates of species status can be highly misleading. Accordingly all of the State's 204 known species of reptiles are assigned to the unknown category 'K'.

Amphibians (see Appendix 15 and Table 1.10)
The Zoology Department of the University of Adelaide is of the opinion that all of South Australia's 24 known species of frogs and toads are still common throughout their natural ranges (M. Davies, pers. comm.).

Fish
The fish are considered under Sections 2.3.1 and 3.3.1 under inland waters and marine environments.

1.3.2 Invertebrates
The invertebrate fauna seems to be almost infinite in its variety; estimates of the total number of species are continually being revised upwards. For the insects alone - one class from a single phylum - estimates of species numbers have increased from less than one million in 1968 (Russell-Hunter, 1968) to projected figures of over 30 million in 1984 (Myers, 1984). The task of bringing order to such a vast array of organisms is an enormous one. In South Australia, with its large area, relatively short period of scientific investigation and small centralized population, it is still at an early stage.

The main repository of knowledge on the State's invertebrate fauna is the South Australian Museum. It is here that many of the authors of the Handbooks of the Flora and Fauna series have conducted their research. One such work aiming to document the Hemiptera or 'true bugs', which is just one of 25 major orders of insect known to occur in South Australia, already stretches to 500 pages, took 25 years to produce, and is thought to represent less than 11% of the group (Gross, 1975, 1976). South Australia's sixty-four species of butterfly on the other hand are relatively well known and are treated quite comprehensively in the 270 pages of the Handbook devoted to them (Fisher, 1978). The butterflies however, are but a small part of the order Lepidoptera, and the moths which make up the bulk of it remain largely undocumented and therefore unrepresented in a form accessible to the public.

In an attempt to discern how far down this road of inventory-making we have advanced in South Australia, approaches have been made to recognised authorities and their opinion sought on the groups with which they are most familiar. For practical purposes the terrestrial invertebrates that occur in the State can be represented in the simplified phyletic classification shown in Table 1.11.

TABLE 1.10: SUMMARY OF THE STATUS OF SOUTH AUSTRALIAN TERRESTRIAL VERTEBRATES

STATUS (CODE)	MAMMALS NO. OF SPECIES	MAMMALS % OF TOTAL	BIRDS NO. OF SPECIES	BIRDS % OF TOTAL	REPTILES NO. OF SPECIES	REPTILES % OF TOTAL	AMPHIBIANS NO. OF SPECIES	AMPHIBIANS % OF TOTAL	TOTAL SPECIES	% OF TOTAL
Extinct ('X')	28	27.5	5	1.3	0	0	0	0	33	4.7
Threatened for natural reasons ('R'*,'V'*,'E'*)	27	26.5	distinction not practical		0	0	0	0	27	
			109	29.1					109 } 145	20.6
Threatened by human activity ('R'**, 'V'**, 'E'**)	9	8.8			0	0	0	0	9	
Uncommon ('U')	n/a	n/a	47	12.5	n/a	n/a	n/a	n/a	47	6.7
Common ('C')	30	29.4	211	56.3	0	0	24	100	265	37.5
Status not sufficiently well known, could be any of above categories ('K')	8	7.8	3	0.8	204	100	0	0	215	30.5
TOTALS	102	100	375	100	204	100	24	100	705	100
Occasional visitors (Birds only)			58						58	
			433						757	

TABLE 1.11: MAJOR GROUPS OF TERRESTRIAL INVERTEBRATES AND CURRENT STATE OF KNOWLEDGE

PHYLUM. CLASS ORDER	SPECIES COLLECTED AS A PERCENTAGE OF ESTIMATED TOTAL	SPECIES DESCRIBED AND NAMED AS A PERCENTAGE OF ESTIMATED TOTAL	INFORMATION ON THE GROUP IN GENERALLY AVAILABLE PUBLISHED FORM YES	NO	COMMENTS
MOLLUSCA					
Gastropoda (snails and slugs)	?70%	?30%	✓		One order (Archaeogastopoda) covered in fauna and flora handbook series (Cotton, 1959). Work on four further orders only reached manuscript stage.
PLATYHELMINTHES					
(flatworms,	30%	10%		×	Species (mainly parasitic)
flukes and	20%	10%		×	described in specialist
tapeworms)	20%	10%		×	literature.
ASCHELMINTHES (roundworms, nematodes)	5%	5%		×	Current survey of parasitic nematodes being conducted at Waite Agricultural Institue, includes parasites of crop and native species. 53 species known to cause plant diseases in S.A. (Warcup and Talbot, 1981). Vertebrate parasites under study at S.A. Museum (D.C. Lee, S.A. Museum, pers. comm.)
ANNELIDA (true worms)					
Oligochaeta (earthworms)	50%	50%	✓		Survey of the State's earthworms (Jamieson, 1974)
Hirudinea (leeches)	?20%	? 10%	✓		The presence of several species is noted in the Natural History of South Australia series.
ARTHROPODA (jointed legged invertebrates)					
Collembola (spring-tails)	>80%	10%		×	Mainly in scientific journals and specialised literature (Greenslade P. 1982).
Protura					
Diplura (bristle-tails)	<60%	<10%		×	Figures based on average estimates for State's insect and myriapod fauna, South Australian Museum 1985.
Insecta					
Thysanura (silverfish)	<60%	<10%		×	
Ephemeroptera (mayflies)	90%	90%		×	Taxonomic and ecological work well advanced (Suter 1980); Suter and Bishop 1979).
Odonata (dragonflies) damselflies)	<60%	<30%	✓		Mentioned in Natural History of South Australia series. No identification keys available (Gross 1983, Gross <u>et al</u>. 1979).
Dictyoptera (cockroaches, mantids, stick-insects)	<60%	<30%	✓		Mentioned in Natural History of South Australia series. No identification keys available (Gross 1983, Gross <u>et al</u>. 1979).
Isoptera (termites)	<60%	<10%		×	
Plecoptera (stoneflies)	?60%	?60%	✓		Only five species known from South Australia (Gross 1983)
Orthoptera (grasshoppers, locusts, (crickets)	<60%	<30%	✓		Several species mentioned in Natural History of South Australia. (Gross et. al. 1979, Gross 1983).
Dermaptera (earwigs)	<60%	<30%	✓		

TABLE 1.11: Continued

PHYLUM. CLASS ORDER	SPECIES COLLECTED AS A PERCENTAGE OF ESTIMATED TOTAL	SPECIES DESCRIBED AND NAMED AS A PERCENTAGE OF ESTIMATED TOTAL	INFORMATION ON THE GROUP IN GENERALLY AVAILABLE PUBLISHED FORM YES	NO	COMMENTS
Anoplura (sucking lice)	not known	not known		✗	
Psocoptera (biting lice)	not known	not known		✗	
Hemiptera (true bugs)	60%	<11%	✓		Two volumes in the handbook series available; cover 11% of species. (Gross 1976).
Neuroptera (lacewings)	<60%	<10%		✗	
Coleoptera (beetles)	<60%	<10%	✓		Four volumes on S.A. beetle genera available from S.A. Museum (Matthews, 1980, 1982, 1984, 1985 in press).
Trichoptera (caddisflies)	<75%	<50%		✗	Specialist account of two species from Brownhill Creek (Towns, 1983).
Lepidoptera butterflies	>90%	>90%	✓		Guide to South Australia's butterflies available in the handbook series (Fisher, 1978).
moths	<10%	<10%		✗	Guide to c.100 species of common urban moths (McQuillan and Forrest, in press).
Diptera (True flies, include mosquitoes and blow flies)	<60%	<10%		✗	A few species of medical or agricultural importance have been documented
Siphonaptera (fleas)	<60%	<10%		✗	
Hymenoptera (ants, bees, saw-flies, wasps)	<60%	<10%	✓		Some information on ants available in the recent scientific literature (Greenslade, P.J.M. 1984). Also see Corbett, (1980) for an interesting account of giant spider-hunting wasps and other hymenopteraus in the Flinders Ranges.
Arachnida (spiders, scorpions, etc.)					
Araneae (spiders)	40%	10%	✓		Brief overview of some common species, (Lee 1979).
Acari (mites)	40%	20%		✗	Some species of medical or agricultural importance described in specialist literature.
Scorpionida (true scorpions)	>90%	>80%	✓		Eleven species recorded from South Australia (Gross et al. 1979).
Chelonethida (False scorpions)	<50%	<20%		✗	
Opilones (harvestmen)	<40%	<10%		✗	
Myriapoda					
Chilopoda (centipedes)	<60%	<30%		✗	Mentioned briefly by Gross (1983). Recent taxonomic work on S.A. millipedes (Jeekel, 1985).
Diplopoda (millipedes)	<60%	<30%		✗	

TABLE 1.11: Continued

PHYLUM. CLASS ORDER	SPECIES COLLECTED AS A PERCENTAGE OF ESTIMATED TOTAL	SPECIES DESCRIBED AND NAMED AS A PERCENTAGE OF ESTIMATED TOTAL	INFORMATION ON THE GROUP IN GENERALLY AVAILABLE PUBLISHED FORM YES	NO	COMMENTS
Crustacea					
Isopoda (slaters, wood-lice)	<50%	10-20%	✓		Brief overview of some isopods from the South East (Zeidler, 1983).
Amphipoda (landhoppers)	50%	50%		✗	Friend (1982) describes only known species from southern Mount Lofty Ranges.

Sources: Taxonomy from Barnes 1980
State of knowledge based on estimates supplied by the S.A. Museum 1985
and from the additional sources cited.

It can be seen at a glance that knowledge about most of these groups is patchy, and that only approximate ideas exist about the actual nature and extent of the invertebrate fauna. Using the limited data available it is possible to make a very rough estimate of the total number of land invertebrate species in South Australia, the number named, and the magnitude of the task to collect and name those that remain. The CSIRO estimate the total number of insect species in Australia to be c110,000 (Seymour, 1983). The majority of insects are terrestrial in habit. South Australia occupies 12.8% of the continents land area. If one assumes that 12.8% of the insects are represented here in direct proportion, we arrive at an estimate of 14,080 insect species in South Australia. Insects are the most varied of the invertebrates, probably accounting for over 60% of all invertebrate species (Barnes, 1980). Therefore if we add a further 40% to the insect total we arrive at an estimate of 19,712 species of terrestrial invertebrates of all types. However this may be an overestimate as this State contains very little natural forest and more specifically no tropical rain forests. In Australia overall, these are the most diverse and species rich terrestrial habitats. Using the percentage estimates of numbers collected and named for each taxonomic group provided by the State Museum (Table 1.11) it is possible to estimate the percentage of the total in each category as presented in Figure 1.24 (Chapter 4). It should be borne in mind that our knowledge varies greatly from group to group as indicated by the high standard deviation (SD) values (named species 25%, SD 24; known but not named 26%, SD 25). For example 90% of butterflies are named whereas only 10% of moths have been described. In the absence of more accurate figures, this is probably a reasonable indication of the task ahead; half the species are still to be collected i.e. they are presently unknown to science, a quarter have been collected but still await attention from taxonomists, and the remaining quarter have been catalogued and described. At historical rates of progress the task will be complete in another 450 years!

However, progress is being made in some areas. Woods and Forests undertook extensive biological surveys of some of their holdings in 1984 using personnel employed under the Commonwealth Employment Programme. Unfortunately an application for further grant assistance to enable the data collected to be sorted, identified and compiled has been refused (Blackwell, Woods and Forests Dept., pers. comm.).

Penny Greenslade an Honorary Museum Associate, has spent many years investigating the ecology and occurrence of Australian spring-tails (Collembola) and has worked extensively in South Australia. Consequently this part of the fauna is relatively well known. Even so it is considered that '... compared with vertebrates and plants, distributional data (for spring-tails) are limited and inferences drawn from them remain tentative' (P. Greenslade, 1982).

Work at the CSIRO Division of Soils in South Australia has yielded potentially valuable results on the use of invertebrates as indicators of environmental condition. Ants, termites, and spring-tails have proved to be particularly useful groups for this purpose as they are easily seen, collected, and not too difficult to identify, as well as being fairly habitat specific. Work of this nature shows promise as a temporary remedy for our poor understanding of the land invertebrates generally and allows at least some of their vast potential in this regard to be utilised (P.J.M. Greenslade, 1984).

In addition to the two handbooks mentioned above, the Curator of Entomology at the Museum has produced three volumes on the genera of South Australian beetles (Coleoptera) with a fourth in press (Mathews 1980, 1982, 1984). He estimates that these four volumes cover 40% of the beetle genera occurring in the State, but also points out that the number of species in each genus is still only a matter of speculation.

The three volumes in the South Australian Natural History series published by the Royal Society of South Australia contain chapters on the invertebrate fauna of the regions with which they deal. They cover Kangaroo Island, the South-East, and the Adelaide region. A fourth volume on Eyre Peninsula is in press. They can only be introductions to the invertebrate fauna by virtue of limited space and the wide unspecialised audience who must be considered in works of this kind. However, further insight into our paucity of knowledge is provided by contained statements such as "... (regarding freshwater invertebrates) the Adelaide area has not been well studied, and there is much to be discovered by enthusiastic naturalists" (Walker et al, 1976); or "... it is not really very useful or informative to provide lists of recorded species... as such would be very incomplete", "The Kangaroo Island arachnid fauna likewise is poorly known", "very little is known about mites and ticks from the island" (Gross et al, 1979); and "the arachnid fauna of the South East... is even more poorly known than much of the rest of the State" (Lee, 1983), "very little is known about Australian leeches...," "... many undescribed (slater) species are known to occur throughout the (South East) area" (Zeidler, 1983). As well as little being known about most of the invertebrates, they have no protection under law and many may be inadvertently destroyed by pesticides applied to control pests.

The current state of knowledge can be usefully summed up by two quotes, the first from Glen Broomhill, the then Minister for Environment and Conservation in the foreword to the first volume in the Handbook series on true-bugs (Gross, 1975). Reference to Table 1.11 will help put this statement in perspective when considering the invertebrate fauna as a whole;

> "Policies for the conservation of the natural resources of South Australia must depend to a large extent on an accurate inventory of the fauna and flora of the State, and this series on the true bugs represents a giant step in this direction..."

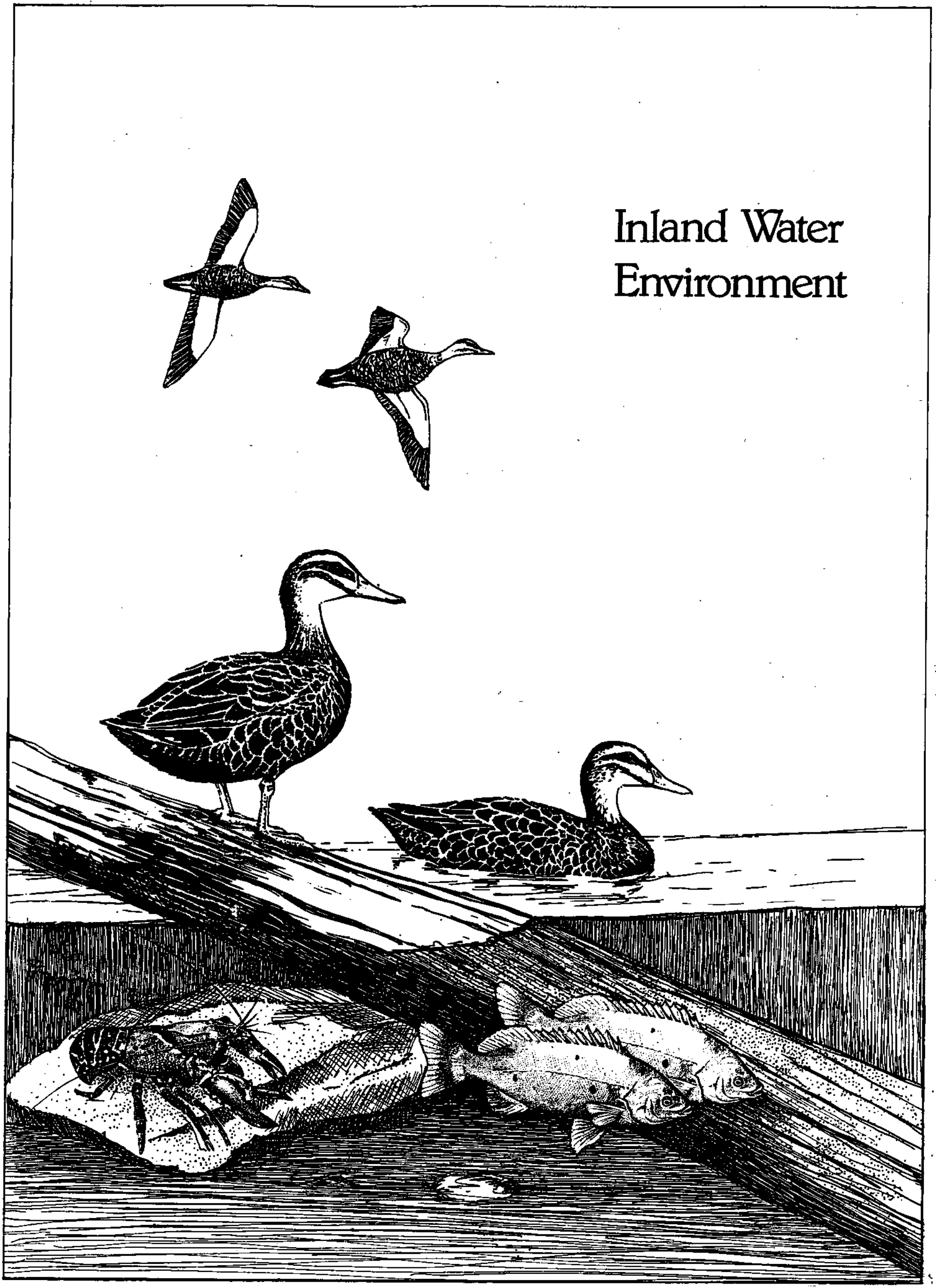
and from John Greenslade on the role of invertebrates in environmental assessment (P.J.M. Greenslade, 1984);

> "For many purposes it is necessary to know precisely what species we are dealing with, and biological information may be required on their distributions, roles and status in communities. All this demands specific identification. Unfortunately, the identification of most Australian invertebrates is difficult. In part, this reflects the large number of species involved, since Australia's fauna represents perhaps fifteen percent of the world's species. To compound this problem, Australia has a small scientific population which contains only a few taxonomists to describe and classify all these species. Consequently, for most Australian invertebrate groups there are no keys for identification; many species have not been described and named, and a large proportion has yet to be collected."

It is clear that the resources allocated to this task are inadequate at both national (Key, 1978) and state level, and that without major priority changes from governments, the only improvements to our knowledge are going to be piecemeal and slow to materialize. Whether changes occur will depend on whether the potential usefulness of knowledge about the vital roles played by invertebrates within living systems is recognised by decision makers, which in turn is influenced by the demands of the population. A considerable change in public attitude away from the commonly-held perception that all invertebrates fall into a nuisance, dangerous, or damaging-to-property category would seem to be a pre-requisite, but the publicly available information that could serve to this end is itself limited by the very lack of knowledge on which to base it.

It will require extremely far-sighted decision making by governments to allocate sufficient resources to break such a cycle of events, and to accelerate the pace of basic scientific investigation. Fortunately the infrastructure necessary for such a task exists in South Australia. The upgraded facilities at the Museum in particular are ideally suited to accommodate the staff necessary for such a research effort. Clearly the amount of basic taxonomic research is finite. To elevate knowledge significantly beyond its present levels would therefore require the same resources for many years, or proportionately more resources allocated to fewer years, how few depending on the desired objectives. However, to expect significant changes from the economic constraints of the recent past is perhaps less than pragmatic!

Inland Water Environment



INLAND WATER ENVIRONMENT

The Black Duck, Anas superciliosa, is perhaps the most common of 14 species of native waterfowl which occur in South Australia, and is often seen in parks and gardens as well as in the wild. At rest, it is easily recognised by the black and yellow stripes on the head and the metallic green flash on the wing, while in flight the rapid wingbeats and white underwings aid recognition. Although it is a popular target with hunters and mortality is high, the Black Duck is one of the few species of waterfowl not presently under threat.

The Yabbie, Cherax destructor is a common inhabitant of slow moving rivers and farm dams in the southern parts of the State.

The Barcoo Grunter, Scortum barcoo is confined to the infrequent creeks and waterholes of the Lake Eyre drainage basin. Growing to a length of 35 cm, it can be an aggressive animal with the spots on its back growing or shrinking depending on its mood. It is a rare fish in South Australia with only a single specimen of it held by the State Museum.

2 INLAND WATER ENVIRONMENT

2.1 BACKGROUND

The term inland waters incorporates all bodies of water ranging from fresh to salty, and of a permanent or temporary nature. In addition to the water body itself, the term extends to elements of the terrestrial environment adjacent to it. Such areas are commonly termed wetlands. Usually incorporated into any discussion of wetlands are estuaries and coastal swamps (mangroves and samphire flats). For the purposes of the present report, however, these have been addressed separately in the marine environment section because their ecology is dominated by marine influences.

A number of wetland types can be distinguished. For South Australia, it is convenient to classify them as either swamps, lakes, or rivers. These categories can be further divided on the basis of salinity and permanence (Lloyd and Balla, in press). Mound springs are sufficiently unique to warrant an additional category.

Swamps are shallow depressions which receive sufficient water from groundwater or runoff sources, to saturate or inundate the soil. They may be freshwater or saline. Freshwater swamps usually support plant communities dominated by reeds and/or sedges (including species of the genera Phragmites, Typha, Juncus, Scirpus and Baumea) and a wide variety of fauna. Saline swamps by contrast often exhibit a low species diversity: however, the few species present may be abundant (Hammer, 1981). Saline adapted plants include Ruppia spp. and the samphire group Sarcocornia spp. The fauna of saline swamps and lakes are dominated by the snail Coxiella spp., and crustaceans Parartemia, Haloniscus, and various copepods and ostracods (Williams, 1981).

Lakes are generally deeper water bodies with a high percentage of open water. Again they can be either fresh or saline. Deep water prevents large expanses of emergent vegetation becoming established away from the shores. Floating and submerged macrophytes (any aquatic plant visible to the unaided eye), e.g. Potamogeton spp., algae, and planktonic plants including diatoms and dinoflagellates occur in the open waters. Biologically, the fringing vegetation is more productive than open waters (see Fig. 1.17). Saline lakes generally have a lower diversity of both plant and animal species. South Australia has substantial areas of intermittent, and some permanent salt lakes (Williams, 1984).

Rivers are water bodies with a unidirectional flow confined to a more or less distinct channel including both permanent and intermittent streams and creeks. The nature of their aquatic vegetation is determined by a variety of physical factors including current strength, turbidity, dissolved nutrients, pH, nature and stability of the substrate, temperature and permanence (Hynes, 1970). In rivers, the food chain is based to a great degree on plant and animal remains (detritus). In fast-flowing and/or temporary rivers much detritus is derived from the land forming the river's catchment. Dead aquatic plants, microscopic plants growing upon the surface of living macrophytes (termed the periphyton), and plankton become increasingly important in slower moving more permanent rivers. Most rivers are fresh, however some are quite saline owing largely to man-induced changes in their catchments (Lothian, 1983; EWS, 1985).

Mound springs are natural outlets for the waters of the Great Artesian Basin, stretching in a broad arc between Lake Frome in the south to Mount Dare near the border with the Northern Territory. High rates of evaporation have resulted in the precipitation of dissolved minerals which cement together sediments transported in the spring water to the surface. The accumulation of these deposits around the springs gives rise to the characteristic mound shape of many older and often extinct springs from which these wetlands derive their name. Because they are a permanent source of water in an otherwise arid environment, and are often unconnected to other drainage features, many unique animals have evolved there (Harris, 1981; Greenslade et al, 1985). The often lush swamp vegetation associated with the springs, and its dependent invertebrate fauna, probably contribute substantially to the well-being of migratory birds and other forms of wildlife during periods of extreme drought, although knowledge of the ecology of the region is not yet adequate to substantiate such an assertion.

Salinity is a modifier of inland aquatic systems in that higher salinities exclude many organisms. Others by contrast are confined to waters with high salt levels - the so called obligate halophiles (Williams, 1984). As in other water bodies, biological productivity is dictated by factors such as temperature and nutrient availability, not by salinity as such. The few species capable of tolerating saline waters may be present in substantial numbers and provide a major food resource, especially for birds (Hammer, 1981). Salinity also dictates the suitability of inland waters for our own uses. Once the concentration of total dissolved solids (the measure of salinity) exceeds 5000mg/1^{-1}, water becomes virtually unusable for crop production, industry, or domestic purposes. For comparison, sea water has an average salinity of 35000mg/l^{-1} (MacIntyre, 1970), and water becomes noticeably salty to the taste at a concentration of c.500mg/l^{-1}. The World Health Organisation recommendation for drinking water stipulates a maximum of 1500mg/l^{-1} with a desirable level of under 500mg/l^{-1} (Australia. Dept. of Resources and Energy, 1983).

Despite its general aridity, the State has several examples of each of the wetland types outlined above, predominantly in the following areas:

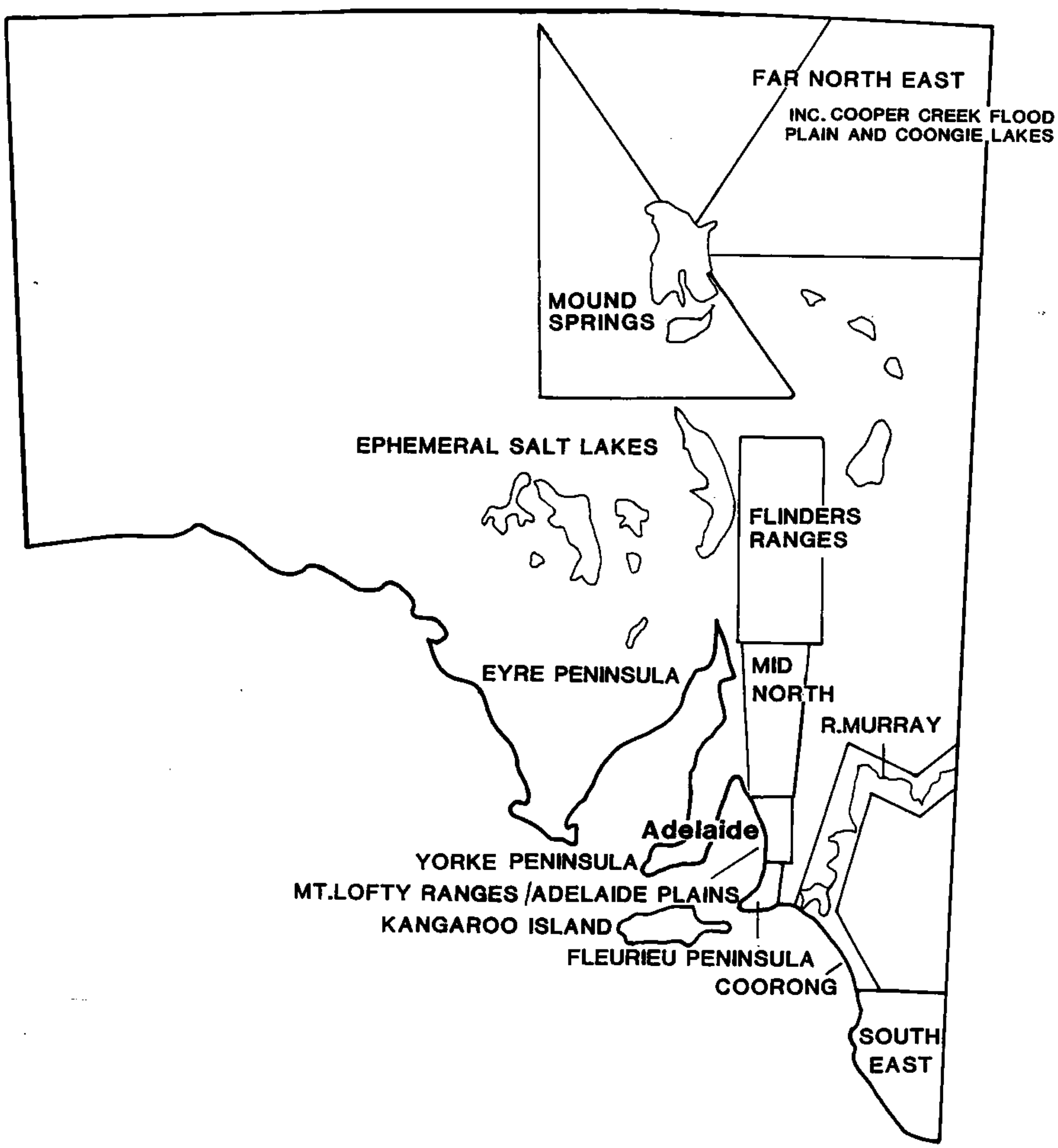
- South-East (freshwater swamps, lakes and rivers, saline swamps and lakes)
- Coorong (freshwater swamps, saline swamps and lakes)
- River Murray (freshwater swamps, lakes and rivers, saline lakes)
- Adelaide coastal plains (freshwater swamps, lakes and rivers)
- Mount Lofty Ranges (including Fleurieu Peninsula) (freshwater swamps, lakes (reservoirs and dams) and rivers)
- Kangaroo Island (freshwater swamps, lakes and rivers, saline swamps, lakes and rivers)
- Mid North (freshwater lakes and rivers)
- Yorke Peninsula (saline swamps, lakes and rivers)
- Eyre Peninsula (freshwater swamps, lakes and rivers, saline swamps, lakes and rivers)
- Flinders Ranges (freshwater lakes and rivers)
- Far North and North-East (freshwater swamps, lakes and rivers, saline swamps and lakes, mound springs).

Fig. 1.13 shows where South Australia's major wetlands are located. Wetlands are characterised by a range of habitat types supporting a variety of plant and animal life. They are essential breeding and feeding grounds for many species including fish (Lake, 1971), waterbirds (Frith, 1982), and many specialised invertebrates. For example, emergent vegetation is of key importance to macro-invertebrates. For example, emergent vegetation is of key importance to macro-invertebrates which spend their juvenile stages in the water but must emerge in order to reproduce. Many insects such as mayflies, dragonflies, damselflies, and caddisflies fall into this category. The surface tension of the water forms an insurmountable barrier to such creatures. Emergent vegetation provides bridges between water and air enabling these animals to make the crucial transition necessary for them to complete their life cycles. Artificial substitutes known as 'fly-boards' have even been used to perform this function in streams which have had their vegetation removed as part of river flood mitigation schemes in southern England. Essentially terrestrial vegetation surrounding wetlands is also important as it increases the diversity of habitat available for animals, as well as providing additional sources of food, and cycling nutrients from the terrestrial to the aquatic system. *Lignum* spp., *Leptospermum* spp., *Crassula* spp. and *Melaleuca halmaturorum* are important South Australian forms. It is important that this relationship is recognised and accounted for when the management of wetlands is being considered.

The associated vegetation serves as a filter for run-off and helps to trap contained sediment. Wetlands also absorb and store water. In so doing the flow rate is regulated, delaying the onset of flood conditions in wet seasons, and retaining water into the dry summer months permitting its use for domestic and agricultural supplies as well as providing refuge and food for wildlife. The prolonged retention of water also contributes to the recharging of aquifers, supplies from which are of major significance in enabling farm production over large parts of the State (EWS, 1985). It is important therefore that a balance is struck between further reclamation in order to increase the area of farmable land, and retention so that supplies of one of South Australia's most scarce and valuable natural resources continues to be available in adequate quantities.

Many wetland areas are popular for recreational activities such as bird-watching (for example, Tolderol Game Reserve), fishing and camping (Coorong), and the more active pursuits of shooting (Katarapko, Bool Lagoon), boating and waterskiing (Lake George, River Murray), and even scuba diving (Ewens and Piccaninnie Ponds). They are also important educational tools useful for demonstrating ecological principles and

FIGURE 1.13 AREAS OF WETLAND IN SOUTH AUSTRALIA



processes. Wetlands are used extensively for such purposes in other states in Australia as well as in Europe and North America (Pierre and Strom, 1970; Sather et al, 1984).

Extensive reclamation and modification of wetlands has occurred in South Australia, particularly freshwater swamps in the southern agricultural regions. Jones (1978) estimated that only 11.2% of former wetlands remained in the South-East. It is conceivable that this figure has decreased since that time. Many others have been degraded due to interference with the water regime, vegetation clearance which can increase the rate of siltation and incursion of saline groundwaters, grazing and trampling by domestic stock (most of the State's wetlands have received at least some impact from this source), and excessive unplanned recreational or developmental activity (for example, the effects of the timber industries log storage practices upon Lake Bonney). Table 1.12 summarises the extent of changes which have occurred and the current status of wetlands.

Most wetland surveys have tended to concentrate on the surrounding vegetation and commercially important fish and waterbirds. There is a need to go further back to the basis of food chains, the primary producers, and organisms such as zooplankton, macro-invertebrates, and even bacteria which have recognised potential in biological monitoring programmes. More information on their biology, their role in local ecosystems, and interactions with other organisms is necessary to enable the formulation of sound management plans for wetland areas.

A Regional Wetlands Survey funded by the Department of Environment and Planning, was commenced in 1985 by freshwater biologist Lance Lloyd from the University of Adelaide. The survey covers five areas: Eyre Peninsula; Yorke Peninsula; Lower Flinders Ranges and Mid North; Mount Lofty Ranges and Fleurieu Peninsula; and Kangaroo Island. It will supplement surveys already conducted in other regions. It focusses on aquatic fauna and flora, features which have tended to be overlooked in previous studies. This will provide for this first time a comprehensive assessment of wetlands in the study areas, their classification, a survey of the flora and fauna covering both aquatic and fringing terrestrial ecosystems, the identification of major impacts affecting wetlands, and provide an environmental evaluation of the wetlands described, including priority recommendations for conservation action.

TABLE 1.12: CURRENT STATUS OF WETLANDS IN SOUTH AUSTRALIA

	SWAMPS		LAKES		RIVERS		MOUND SPRINGS
	FRESHWATER	SALINE	FRESHWATER	SALINE	FRESHWATER	SALINE	
South East	A. heavy B. high C. poor	A. slight B. slight C. poor	A. moderate B. moderate C. poor	A. mod-heavy B. moderate C. poor	A. mod-heavy B. moderate C. poor	- -	- -
Coorong	A. moderate B. moderate C. adequate	A. moderate B. moderate C. adequate	- - -	A. slight-mod B. slight C. adequate	- - -	- - -	- - -
River Murray	A. moderate B. high C. poor	- - -	A. moderate B. high C. poor	A. high B. high C. poor	A. moderate B. high C. poor	- - -	- - -
Adelaide coastal plains	A. heavy B. high C. unconserved	- - -	A. heavy B. slight C. adequate	- - -	A. heavy B. high C. unconserved	- - -	- - -
Mt Lofty/ Fleurieu Peninsula	A. heavy B. high C. poor	- - -	A. moderate B. moderate C. adeq-poor	- - -	A. slight-mod B. slight-high C. poor	- - -	- - -
Kangaroo Island	A. slight-heavy B. slight-high C. adeq-uncons	A. mod-heavy B. slight C. unconserved	A. mod-heavy B. moderate C. poor	A. mod-heavy B. slight C. poor	A. slight-heavy B. slight-high C. adeq-uncons	A. heavy B. high C. unconserved	- - -
Mid North	- -	- -	insufficient data available	- -	insufficient data available	- -	- -
Yorke Peninsula	- - -	A. mod-heavy B. high C. unconserved	- - -	A. slight-heavy B. mod-high C. poor	- - -	insufficient data available	- - -
Eyre Peninsula	insufficient data available	insufficient data available	A. moderate B. high C. unconserved	A. moderate B. moderate C. poor	A. heavy B. high C. unconserved	A. heavy B. high C. unconserved	- - -
Flinders Ranges	insufficient data available	insufficient data available	A. heavy B. high C. poor	- - -	A. slight B. slight C. poor	insufficient data available	- - -
Far North and North East	A. heavy-mod B. slight-mod C. unconserved	A. slight-mod B. slight-mod C. unconserved	A. moderate B. moderate C. unconserved	A. slight B. slight C. poor	A. moderate B. moderate C. unconserved	- - -	A. slight-heavy B. high C. poor-uncons

Source: Modified after DEP, 1983

A. Degree of modification : heavy/moderate/slight
B. Degree of threat: high/moderate/slight
C. Conservation status : adequate/poor/unconserved

A major study covering the extensive wetlands adjacent to the River Murray and those surrounding the southern lakes and the Coorong has recently been completed (Thompson, in press). One of the interesting findings in this work has been that many of the swamps along the Murray have been changed from temporary to permanent water holding bodies due to the building of locks and weirs which has had major repercussions on the ecology of the area. Work carried out in New South Wales (Briggs, 1984; Maher, 1983) confirms that certain nutrients are chemically bound to the clays that form the substrate and are only released upon the desiccation of the swamp bed. It seems that if the swamps fail to dry out, the nutrients remain trapped which may reduce productivity throughout the food web and have repercussions for the populations of fish and waterbirds for example. This in turn, has wide ranging implications for the hydrological management of the River Murray.

In the arid north of the State are the ephemeral salt lakes including Lakes Eyre, Torrens, Frome, Callabonna, Gairdner and Everard. There appears to be a paucity of published information about these lakes, perhaps due to the general aridity of the region and remoteness from population areas. They are of considerable scientific interest however, and are considered to provide a range of habitats, albeit limited (Williams, in press). The lakes basically act as internal drainage sumps and in most cases are filled with water only after significant rainfall in their catchments. A notable exception is Lake Eyre, which is mainly filled as a result of heavy rainfall in western Queensland and north-western South Australia. The waters of the Diamantina River and Coopers Creek in particular feed Lake Eyre and bring fish and other aquatic life to the lake. This in turn attracts many waterbirds to the area and until the waters become hypersaline the lake is biologically active. Lake Eyre is now believed to fill two to three times per century, but the exceptional 1974-76 floods were considered to be a one in 500 years occurrence (C. Harris, DEP, pers. comm.). A report on Lake Eyre by the Royal Geographical Society of Australasia (SA Branch) Inc. is due for publication at the end of 1985. It will include sections on the terrestrial and aquatic biology as well as the geology, bathymetry, climatology and meteorology of the area, and will contribute much needed information to our understanding of this region. The previously unallotted crown land status of Lake Eyre North has recently been changed to that of a Conservation Park.

Conservation of wetlands varies over different regions. Approximately 10,000 hectares are conserved along the River Murray in South Australia. Less than 1,000 hectares are in nine Conservation Parks, and the remaining 9,000 hectares are contained within four Game Reserves. The Woods and Forests Department control Murtho Forest Reserve which covers approximately 2,000 hectares and includes some valuable areas of wetland (Thompson, in press). The majority of Coorong wetlands are conserved inside the Coorong National Park which covers nearly 40,000 hectares. Approximately 7% (40 sq. km.) of the remaining wetlands in the South-East are conserved (DEP, 1983). This area was once extensively covered by wetlands before the advent of systematic drainage practices in 1931 when the South-East Drainage Act was passed with the aim of extending agriculturally productive land. A major study on wetland resources of the South-East of South Australia, aimed at the evaluation of wetland habitat areas for conservation and recreation purposes has recently been published (South-Eastern Wetlands Committee, 1984). This will provide vital input into conservation management decisions for the region.

Twenty-five percent of the wetlands on Kangaroo Island are located in Conservation and National Parks. However extensive clearing on the island has induced salinity in many of its formerly freshwater lakes. Middle River Reservoir supplies most of the island's reticulated water: more than 50% of its catchment has been cleared. As a result salinity in the reservoir now has a range of between 600-1800mg/1^{-1}. Calculations have shown that clearance of the remainder of the catchment would increase salinity to 2500-3000mg/1^{-1} (Hartley and deVries, 1983, cited in Lothian, 1983), which would make the water effectively useless. Fortunately the vegetation clearance regulations have prevented this situation from arising, and the E&WS Department monitor reservoir salinities on a regular basis. Most wetlands outside the park system show at least some impact from the grazing and trampling of livestock. Edwards Lagoon was drained and ploughed shortly before the vegetation clearance regulations became effective (Lloyd and Ball, in press). This lagoon was identified as overlying one of the island's few local high quality rain-derived aquifers (Barnett, 1974) which in turn overlies the main highly saline water table. Incursion of salt water as the freshwater aquifer is gradually depleted by drainage will in all probability render the area unfit for agriculture. Rocky River in Flinders Chase National Park was recognised as being biologically outstanding on the island in a survey by Lloyd in 1985 (Lloyd and Balla, in press) scoring 38 out of a possible 40 on an index of ecological quality devised for the survey.

A proposed sand mining and washing operation at Mount Compass on Fleurieu Peninsula threatens Tookayerta Creek, which like Rocky River on Kangaroo Island, also scores 38 out of 40 on an ecological quality index (Lloyd and Balla, in press). This is one of the few rivers in the State to flow for the whole year. It also has a very low salinity. These factors probably account for its diverse and, in South Australia, unique macro-invertebrate fauna (Suter, in progress). The river's rich fish fauna makes it a popular venue for fly fishermen. More stringent regulations on the quality of water discharged from the operation than those currently proposed by the developer would probably reduce impacts to an acceptable level (ACI, 1985; EWS, 1985; L. Lloyd, Uni. Adelaide, pers. comm.).

Mount Dare Station on the South Australia/Northern Territory border has been acquired by the National Parks and Wildlife Service in order to preserve the Dalhousie mound springs. As mentioned already, these and other springs like them are literally oases in the desert surrounded by dense wetland vegetation. They provide habitat for numerous waterbirds and other animals, and much of the flora and fauna is of biological and biogeographic significance (Harris, 1981; Greensldae et al, 1985). No mound springs, other than those on Mount Dare Station, and no freshwater areas of the Cooper Creek/Diamantina River drainage system in the Far North-East have been conserved.

If wetlands are to be adequately protected, for whatever purpose, it is also necessary to ensure their water sources are protected. This entails control of development in catchments in order to maintain quality and regularity of run-off. Where the source is groundwater, extraction for competing uses from the same aquifer must be controlled. Concern has been expressed about the large quantity of water to be extracted from the Great Artesian Basin for the Olympic Dam mine north of Port Augusta (Ponder, 1985). It remains to be seen whether the current flow of mound springs will be adversely affected by this development.

The wetland areas considered to be the most significant and most in need of conservation are listed in Table 1.13.

In South Australia the majority of the State's water supply comes from either the Mount Lofty Ranges catchment and reservoirs, or from the River Murray. Reservoirs and their adjacent catchments in the Mount Lofty Ranges are closed to the public, thereby protecting significant areas of watershed wetlands. Access is available for research by formal approach to the E&WS Department. Land use in both the Mount Lofty Ranges and the River Murray areas is predominantly agricultural consisting of fruit growing, market gardening, dairying, stock rearing, and the intensive rearing of pigs and chickens. In the Mount Lofty Ranges there are also large numbers of horse stables and dog kennels. Urban development is also expanding in this catchment area, increasing the rate and decreasing the quality of run-off. Sewage facilities for new dwellings, commonly septic tank systems, are inadequate overall (EWS, 1985) adding a further source of pollution. The major factors contributing to the increased pollution load finding its way into the State's water supplies have been identified as: excessive or inappropriate tillage; land clearance and development; and inadequate provisions for the storage or disposal of animal wastes (EWS, 1985).

The increased quantities of chemicals used to treat the State's water supplies reflect the deteriorating quality of the water, although part of the increase (approximately ten-fold in the Happy Valley Reservoir since 1950; EWS, 1985) is accounted for by a policy of maintaining high water quality further into the distribution system. The developing situation is not only a burden to the consumers of water owing to the increased cost of treatment, but poses a further threat to organisms dependent upon relatively high water quality in the catchments.

Fortunately, there is little industrial activity in the catchments, so persistent and toxic industrial effluents do not pose a significant additional threat. The sewage effluent of the population's coast-hugging majority is discharged to the sea, removing the burden of this common source of pollution from most inland waters (although it does pose some problems in coastal seas as will be seen in section 3).

Threats to inland aquatic flora and fauna in the remainder of the agricultural and the arid regions of the State are not so apparent. They probably consist primarily of salting and siltation, and therefore habitat modification, resulting from land degradation and soil erosion; and threats to wetlands reliant upon aquifers for their water as a result of excessive withdrawals for our own uses. Local contamination of water bodies by chemicals used during the exploration and production of minerals could also threaten aquatic communities, especially in the arid zone where spillages from road transporters are frequent.

TABLE 1.13: UNCONSERVED WETLANDS OF PARTICULAR SIGNIFICANCE IN SOUTH AUSTRALIA

REGION	LOCATION	REFERENCE	*TENURE
South-East	Lake Frome/Mullins Swamp	Jones, 1978	2/4
	Lake Hawdon South	"	5
	Bloomfield Swamp	"	2
	Naen Naen Swamp	S.E. Wetlands Comm.	1
	Hundred of Wells, Site 2a	Mowling & Barritt, 1980	2
	Hundred of Wells, Site 8	"	2
	Eight Mile Creek		1/4
	Glenelg River		1
River Murray	Chowilla Area	SPA, 1978; Krastins, 1981	4
	Lake Merreti/Clover Lake	"	3
	Pike River	"	2
	Gurra Gurra Lakes	"	2
	Tolderol and Mosquito Points	Pillman, 1980; Krastins, 1981	
	Murray Mouth Area	SPA, 1978	2/4
	Yalkiri Sanctuary	SPA, 1978; Krastins, 1981	2
	Narrung Narrows	Pillman, 1980; Krastins, 1981	2
Fleurieu Peninsula	Pt Sections 183, 185, Hd. Waitpinga	Mitchell, 1979	4
	Square Waterhole Swamp[1]	"	2
	Nangkita Swamp	"	2
	Tookayerta Creek	Lloyd & Balla (in press)	1
	Finnis River	"	1
Flinders Ranges	Willochra Basin	P. Suter, EWS, written comm.	3
	Stubbs Waterhole	Corbett, 1980	3
	Spring Creek and Goat Head Waterhole	"	
	Paralana Hot Springs	"	3
	Parachilna Creek	"	3
	Balcanoona Creek	"	3/4
	Chambers Gorge	"	3
Mound Springs	Dalhousie Springs[2]	C. Harris, pers. comm.	3
	Freeling Spring	SEA, 1984	3
	Blanche Cup/Bubbler Spring Group	"	3
	Strangways Spring Group (Telegraph Reserve)	"	3
	Nilpinna Spring	"	3
	Hermit Springs	"	3
	The Fountain or Big Perry Springs	"	3
	Big Cadna-owie Spring	"	3
	Twelve Springs	"	3
	Coward Springs and/or Warburton Springs	"	3

Far North East	Coongie Lakes	NCSSA, 1975	3
	Diamantina River and Cooper Creek Floodplain	"	3

*Tenure
1. Freehold
2. Mixed including Freehold and/or Perpetual Lease
3. Pastoral Lease
4. Government Reserve or Undedicated Crown land
5. Miscellaneous Lease

Notes: 1. Has since been cleared and cultivated
2. Acquired by NPWS in 1984

Source: Modified after DEP, 1983.

2.2 INLAND AQUATIC FLORA

Aquatic plants are those growing in or on permanent water. They may be completely submerged, floating, or emergent, and have definite life form (habit or structure) adapted to their aquatic environment. Also included are semi-aquatic species which can withstand near-permanent dry land or terrestrial condition and only require periodic temporary inundation for survival. They are suited to living in a fluctuating aquatic environment involving alternate periods of flooding and desiccation, their life form remaining essentially unaltered throughout. They are typically found bordering areas of permanent water in bogs and shallow swamps (Aston, 1973; Sainty et al, 1981).

Aquatic plants have several important functions in aquatic ecosystems. They provide shelter or substrates for many types of fish, invertebrates, and other plants. They contribute to the oxygenation of the water by means of their photosynthetic activity and along with detritus derived from terrestrial sources form the basis of biological productivity in the ecosystem. In life they assimilate large quantities of dissolved inorganic nutrients, particularly nitrogen in the form of nitrate, phosphorous as phosphate, and carbon as carbon dioxide or bicarbonate. They also concentrate trace elements during the growing season including the planktonic diatom's requirements for silica, and the needs of macrophytes for calcium, especially in water of high pH (Moss, 1980). It is known that they excrete various soluble organic compounds, and that seasonal drying out stimulates bacterial activity and decomposition, speeding the return of elements such as nitrogen and phosphorus to the water in organic rather than inorganic form making them available for use by other organisms (Briggs, 1981). The immediate effect on water quality is the temporary removal of quantities of inorganic nutrients. These are then temporarily stored by the plants. Nutrients may be dispersed to the terrestrial environment as well as being returned to the aquatic ecosystem directly as food or in the form of detritus, owing to the interactions between sediments, water, atmosphere, and terrestrial and aquatic organisms. However, the assimilation and cycling of nutrients needs energy, and energy utilisation generally requires oxygen (Gangstad, 1979). The availability of oxygen in water is determined by the comparatively slow process of diffusion (Mason, 1981). Excess nutrients combined with optimum conditions of light and temperature can result in a population explosion of aquatic plants. The process of nutrient enrichm of aquatic systems which leads to abnormally high plant production is termed eutrophication. However, as plant numbers increase beyond the capacity of the water to supply their nutrient and/or oxygen requirements large scale death results, and the subsequent decay of the plant material can have serious consequences for other organisms in the water. These include direct toxic effects from the decay of cyanobacteria (blue-green algae), and further oxygen depletion as the organisms of decay, such as bacteria, fungi and protozoa, increase their own populations in response to the newly available food source. Such a situation will cause the death of all oxygen utilizing animals, leaving only those bacteria capable of functioning in its absence. These anaerobic bacteria produce hydrogen sulphide as a by-product of their respiration rather than the usual carbon dioxide. It is this toxic substance that can cause water to smell like rotten eggs. Such a situation is fortunately rare in the River Murray. The reason for this is thought to relate to the highly turbid river water preventing sufficient light penetration to allow such 'blooms' to occur, even though nutrient levels are probably high enough. A close watch is kept on reservoirs for this reason, and nutrient enrichment originating in surrounding farmland, from intensive animal husbandry, and increasing numbers of domestic dwellings is giving considerable cause for concern in the Adelaide Hills catchment areas (E & WS, 1985). Algal blooms have already occurred in Mount Bold and Happy Valley Reservoirs (Ganff, 1982, E & WS, 1985).

South Australia has experienced infestations of the notorious introduced weed water hyacinth Eichhornia crassipes but not on the extensive scale known in the eastern States. During the late 1930s, the weed presented a problem as it spread rapidly from a lagoon at Ramco into the main channels of the River Murray (Tideman, 1977). It was eventually eradicated. No further outbreaks have been recorded.

However, there may be a positive application of 'problem' weeds which could be of use in the South Australian context. In several tropical countries there is increasing interest in the applied use of water hyacinth and other fast growing aquatic plants. They thrive in waters with a high organic content, especially sewage ponds and polluted water-ways. They can be harvested and processed for use as livestock feed or fertilizer, or digested in sealed vessels with air excluded (anaerobic fermentation) to produce methane gas for the supply of local energy. The feature that makes them weeds - their rapid growth rate - also provides enormous potential if they are viewed as a crop species. They give high yields per hectare on areas with no other potential, require no fertilizers, irrigation or cultivation, and clean up polluted water at no cost whilst providing free raw materials to replace ones usually imported at considerable cost (Hall et al, 1982). As the costs of non-renewable sources of energy and raw materials continue to rise and become increasingly scarce, society will have no option but to recycle what resources it already has more completely. It makes sense to embark upon the research necessary to put theory into practice before the need becomes essential.

Recent studies have been carried out on the aquatic macrophytes in various water bodies, such as the freshwater lagoons on Kangaroo Island and the saline and freshwater lakes of the South-East. Biological and water quality data have been collected over 40 years from the State's water supply reservoirs and the River Murray by the E & WS Department and assessment of this data is currently in progress (P. Suter, E&WS, written comm.). Work on one of these reservoirs, Mt. Bold Reservoir, has involved the investigation of factors controlling the growth of phytoplankton and algae (Ganf, 1982, Ganf et al, 1982). As an operational function the E&WS Department monitor phytoplankton abundance regularly from the State's 28 reservoirs and at 19 locations on the River Murray. Aston (1973) produced a guide to aquatic plants of Australia, both native and naturalised. A more up-to-date work based on the aquatic flora of New South Wales (Sainty et al, 1981) contains many of the plants likely to be encountered in South Australia. The marine benthic flora (Womersley, 1984) also includes species occurring in saline inland waters. Information on the inland aquatic flora and its distribution on a statewide basis needs to be brought up to date. It appears that research in this area is rather piecemeal and it is difficult to gain a comprehensive overview of the status of South Australia's freshwater flora.

2.3 INLAND AQUATIC FAUNA

Each distinct type of inland water environment is characterized by its own suite of associated fauna. Some are exclusive to a particular habitat type while others are less selective. Indeed in many parts of the world, inland water bodies are defined by the animals found within them (Hawkes, 1975). In Australia however, the study of inland aquatic fauna is generally not at a stage where organisms can be so used, and many groups remain relatively unknown. Despite this, the State Water Quality Laboratory has built up a collection of over 300 inland water macro-invertebrate taxa, many of which have been successfully used to monitor water quality in the River Murray, Sturt River, Torrens River, North Para River and Tookayerta Creek (Table 1.16). These circumstances have contributed to the observations made by W.D. Williams (1980) in his book Australian Freshwater Life that:

> "A great deal of (basic taxonomic work) remains undone ... especially with reference to the invertebrate animals of Australian inland waters. Only a small number of such animals has yet been studied intensively from a taxonomic point of view". p. 18; and "despite the ubiquity of such water-bodies (small ponds or farm dams) in Australia, surprisingly little is known about their ecology". p. 9.

Information based on such a system can be employed in tandem with physico-chemical monitoring programmes already used extensively by the water industry for purposes of water quality control. Biological monitoring reveals the extent of ecological imbalance caused by pollution or natural fluctuation of the water regime in that communities are affected over the long term by such occurrences, so significant changes in the composition of the fauna remain apparent (Mason 1981). This is the case even when a polluting incident may have passed and been of only short duration. The basic reason for biological monitoring is to detect any change in the well-being of the aquatic community. This is not an extension of animal welfare sentiment to worms and wigglies by the water authorities, but has its roots in the basic similarity that exists in the way many organisms respond to contamination. Certainly there are organisms which are capable of, or even specialise in living in what are considered to be contaminated waters for example air-breathing mosquito larvae, but these are usually found in abundance only where the more diverse communities characteristic of particular aquatic environments have been displaced by contamination. By contrast some organisms are so choosy about their homes that their presence or absence is a sure indication as to the quality or otherwise of the water. Such indicator species (including the acquatic larval stages of stoneflies eg. Leptoperla spp. and many of the mayflies eg. Tasmanophlebia sp. and Atalonella fuscula) are rare in South Australia however, owing to the transient nature and variable quality of many inland waters which dictates that only species capable of tolerating a wide range of environmental conditions will be successful, hence a reliance upon community diversity for State monitoring programmes. The development of equipment capable of continually monitoring the physico-chemical nature of water has made it possible to detect, identify, and measure the changes which might be responsible for any observed change in the biological community. These procedures are essential to ensure that water extracted from reservoirs or rivers is suitable for its intended use.

Many fish are sensitive to water quality (Alabaster and Lloyd, 1980), and being high in the food chain tend to accumulate the effects of pollution. Catch statistics from commercial operations and amateur fishing associations are often available. For these reasons fish are commonly used as determinants of water quality. In South Australia the Mount Lofty Ranges reservoirs are not available to recreational fishermen and are not managed for this purpose, so there is no requirement for research into the biological suitability of the various reservoirs to support fish populations or to determine stocking rates and so forth. In the River Murray, commercial fishermen are licensed by the Department of Fisheries and catch statistics are available. Historical decline of the most important commercial species including the Murray Cod, *Maccullochella peeli* Trout Cod, *M. macquariensis*, Callop *Macquaria ambigua*, and Cat Fish *Tandanus tandanus* are well documented (Cadwallader 1978, Reynolds 1976). The influences of hydrological management for purposes including flood control, irrigation supply, and the maintenance of year-round navigability, plus the impact from introduced fish species including the European Carp *Cyprinus carpio* and Mosquitofish *Gambusia affinis*, make deductions about biological factors which may have contributed to their decline difficult to draw, more so since the ecological requirements of these species and others are incompletely known (Glover, 1983, Lloyd & Arthington *et al*, 1984, Lloyd and Walker, in press).

An apparent lack of enthusiam for the natural history of inland waters probably has several underlying causes. The lack of basic taxonomic knowledge is clearly the most important, because without this the production of keys and field guides for interested non-specialists is not possible. Widespread perception of South Australia as the driest state on the driest continent on Earth, is almost certainly another contributing factor. The River Murray is the State's most accessible inland water body (Davis and Moore 1985). It is a favourite holiday destination, but its waters are too murky to reveal any of the life they contain other than the limited variety seen by anglers, so the interest the River is capable of stimulating amongst the general public is very limited. Other than the Murray there are few permanent inland waters where it is possible to dabble with a net in an informal manner and become familiar with the creatures living there. Although access to water bodies will generally be freely given by landholders to individuals with a bona fide research interest (including the E & W.S. Department, who also supply any relevant data they hold if necessary), such a privilege does not extend to the general community. Fresh waters in more distant regions of the State only attract attention from a few individuals on rare occasions. NPWS resources are inadequate to stretch to comprehensive biological surveys of lands under their control.

Information on the status of inland water fauna in the State is therefore largely confined to species of some economic importance, including several species of fish (Merrick and Schmida, 1984) and larger crustaceans (Mills *et al*, 1980, 1983; Walker 1982), and various scientific studies of aspects of fresh water ecology such as that of mussels in the River Murray (Walker, 1981), plankton community studies in the Lower Murray (Geddes, 1984a,b Sheil 1978, 1981; Sheil *et al*, 1982) and long-term studies of the Murray's bottom dwelling organisms (Walker (unpublished)), River Murray Commission and E & W.S. (in progress) (see Table 1.16).

The enthusiasm with which South Australia's small but vigourous inland water research community approach their chosen vocation, will hopefully yield more knowledge of interest to the general community in the future. Like many other facets of Australian biology, its inland water fauna is unique. It is a community asset and should be recognised and managed as such for the benefit of people now and those still to come.

2.3.1 Vertebrates

Mammals

The platypus *Ornithorhynchus anatinus* is now extinct in South Australia. A population has been introduced into Flinders Chase National Park on Kangaroo Island. A total of twelve animals were released between 1928 and 1947 (Inns *et al*, 1979), and appear to have established a stable population in the Park.

The Swamp Antechinus, *Antechinus minimus* has been greatly reduced in range and numbers owing to the drainage of its swamp habitat in the South-East (Aitken 1983). The Mullins Swamp - Lake Frome complex south of

Beachport contains the only remaining viable population of the species in the State (S.E. Wetlands Committee 1984). The area has been recommended for inclusion into the adjacent Canunda National Park by the Committee.

The Australian Water-rat Hydromys chrysogaster and the Swamp Rat Rattus lutreolus are believed to be quite common (see Appendix 12). The water-rat can still be found along the permanent water courses of the Cooper Creek and River Murray floodplains. It has disappeared from metropolitan waterways, probably because of habitat modification, and has not been recorded from Kangaroo Island (Inns et al, 1979; Tyler et al, 1976). The Swamp-rat is confined to the southern Mount Lofty Ranges and the higher rainfall regions of the South East where it seems to have adapted to the changes resulting from drainage. It is only known from one location on Kangaroo Island (Inns et al, 1979), but this is almost certainly a result of its secretive habits and the absence of systematic searches for the animal.

Birds

Many species of birds utilise areas that are classified as wetlands during parts of their life cycles. Some birds such as pelicans and ducks are more obviously dependent on areas of open water than some of the gulls and wading birds, which appear equally at home in urban or rural settings. However, those species that exhibit a preference for wetland areas either as breeding sites, sources of seasonally abundant food or as favoured staging areas for migrating species, have been identified (J. Reid, NPWS, pers. comm.). Only resident or regularly migrant species are included in Table 1.14. The birds considered as wetland species are identified by a ~ in Appendix 13.

Of the 100 wetland species, one is extinct, 24 are either rare, vulnerable, on endangered owing to a combination of habitat loss, persecution and natural scarcity (the migratory nature of many wetland species makes it difficult to determine causes behind observed population changes), and eighteen species of mainly migratory waders are classified as uncommon. The remaining fifty-seven species are still common and some, such as the Cattle Egret Bubulcus ibis are increasing their numbers here.

TABLE 1.14: STATUS OF WETLAND BIRDS IN SOUTH AUSTRALIA

Order	Species Status[1.]						
	C	U	R	V	E	X	Total
Podicipediformes	2	0	1	0	0	0	3
Pelecaniformes	6	0	1	0	0	0	7
Ardeiformes	7	2	3	2	1	0	15
Anseriformes	8	1	3	2	0	1	15
Gruiformes	6	1	2	1	0	0	10
Charadriiformes	26	14	4	3	0	0	47
Coraciiformes	2	0	0	0	1	0	3
Total	57	18	14	8	2	1	100

1. See Appendix 2 for explanations of status symbols and the birds represented in each order.

Most of the birds seem to be able to adapt to changing environmental conditions to some extent. Because of their high mobility they can take advantage of favourable conditions when they occur and move further afield. Although certain species are probably less common now than at the time of settlement (at least two species have become extinct), the bird fauna of inland waters is still rich and varied. The potential for major bird kills still exists however, and the cumulative impacts of agricultural chemicals on breeding success, acts of vandalism, disturbance of nesting birds by power boats and even the toxic effect of lead shotgun pellets and fishermen's split lead weights on bottom feeding ducks and swans (Feierabend, 1983) should be carefully watched.

Reptiles

The status of aquatic tortoises (Appendix 14) is unknown, though they apparently occur quite commonly along the River Murray (Thompson, M., Uni. of Adel, pers. comm.), in certain parts of the River Torrens (Hassel and Partners, 1979), and in the permanent waterholes of the Cooper Creek system.

Amphibians

All the frogs and toads occurring in the State (Appendix 14) rely on freshwater at some stage in their life cycle, even those adapted to life in the desert. Their status as common suggests that any changes that have occurred since European settlement have not had deleterious consequences for them and may even have been advantageous, such as the provision of more permanent sources of water on pastoral properties in the arid and semi-arid zones. No newts or salamanders occur in Australia.

Fish

The current known status of freshwater fish is shown in Appendix 15. Of the 44 indigenous fish species recorded from South Australia, only 13 are considered to be common.

The Trout Cod Maccullochella macquariensis, once common in the River Murray, is now considered to be extinct in the South Australian section of the river as a result of changed hydrological conditions and past fishing pressures.

The six species considered to be threatened to some degree for predominantly natural reasons are species largely confined to the more arid regions of the State. Their future depends on the conservation of the few fresh water springs and permanent water courses to which they are confined, or to which they retreat during times of drought. Recent acquisition by NPWS of Mount Dare Station which includes the Dalhousie Springs is a welcome move. However, mineral exploration and extraction in the Flinders Ranges and Gammon Ranges National Parks, permitted under Section 43 of the National Parks and Wildlife Act 1972-81 is a reminder that a species is not necessarily safe even when present in such an area. The Purple Spotted Gudgeon Mogurnda mogurnda is thinly spread in the arid north but has major strongholds in the Flinders Ranges (Balcanoona Creek) and at Dalhousie Springs. John Glover of the State Museum is of the opinion that both the Balcanoona and Dalhousie populations may prove to be distinct species of Mogurnda, with Mogurnda mogurnda being distributed throughout the remainder of the arid north. An accidental spillage of chemicals, widely used in the drilling of exploratory bore holes, could conceivably eliminate entire populations of fish and other freshwater organisms in this environment.

Seventeen species are now considered to be either rare, vulnerable, or endangered owing to some aspect of human influence, mainly the alternation of flow regimes in natural watercourses which can interfere with reproductive and migratory behaviour, or as a result of competitive influences from the eight species of introduced freshwater fishes now established in South Australia.

The remaining seven species are not adequately known to be given a status, though it is unlikely any will prove to be either widespread or common. The Barcoo Grunter Scortum barcoo for example is only known from a single specimen, and three species have been discovered so recently that they have not even been described. (Lloyd, L., Univ. Adelaide, pers. comm.).

The status of fishes in inland waters in South Australia is summarised in Table 1.15.

TABLE 1.15: STATUS OF INLAND WATER FISHES IN SOUTH AUSTRALIA

	Species Status[1]									
	X	E**	E*	V**	V*	R**	R*	K	C	Total
Species (n)	1	3	2	8	0	6	4	7	13	44
Species (%)	2.3	6.8	4.5	18.2	0	13.6	9.1	15.9	29.6	100
		11.3		18.2		22.7				

[1]See Appendix 2 for explanation of coding

2.3.2 Invertebrates

The invertebrate fauna of South Australia's inland waters has only come under close scrutiny in the last twelve years (Williams 1981). Most attention has been directed towards the River Murray upon which there is a growing body of literature and expertise.

The invertebrates of the Coorong have been largely unstudied in the past. Research is now under way at the University of Adelaide Zoology Department aimed at determining the nature and ecology of the benthic (bottom dwelling) and zooplankton faunas. Preliminary findings indicate that amphipod crustaceans, and snails of the genus Hydrobius are important items in the diets of fish, and that the distribution of these organisms is limited by high water salinities. Such conditions occur when fresh water is prevented from entering the Coorong Lagoons by the barrages across the Murray Mouth during drought seasons (fifty percent of the time). The overall effect of these conditions upon fish populations is also being studied (Kangas and Geddes, in press; Geddes and Butler, unpublished; M.C. Geddes, Uni. Adelaide pers. comm.; D. Hall, Dept. of Fisheries, pers. comm.). Systematic sampling of the benthic communities of the River Murray between Renmark and Wentworth was carried out in 1980 (Walker, unpublished) and by the E & W.S. for the River Murray Commission between the new South Wales border and Tailem Bend since 1980. The results of this work were being assessed in late 1985 (P. Suter, E & W.S., written comm.)

Several projects investigating the biology of a commercially important crustacean the yabbie Cherax destructor (Mills et al, 1980, 1983), and to a lesser extent the Murray crayfish Euastacus armatus (a large and impressive species once common in the South Australian Murray but probably extinct since the 1950s) are providing important results. Complementary research on two species of fresh water mussel Alathyria jacksoni and Velesunio ambiguus indicates that the changed flow regime of the Murray, brought about by a system of weirs designed to maintain river levels for purposes of water supply and navigation, has provided improved conditions for the yabbie and V. ambiguus. Both species are adapted to the relatively stressful stagnant water floodplain environment, which the main body of the river increasingly resembles. E. armatus and A. jacksoni are adapted to faster flowing river conditions and have fared less well (Walker 1983; Barley and Geddes 1984, Thompson, in press). No clearly identifiable reason for the extinction of the crayfish has been established to date. Speculation has included changed hydrological conditions, possible seasonal oxygen depletion, overfishing and th mobilisation of large quantities of pesticide by the floods of 1956 following heavy use of DDT to control plagues of grass locusts in New South Wales and South Australia in the early 1950s (Walker, 1982; P. O'Conner, pers. comm.)

Further evidence that the Murray has become more like a lake and less like a river are the findings of Shiel (1978, 1981) who reports that its zooplankton community of predominantly cladoceran and copepod crustaceans is typically lacustrine. Only in the comparatively unregulated waters of the Darling River in New South Wales is this fauna more characteristic of a river, dominated by members of the phylum Rotifera.

An ecological survey of sixteen wetlands in the South-East of the State is being made by Zoology Department at Adelaide University. It is hoped that much of the resulting data will be of value in improving management practices for these and similar areas. (Williams, W., Uni. Adelaide, pers. comm.)

A surge in interest surrounding the unique mound springs in the arid north, culminating in the recent purchase of Mount Dare Station for incorporation into the park and reserve system, may stimulate further research into the fauna of these desert oases, which are already known to support at least two endemic species of fish (Glover, S.A. Museum pers. comm.), fourteen endemic snails, four crustaceans, and a flatworm (Ponder 1985).

The Engineering and Water Supply Department have provided a list of surveys and monitoring programmes of benthic invertebrates conducted by them since 1978 (Table 1.16). Material collected during the course of these surveys forms the basis of the reference collection based at the State Water Laboratories, Bolivar, and is also included in the Musuem of Victoria's voucher collection of South East Australian aquatic invertebrates. Both are valuable sources of reference for anyone working on aspects of the State's inland water fauna.

The North Para River survey (Suter 1984, Table 1.16) established an inventory of the macro-invertebrates found in the river for the first time, recording over 135 different species, and provided an analysis of the impact effluents from the wine idndustry have upon the river's fauna.

The life cycles of some South Australian mayflies have been investigated in detail (Suter & Bishop, 1979, Suter, 1980). The fauna of Brownhill Creek has also been surveyed, with emphasis being on the caddisflies found there (Towns, 1983). A survey of the aquatic invertebrates found in the River Torrens was conducted in 1978 (Ferris, 1979) as part of a review to determine possible future development options for the river (Hassell and Partners, 1977 a,b, 1979). Two further surveys of the River Torrens invertebrate fauna contain additional information (Klippel et al, 1979; Walker et al, 1976).

References to research relevant to South Australian wetland invertebrates can also be found in Sullivan and Lothian (1982), Department of Environment and Planning (1983) and University of Adelaide (1984). Using information from the E.&W.S. Department and the State Museum it is possible to estimate the extent of the South Australian inland water invertebrate fauna as follows: The E.&W.S reference collection contains approximately 300 named species (Suter, E.&W.S. written comm.). Percentage estimates supplied by the museum (Table 1.17) indicate that slightly under 50% of the aquatic invertebrates are collected and named (48% with a standard deviation of 17), thus suggesting the total likely to be recorded eventually will be in the region of 600. Only an estimated 3% have been collected and remain unnamed, indicating to an extent the practical value placed on aquatic invertebrates and the research invested in them in relation to the crucial water supply industry in the wetter southern part of the State. The myriad of aquatic insects emerging in the arid zone after soaking rains no doubt represent a substantial proportion of the aquatic invertebrates still to come under scientific scrutiny. Figure 1.24b presents the above estimates diagramatically.

Referring to Australian freshwater faunas in general, Williams (1981) notes two major points:

1. Many groups of animals associated with fresh waters in other parts of the world do not occur in Australia; and

2. Those groups that do occur commonly exhibit a high degree of endemicity and adaptive radiation, and are representatives of evolutionary primitive groups.

These two factors are a result of Australia's long history of isolation from the rest of the world. A parallel between the aquatic fauna in general and the marsupial and monotreme mammal faunas is evident. All of these are primitive groups which have successfully adapted to many different ways of life or survived in specialized niches in the absence of competition from the mainstream of evolution.

As well as being of scientific interest in their own right, these distinctively Australian animals and plants require conditions for their survival which are also unique, and need appropriate consideration from regulatory authorities if their future is to be secured. This of course necessitates a sound understanding of the organisms concerned and once again raises the questions; are we committing sufficient resources for this basic research in view of the rapid changes we are bringing about to the environment, or are we unwittingly consigning a significant and often unknown fraction of our biological resources to the history books because

TABLE 1.16: FRESH WATER INVERTEBRATES MONITORED BY THE STATE WATER LABORATORY OF THE ENGINEERING AND WATER SUPPLY DEPARTMENT SINCE 1978

SURVEY	STATUS	DATA COLLECTED	FREQUENCY	DATE RANGE	DATA STORAGE
North Para River	Ceased 1981 2 additional surveys 1983	Benthic Invertebrates	Approx. Seasonal	1978–81 & 1983	1978–81 Departmental Report 1983 (Suter 1984) data not analysed
River Murray	On going	Benthic Invertebrates	2/year	1980 –	Computer storage at Rural Water Commission of Victoria and worksheets
Katarapko Is. Evaporation Basin	On going	Benthic Invertebrates	Seasonal	1985 –	Computer and worksheet
River Torrens	Ceased 1984	Benthic Invertebrates	1/year	1983–84	Computer
River Torrens	Ceased 1979	Benthic Invertebrates	1/year	1978–79	Computer
Sturt River	Ceased 1982	Benthic Invertebrates	Approx. Seasonal	1978–82	Worksheets
Tookayerta Creek	Ceased 1985	Benthic Invertebrates	Seasonal	1984–85	Computer

North Para river data assessed in a non-restricted Departmental Report. All other data not adaptable for non-specialist use.

of indifference or perceived short-term economic necessity? To put it another way, is conservation a luxury promoted by a minority of eccentrics, or is it the sound scientific basis of sustainable resource management upon which the vitality of future generations will depend?

Table 1.17 lists the major groups of aquatic invertebrates found in South Australia and the current extent of our knowledge.

TABLE 1.17: MAJOR INVERTEBRATE GROUPS OF INLAND WATERS AND CURRENT STATE OF KNOWLEDGE

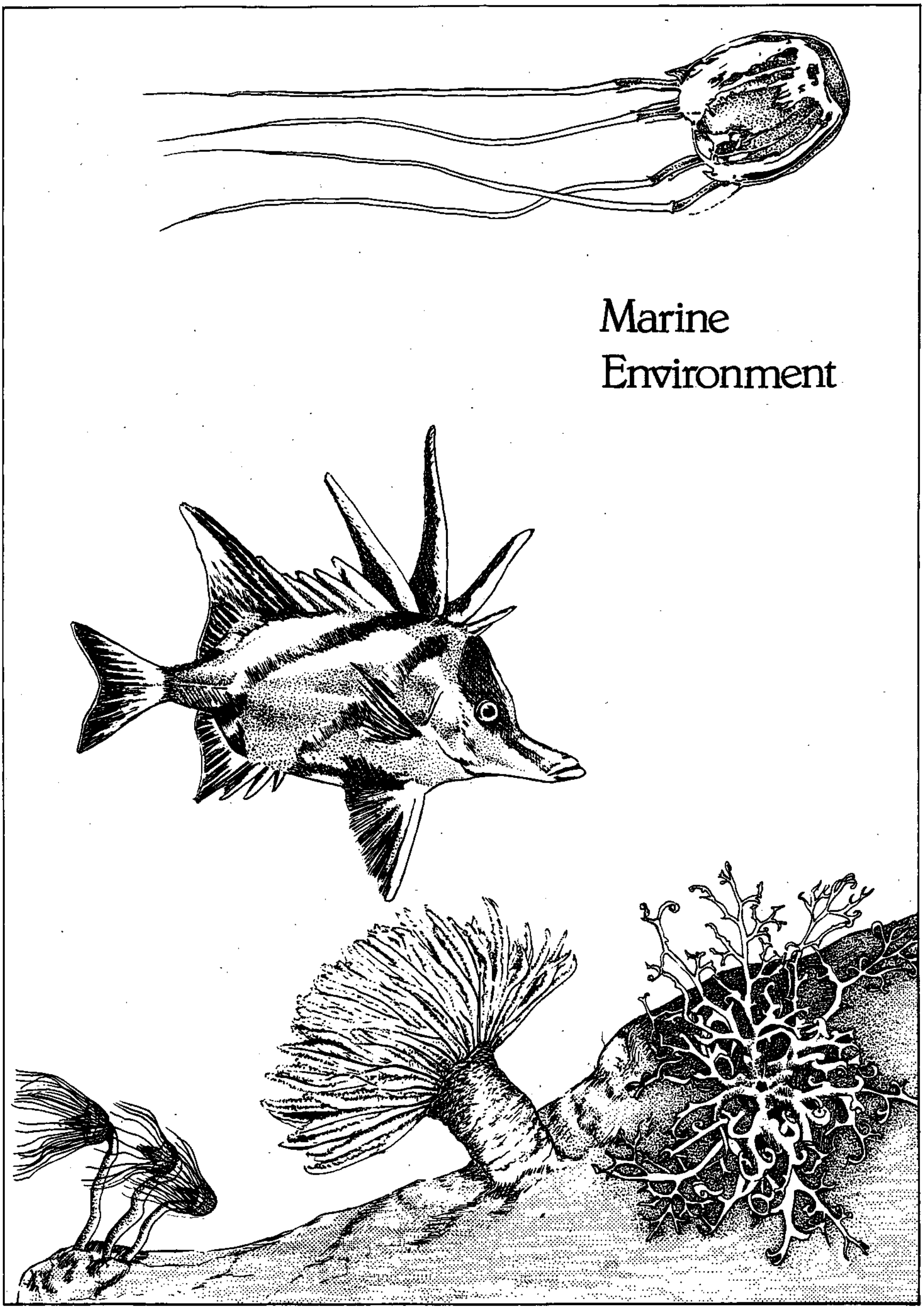
PHYLUM. CLASS ORDER	SPECIES COLLECTED AS A PERCENTAGE OF ESTIMATED TOTAL	SPECIES DESCRIBED AND NAMED AS A PERCENTAGE OF ESTIMATED TOTAL	INFORMATION ON THE GROUP IN GENERALLY AVAILABLE PUBLISHED FORM YES	NO	COMMENTS
PROTOZOA (single celled animals)	<25%	<25%		×	
PORIFERA (sponges)	75%	75%		×	
CNIDARIA (hydroids, jelly fishes anemones)	25%	<25%		×	
PLATYHELMINTHES (flatworms, flukes, tapeworms)	<50%	<50%		×	
ASCHELMINTHES (roundworms, nematodes)	<25%	<25%		×	
ROTIFERA (wheel animalcules - very small planktonic or attached organisms)	<75%	<75%		×	Recent taxaonomic works by R.J. Shiel, Dept. of Botany, University of Adelaide.
GASTROTRICHA (microsopic animals of sediment and detritus)	<50%	<50%		×	
BRYOZOA (moss animals)	<50%	<50%		×	
MOLLUSCA					
Bivalvia (bivalves)	<50%	<50%	✓		See Cotton (1959, 1961, 1964) and Zeidler (1983) Gross et al. (1979) for accounts of Mollusca.
Gastropoda (snails and limpets)	<50%	<50%	✓		
ANNELIDA (true worms)					
Hirudinea (leeches)	<75%	<50%	✓		
Polychaeta (bristleworms)	<50%	<50%		×	
Oligochaeta (earthworms)	<50%	<50%	✓		
TARDIGRADA (water bears)	<25%	<25%		×	Found mainly associated with damp moss and other lower plants. Poorly known.
ARTHROPODA (jointed legged invertebrates)					
Arachnida (spiders and mites)					
Hydracaraena (water mites)	50%	50%		×	
Araneae (water spiders)	25%	<25%		×	
Crustacea					
Planktonic and microscopic crustaceans including the Branchiopoda Ostracoda, Copepoda, and Branchiura	25-75%	<25-75%		×	
Syncarida	<25%	<25%		×	Recently discovered in South East region (Zeidler 1983).
Isopoda (water lice)	<50%	<50%	✓		Larger freshwater crustaceans described in Hale (1927, 1929).

TABLE 1.17: Continued

PHYLUM. CLASS ORDER	SPECIES COLLECTED AS A PERCENTAGE OF ESTIMATED TOTAL	SPECIES DESCRIBED AND NAMED AS A PERCENTAGE OF ESTIMATED TOTAL	INFORMATION ON THE GROUP IN GENERALLY AVAILABLE PUBLISHED FORM YES	NO	COMMENTS
Amphipoda (freshwater shrimps)	<50%	<50%	✓		
Decapoda (crayfish, shrimps, crabs)	50–75%	50–75%	✓		
Insecta					
Plecoptera (stoneflies)	60%	60%		✗	Only five speices known from S.A. (Gross 1983)
Ephemeroptera (mayflies)	90%	90%		✗	Taxonomic and ecological work well advanced (Suter 1980; Suter and Bishop 1979).
Odonata (dragon flies and damselflies)	>50%	<50%		✗	
Trichoptera (caddisflies)	75%	50%		✗	Specialist account of two species from Brownhill Creek (Towns 1983)
Hemiptera (true bugs)	75%	50%		✗	Aquatic Hemiptera not covered in published volumes (Gross 1975, 1976).
Megaloptera (alder flies)	75%	<75%		✗	
Neuroptera (lace-wings)	50%	<50%		✗	
Coleoptera (beetles)	<50%	<50%	✓		Genera of water beetles described in Matthews (1982).
Diptera (true flies)	75%	50–75%		✗	75% of adult forms known. The aquatic larval stages are compartively poorly documented
Hymenoptera (parasitic wasps)	<25%	<25%		✗	
Lepidoptera (aquatic moth larvae)	<25%	<25%		✗	

Sources: Taxonomy from Barnes 1980
State of knowledge based on estimates supplied by the S.A. Museum 1985 and from the additional sources cited.

Marine Environment



MARINE ENVIRONMENT

The mauve stinger jellyfish Carybdea rastoni is almost transparent and has four mauve tantacles. These creatures can be seen singly or in hundreds, gently pulsating along near the surface of our coastal waters. Fortunately, this species does not have the same stinging powers as its tropical relatives.

The long-snouted Boarfish Pentaceropsis recurvirostris is a very distinctive fish with a tube-like snout and three oblique dark stripes across its body. It grows to a length of 50 cm and is reasonably common in our shallow coastal waters.

Ralpharia magnifica is a large hydranth up to 5 cm in diameter across the extended tentacles. It is a carnivorous invertebrate, lives in groups of two to fifty, and occurs in sheltered pockets in the ocean and bays.

The feather duster worm, Sabellastarte indica, has a graceful crown of slender tentacles. It lives in a mud-coloured tube which it constructs using sand and mud from the surrounding sea floor. Small organisms and food particles are filtered from the water by tiny bristles along the tentacles and wafted to the animal's mouth in the centre.

The basket-star, Astroba ernae, grows to 5 cm across the disc and has multi-branched arms about 12 cm long. It is a salmon pink colour and spends the day curled up as a circular pad. At night it emerges to feed, catching planktonic creatures in its 'basket of arms'.

3 MARINE ENVIRONMENT

3.1 BACKGROUND

3.1.1 Seas and their significance to South Australia

The oceans occupy 361.3 million km^2, or 71 per cent of the Earth's surface (Ehrlich et al 1977). Historically they have been able to absorb the simple wastes of a small, dispersed human population without significant disturbance to ocean processes or their living communities (Whittaker, 1975). However human numbers have been increasing exponentially since the early 19th century when the industrial revolution marked the beginning of mechanised agriculture and set the scene for major advances in the fields of medicine, science, and technology. The ensuing urbanisation of previously rural populations has been repeated in progressively more countries as labour requirements and expectations have swung from the agricultural to the industrial sector, with an inevitable concentration of human consumption and waste production in cities. Cities are often located on the coast or on the shores of major inland water bodies (Douglas, 1983). The opportunity for transport and trade has made such locations an obvious preferred choice. Estuaries have been particularly favoured because of their often sheltered nature and the access they provide to international sea-routes and inland destinations. Inland waters have received much of the wastes generated by industry and urban populations located there, simply because they conveniently carry it away, usually free of any immediate cost. Consequently large amounts of liquid and solid wastes are either deposited directly in coastal waters or are transported there by rivers.

For various physical reasons related to the circulation of ocean waters, and the distribution of dissolved nutrients, the world's major commercial fisheries are also concentrated in coastal waters with over 90% of the world's commercial fish catch being of that origin (Ehrlich et al, 1977). Circumstances including the poisoning of several thousand people in the fishing community of Minimata, Japan in the 1950s-60s by effluents from a chemical factory which contained highly toxic methyl mercury (Huddle et al, 1975); high concentrations of pesticide and heavy metal residues in seafood caught in the relatively confined seas of Northern Europe (FAO 1971); major oil pollution incidents; and the dumping of radioactive waste (Holdgate, 1979), have prompted the international community to adopt various regulations controlling or prohibiting the discharge of many toxic substances into the seas, in order to protect fish stocks and their eventual human consumers from unacceptable levels of exposure. While pollution is still a major problem in many regions, it would appear that measures taken so far have succeeded in averting or reducing the severity of many recent pollution incidents which could otherwise have had even more serious consequences (IOC, 1983; Keckes, 1983).

For South Australia initial appearances indicate the coastal waters to be largely free from the effects of pollution. There have been no major oil spills resulting in grossly polluted beaches, no recorded large scale deaths of sea birds or fish under suspicious circumstances, and no beach signs warning of the possible risks to health associated with inadequately treated discharges, all of which are familiar to residents of highly urban and industrialised communities in other parts of the world. However, the potential for coastal pollution certainly exists here. Over ninety per cent of the State's population lives on the coast (ABS, 1985) and most major industries are located there. A recent study of the heavily industrialised 'Iron Triangle' region of Northern Spencer Gulf (McLaren et al 1984) indicates the presence of many environmental contaminants in locally elevated concentrations. An absence of baseline biological monitoring data makes it difficult to determine what changes, if any, have been brought about in the living communities of the area. The lack of clear indications that pollution is both present and is having a detrimental effect on flora and fauna may be a result of our not knowing precisely what signs to look for. In a recent survey of toxic heavy metal concentrations in South Australian inland water and marine life, Olsen (1983) found that of the 2728 analyses carried out on specimens representing 100 species, 9.5% resulted in levels above those recommended in seafood for human consumption by the South Australian Food and Drugs Act 1908-1976. Most of the higher concentrations were from sedentary plants and invertebrates taken from waters polluted by heavy industry in northern Spencer Gulf. Some were from animals caught near large towns on the River Murray - sites receiving urban runoff. The remainder were larger specimens of predatory marine species whose comparatively advanced age and position at the top of the food chain renders them susceptible to high accumulation of substances such as lead, zinc, cadmium and mercury. Several fish from polluted waters had gross skeletal deformities leading to them being termed 'wavy backs'. Analysis revealed lead and cadmium concentration at extremely high levels in their bones. At the moment there isn't sufficient evidence to establish a definite connection between the two phenomena. The survey didn't attempt to identify pesticide residues in the sample but they are likely to be present, especially in organisms spending significant time in coastal or river waters receiving urban and agricultural runoff. A sub-sample confined to food species was not significantly different, other than for mercury which reached its highest levels in sharks not generally destined for human consumption. The incidence of mercury contamination was therefore lower for species likely to be eaten than for the general sample. Yearly, or biannual monitoring for toxic contaminants in the more common food species should be conducted as a matter of course at the very least. If we are to continue to avoid the consequences of marine pollution, painfully felt in other parts of the world, it is essential that adequate resources be directed towards the collection and appraisal of baseline ecological data before new developments proceed, and to establish regular and co-ordinated monitoring programmes thereafter. This will enable:

a) The identification of potential pollutants, and the circumstances under which they might threaten the local or regional marine community, particularly where species of economic importance are involved.

b) The early detection of deteriorating conditions necessitating remedial action.

In this light, it is worth quoting the Spencer Gulf Study already mentioned (McLaren et al 1984)...

> "...a community-oriented approach which examines the diversity and abundance of the components of the (marine plant and animal) community is likely to be a more useful basis for monitoring studies than single organisms. In agreement with this interpretation, Ward (1979) believes that whilst the overall habitat may appear to be in a healthy and unchanged condition, an examination of the diversity and abundance of its biota may be capable of detecting subtle changes in community structure (elimination of some fauna or flora). Even suh subtle changes may eventually have a profound effect upon the abundance of other species via food chains.

Very little is known of the effects of specific pollutants on the local species or of the effects on the ecology of the gulf (or other coastal areas of South Australia) of changes in the abundance of particular species.

Acute effects of pollutants on specific organisms can be studied in laboratory experiments. This type of work needs to be encouraged for pollutants of local concern and species of commercial or particular ecological importance. It would be useful to establish the lethal concentration of various heavy metals and hydrocarbons on the larval, juvenile and adult stages of a variety of fauna such as the western king prawn *Penaeus latisulcatus*, the razor shell *Pinna bicolor* and King George whiting *Sillaginodes punctatus*.

The study of chronic effects on individual species or the wider ecological effects present a more difficult problem. Further investigations to determine the concentrations at which sublethal effects such as alteration of behavioural and physiological activities occur would be useful in setting emission standards for current and future industries."

Such an approach will require increased coordination between the various bodies currently active in marine research. A pooling of resources by organisations with an active research interest in the field of marine science is highly desirable. Included could be government departments (Engineering and Water Supply, Fisheries, Environment and Planning, State Museum, Marine and Harbours, Electricity Trust of S.A.); institutions of higher education (Adelaide and Flinders Universities, Colleges of Advanced Education); industry (SANTOS, Broken Hill Pty. Ltd, Broken Hill Associated Smelters Pty. Ltd., oil companies operating the Port Stanvac oil refinery); and interested amateur groups (sea fishermen and particularly the local underwater clubs). The establishment and funding of a permanent facility dedicated to the systematic study of local marine science is also highly desirable. The Australian Marine Sciences and Technologies Advisory Committee made such a recommendation in November 1982 (AMSTAC, 1983). The State Government is presently working on plans to establish such a facility at West Beach. In the meantime the recently launched marine research vessel Ngerin will be able to fulfil the role of laboratory for urgent research programmes (S.A. Department of Fisheries, 1985).

A local committee exists, the South Australian Marine Environment Advisory Committee (SAMEAC), whose current role is as a forum for individuals and organisations to confer, exchange ideas, and hopefully avoid duplication of effort. Despite its name, SAMEAC is not an advisory body. It would be ideally situated to take on such a role should commitment to a coordinated marine research effort materialise.

Only two attempts to monitor changes in the marine community over time have been conducted. The first was a survey of the intertidal ecology between Hallett Cove and Witton Bluff, including the Port Stanvac oil refinery site. This section of coast lies approximately 20-40km south of Adelaide (Womersley and Clarke, 1978). Transects were marked out, and monitored for three years at three-monthly intervals, subsequent to the initial survey. Most of the survey marks have now disappeared as a result of natural weathering or coastal construction works. The collected data, held at Adelaide University's Botany Department, has not been fully analysed owing to a lack of funds. However a pattern of highly changeable communities with close seasonal links is apparently detectable (S.M. Clarke, Dept. Fisheries, pers. comm.), indicating the need for regular sampling intervals in future programmes if the consequences of pollution incidents (in this case oil spills in particular) at any given time are to be adequately predicted and appropriately dealt with.

A second study is currently underway at the Port Bonython (formerly Stony Point) hydrocarbons terminal on the upper western shore of Spencer Gulf. Periodic surveys of the inter-tidal and sub-tidal living communities have been conducted since 1982. The species composition and numbers of organisms from representative habitats around the installation during this survey, have given no indication that present activities are deleterious to the local biota, other than in sediments disturbed by ships' propellors, as was originally anticipated (SANTOS, 1985). As with the Port Stanvac Study, there appears to be a clear seasonality reflected in community composition, representing high recruitment of individuals during spring (apparently a favourite breeding season in the marine habitat too) followed by a decline in populations during summer, when inter-tidal organisms especially are subject to stress from high temperatures and the risk of dehydration.

The Department of Fisheries are also conducting biological survey work in Upper Spencer Gulf, aimed primarily at identifying the requirements of the western king prawn Penaeus latisulcatus, the primary target of commercial fishing operations in the Gulf. A population crash in

1985 resulted in closure of the fishery. The present work is aimed at re-establishing the population and formulating a management strategy for future exploitation at a sustainable level.

The major thrust of marine work conducted by the Pollution Management Division of the DEP is currently directed toward the drafting of proposed State marine pollution control legislation. It involves identifying the manufacturers and users of potential pollutants and the known effects of these upon organisms described in the specialist literature. Further work will then be necessary in order to determine the relevance of findings from other parts of the world on local biota. In addition, details concerning concentration levels, dispersion patterns, and subsequent toxic effects will need to be known before legislation can be put into place. Work of this sort could be quicker, more comprehensive, and more efficient if a coordinated approach using all available resources were taken.

There are currently twelve aquatic reserves located at key locations along the coast with a total area of 14740ha (S.A. Dept. Fisheries, 1984). Sites have been chosen because of their conservation or recreation value, or because they are important habitats in the lifecycles of major commercial species. The use of and range of activities allowed in the reserves is controlled by legislation contained in the Fisheries Act 1971-82. Unfortunately the policing of the reserves is constrained by a lack of resources, and the concept of an aquatic reserve does not seem to have reached much of the community. Interpretive and advisory information displayed at popular reserves such as Aldinga Reef is soon destroyed by vandalism. Consequently there is little opportunity for visitors to appreciate the need for such reserves, or to learn of their responsibilities toward them. It is important therefore that the results of fundamental research be made widely available to the public in a digestible form. In this way the value of the marine environment will become more widely and fully understood. In addition all mangrove stands are protected under the South Australian Fisheries Act 1971-84 effectively adding a further 23000ha to protected coastal habitat in the State. Marine conservation measures can only be effective with the cooperation of the community - the fencing of these reserves is impractical.

3.1.2 The marine biota of South Australia

Now let's look more closely at what is known about local seas, and the variety of life they contain.

Coastal waters are the ones with which most of us are familiar. However we generally only swim or travel in boats across the sea's surface, or observe its breaking waves from the safety of the shore. Most of the plants and animals that inhabit these waters and with which we come into contact are seen either washed up on the beach, or on the end of a fishing line. The majority remain hidden beneath the waves. Except that is, for the narrow strip of shoreline revealed twice daily by the retreating tides. This is the part of the ocean most intensively studied by marine bioligists because of its comparative accessibility. Because the plant and animal community in this zone is subject to a constantly changing environment, as well as the full impact of occasional storms, it is hardly surprising that the numbers and diversity of its inhabitants change readily (Shepherd et al, 1982). Accordingly marine scientists generally use a classification system based upon the relatively constant nature of the substrate or sea bed (Table 1.18) for inter-tidal, and some coastal regions.

Areas with similar substrates share many species wherever they occur along Australia's southern coast, so much so that certain characteristic species can reasonably be predicted to be present before an area is sampled providing the nature of the substrate is known. This entire stretch of coastline shares sufficient common elements along its length to be classified as the Flindersian Province. It stretches from Cape Leeuwin in Western Australia to Cape Howe in Victoria (Womersley, 1984).

The mostly submerged marine plant communities are less conspicuous than their counterparts on land and so appear to form a much smaller component of the living system. While this is true on a global basis (marine plants contribute only 32 per cent of net primary productivity, from oceans which occupy 71 per cent of the Earth's surface (Whittaker and Likens, 1975)), locally the communities of seaweeds and seagrasses are of considerable importance particularly in the shallow gulf region. The distribution of all marine plants is determined primarily by availability of the light which enables photosynthesis to take place (Steeman-Nielsen, 1977). The algae and seagrasses (the benthic flora) are further limited by their need to attach themselves to, or take root in the sea bed. Light is absorbed by seawater (Jerlov, 1976), so there is progressively less light available to photosynthesising plants as the depth of water increases. In addition substances dissolved or suspended in the water further reduce the ability of light to penetrate. In South Australia this ability varies between only a few metres in some coastal areas, gulfs, and bays

TABLE 1.18: MAIN TYPES OF MARINE HABITAT AND ASSOCIATED BIOTA

SUBSTRATE	BIOTA
Mud	Characteristic of calm waters, e.g. harbours and similarly sheltered locations. Fauna similar to that of muddy littoral areas, with species tolerant of anoxic conditions. Polychaetes, certain bivalves, etc. may be locally abundant, together with certain species of crabs, shrimps and other crustaceans. Brittle stars and starfish may be locally abundant, and seagrass beds can provide an important habitat for many invertebrates. Muddy areas and those colonized by mangroves are important feeding grounds and nursery areas for fish.
Sand	Bivalves may occur in commercially important numbers in sandy areas. There are also common burrowing polychaetes, gastropods and crustaceans and (in areas of clean sand) large populations of heart-urchins and brittle-stars. Sandy areas inshore are feeding grounds for young fish and support extensive seagrass beds, and in deeper offshore waters provide commercial fishing grounds.
Shell gravel	Contains many of the burrowing species found in coarse sands, but with additional specialized species. Bivalves, echinoderms and decapods are common. Starfish are found on the surface, together with many fish, especially bottom-dwellers such as flatfish.
Stones and boulders	As with the littoral zones, the type and abundance of organisms to be found depends upon the mobility of the substrate. The more mobile areas may be devoid of macrofauna, but the larger boulders provide a stable and rich habitat, merging into bedrock which offers the most luxuriant populations of all.
Bedrock/rock reefs	Kelp forests cover large areas of stable bedrock, down to a depth of about 20m. In deeper waters, algae more tolerant of low levels of light predominate and may continue right down to the limits for algal growth. The kelp provides a habitat for a very wide range of flora and fauna, particularly red algae, sponges, anemones, hydroids, corals and soft corals, tube worms, bryozoans, and ascidians. These in turn provide food for a large range of predators and grazers.
Tidal streams and rapids	These areas are characterized by suspension-feeding organisms attached to stable rock surfaces. They are usually most abundant in areas where the movement of water is sufficiently strong to prevent the settling-out of suspended matter which would cause the clogging of filter feeding mechanisms. Where these conditions extend into the littoral areas, they have much potential for teaching and study purposes.

Modified after Pritchard, 1983

(especially if the bottom sediments have been stirred up by inclement weather), to as much as 70m in the clear waters of the Great Australian Bight (Shepherd et al 1982). These limits of light penetration determine the point at which the benthic flora can no longer grow, and largely controls the distribution of these plants. Different groups of plants have evolved the ability to use the light available at certain depths under certain conditions, resulting in a changing composition of plant communities with depth (Womersley, 1984).

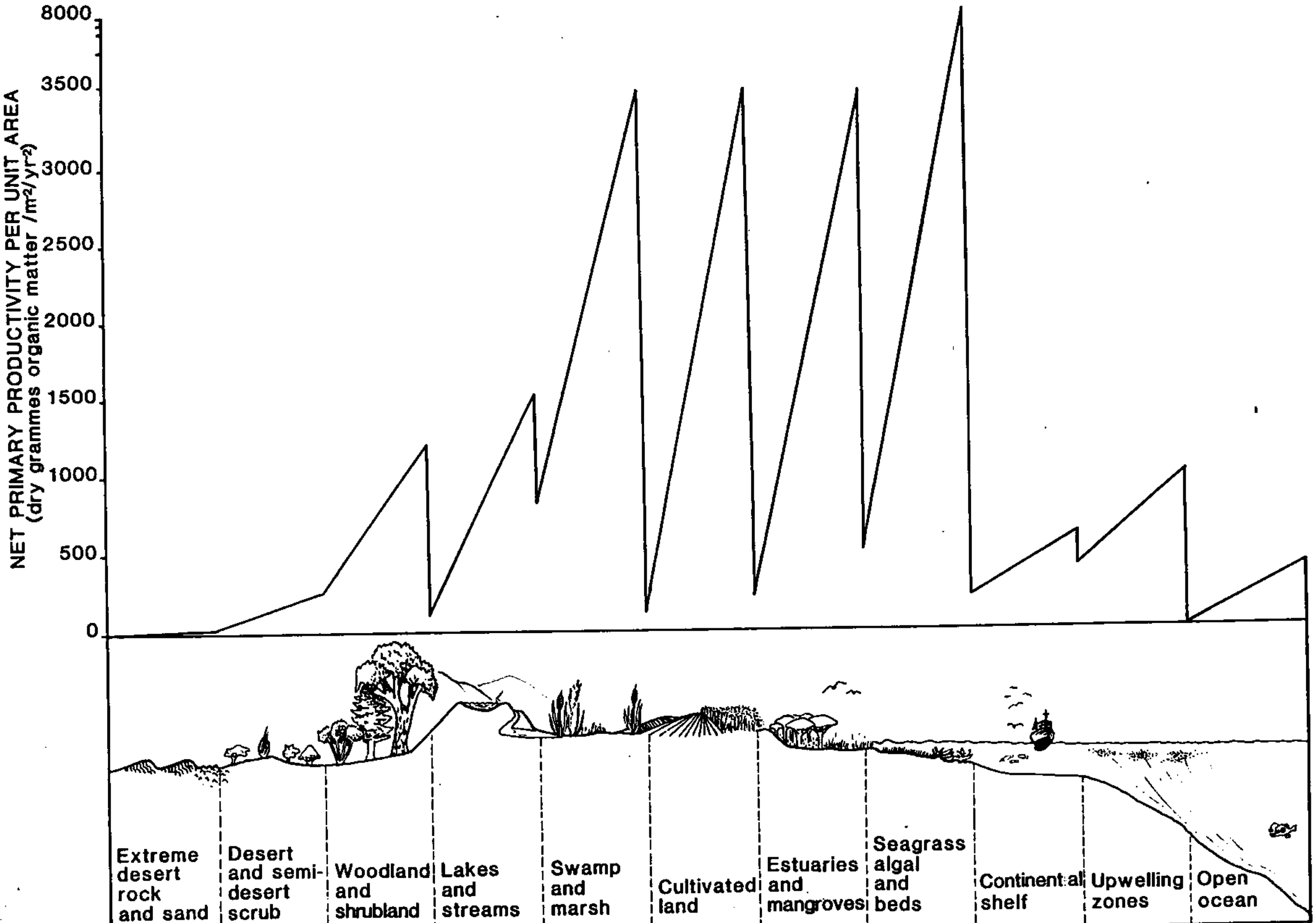
The most important group of plants on a global basis are the largely unseen phytoplankton (Whittaker and Likens, 1975), which drift in the well-lit surface layers (the 'euphotic zone') of the oceans. These minute plants contribute a total of 24.4 per cent of the Earth's primary productivity, compared to the 22 per cent contribution made by the tropical rain forests in 1974 (Whittaker and Likens, 1975). This remarkable figure is only achieved by virtue of the vast area of open ocean in which the phytoplankton can live. In fact on an area for area basis, it is now clear that the open oceans have just about the lowest productivity of any distinct environment type, with primary productivity ranging between 2-400$g^{-1}/m^{-2}/yr^{-1}$. Only extreme desert, rock, sand, and ice are less productive (0-10$g^{-1}/m^{-2}/yr^{-1}$). Figure 1.14 provides information on the relative productivities of the world's major ecosystems and identifies those encountered in South Australia. Fortunately the plankton are not as thinly spread as the figures would suggest; other than light, their productivity is limited by the availability of essential inorganic nutrients dissolved in the water, particularly nitrates and phosphates. These nutrients are only available in surplus quantities in certain areas of 'upwelling' (where ocean currents force comparatively nutrient-rich waters from oceanic depths to the surface), or where rivers discharge to the sea with their loads of land derived nutrients. South Australia's oceanic waters are low in nutrients even by world standards. Upwelling is confined to restricted areas off the western coast of Eyre Peninsula, off the western coast of Kangaroo Island, and to the southern South East coast near Port MacDonnell (Rochford, 1980; Lewis 1981). Nutrient input to coastal waters from land sources is also of little significance because of the low quantities of natural run-off and discharge.

Globally, the most productive fisheries correspond closely with known areas of coastal upwelling and therefore of high phytoplankton primary productivity (Ryther, 1969). Evidence from South Australia however is increasingly indicating the major local source of marine primary production to be the benthic flora (Womersley, 1984) and the mangrove/estuarine ecosystems. The local proximity of these important plants to coastal settlements and industrial development renders them and the animals ultimately dependent upon them vulnerable to changes in habitat or from pollution, with the possibility that fisheries' yields could decline. The popularity of SCUBA diving has made coastal areas increasingly accessible for purposes of study and recreation in recent years and affords an opportunity to investigate the rich and varied life forms of coastal waters more comprehensively than hitherto.

Together with an increase in resources allocated to basic research necessitated in part by requirements of State environmental impact legislation (an environmental impact statement is required for any development or project entailing significant social, economic, or environmental changes to be undertaken at the request of the Minister for Environment and Planning, Section 49, Planning Act 1982-85), but mainly by the re-definition and extension of State and Federal territorial waters following the United Nations Law of the Sea Convention adopted in 1982 (the declaration of a 200 mile/322 km exclusive economic zone around sovereign states effectively doubled national territory, it soon became clear that knowledge of the newly acquired Australia was too sparse to provide for effective management), the prospects of our managing the seas and their living resources from a position of knowledge rather than ignorance and convenience, have never been better.

Figure 1.15 is a diagrammatic representation of the major features of the coastal zone.

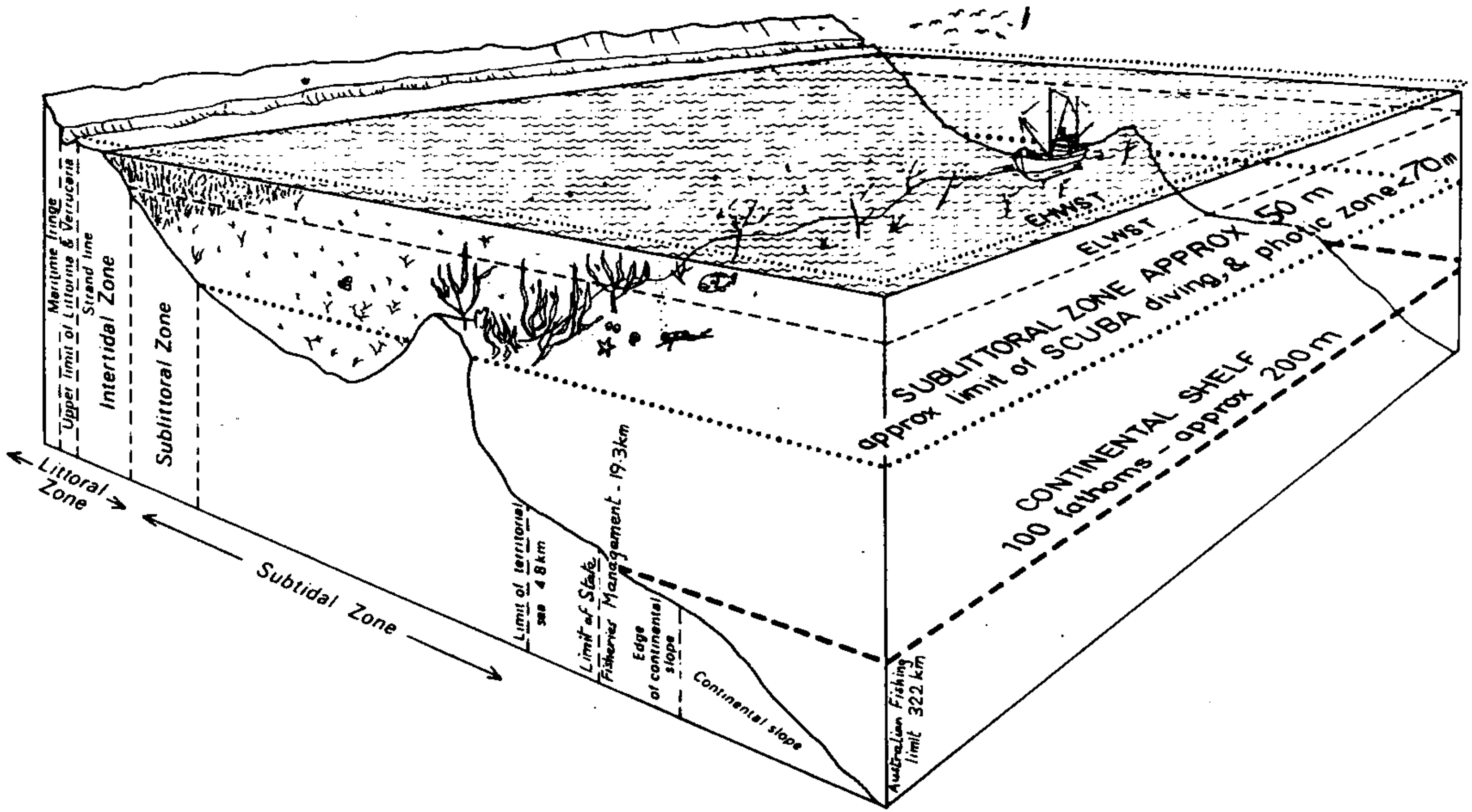
FIGURE 1.14 PRIMARY PRODUCTIVITY OF SOUTH AUSTRALIAN ECOSYSTEMS



Productivity and biomass expressed as dry organic matter can be divided by 2.2 as an approximate conversion to carbon.

Source : Productivities are global maxima and minima from Whittaker and Likens (in Lieth and Whittaker, 1975)

FIGURE 1.15 MAJOR FEATURES OF THE COASTAL ZONE



Modified from: Joint Nature Conservancy Council / Natural Environment Research Council Working Party Report (1979)

Many marine organisms have relatively short life spans. Mortality is high in the sea and survival is assisted by the production of large numbers of offspring or some form of extended parental care such as the brooding of eggs as practised by the Blue Swimmer-crab Portunus pelagicus, and many species of echinoderms for example (Barnes, 1980). Attached organisms in rocky coastal areas and those living within the substrate are subject to the effects of storms and the energy of wave action. Not surprisingly they are subject to removal by such actions, leaving space for colonization by other organisms. Related to this phenomenon is the ease of dispersion of animal eggs and larvae, and plant seeds and spores in the comparatively homogeneous marine environment. Thus the effects of catastrophic local events are readily offset by passive immigration from surrounding areas. Although the species composition of an area may change after the occurrences of a storm, those species that are locally devastated by one event may compensate at another time by being able to colonise the same or other disturbed areas, particularly when this coincides with the free-floating, dispersive juvenile stages of their life cycle.

With committed research, the details of large areas of currently unknown marine ecology will become clearer. From such a position it will be possible to conduct activities to the long term sustainable advantage of all, without running the risk of long term damage to crucial parts of the ecosystem. Because of the large area of coastal waters, the still small population and limited development pressures, South Australia is still in the advantageous position of being able to determine the future of its local seas through strategy rather than accident. Hopefully, lessons from exploitation of the land have been well enough learnt.

3.2 MARINE FLORA

Only recently has it been recognised that the plant life of the oceans is responsible for removing a substantial proportion of the ever increasing amounts of carbon dioxide our energy consuming societies release to the atmosphere. Thirty-two percent of carbon dioxide assimilated by plants in 1974 was taken up by marine plants (Whittaker and Likens, 1975). The role of the oceans in this regard is likely to become more important as large expanses of forest are converted to other forms of land use in order to accommodate and provide for increasing human populations. Their carbon dioxide gathering potential is removed and their own stored carbon is released in the process. It is important therefore that the ocean's capacity for this vital function is maintained (Woodwell, 1978) although there are indications that increased CO_2 may stimulate plant photosynthesis, thereby automatically buffering atmospheric levels (Idso, 1985). In addition marine plants provide the basis of the food chain from which we harvest in the region of 80 million tonnes of fish and other organisms from the world's seas each year (Council of Environmental Quality, 1982), accounting for more than fourteen per cent of the world consumption of animal protein (Brown _et al_, 1976).

Marine plants can be divided into three broad categories: the _seagrasses_; the _algae_ or true seaweeds; and the many different groups of photosynthetic plankton or _phytoplankton_. In addition _mangrove_ communities are regarded as being essentially marine. As with many other components of the South Australian fauna and flora, the study of marine plants has not been methodical. Interest and research is currently divided between the Fisheries Department, Engineering and Water Supply Department, Department of Environment and Planning, the South Australian Museum, Universities, industry, and interested amateur groups. Other than the long but fragmented histories of research applied to specific groups (the algae in particular) at the University of Adelaide and the State Museum, research efforts have been initiated only when real or potential problems have become apparent. An attempt will be made to outline the current state of knowledge for each of the marine plant groups mentioned above.

3.2.1 Seagrasses

These are true flowering vascular plants, or angiosperms, which have become secondarily adapted to living in the marine environment. They are widely distributed throughout the temperate and tropical seas of the world. There are twelve recognised genera comprising fifty species, of which five genera and ten species are recorded from South Australian waters (Phillips & McRoy, 1980). They grow in coastal waters with unconsolidated substrates (although _Amphibolis_ spp can also colonise bedrock) between depths of 0.5m and 35m. By contrast certain algae (particularly the red coloured taxa of the Rhodophyta) can grow at depths of up to 70m owing to their possession of specific photosynthetic pigments enabling the use of blue and violet light, which alone is capable of penetratig water beyond a depth of approximately 50m (Jeffrey, 1981; Womersley, 1981). In South Australia there are extensive meadows of seagrass all along the metropolitan coast, Gulf St. Vincent, Spencer Gulf, Backstairs Passage, offshore from Robe on the south east coast, and in bays along the western coast and Eyre Peninsula wherever suitable substrate occurs. Although no definitive figures exist, extrapolation of known areas from the metropolitan coast to other regions where seagrasses are known to grow suggests there may be over 15,000km2 (1,500,000ha) of seagrass beds in South Australian waters (DEP provisional unpublished data) with an average plant cover of 60% (S. Clarke Dept. Fisheries research in progress). They have a recognised and important role in stabilizing shifting sediments and subsequently in encouraging the accumulation of further material. This is by virtue of their extensive sub-surface network of roots and rhizomes acting to bind the sediments together. Furthermore their dense foliage has an ameliorating effect on the scouring action of waves in shallower waters greatly reducing the rate at which sediments are transported both onto the shore and along it. As the energy of the waves is dissipated in the seagrass beds, parts of its sediment load settle out and become trapped in the vegetation adding to the build up of mud and sand banks, eventually causing the shore to migrate seawards, as has happened in the Port Broughton area in Spencer Gulf (Lithominerals, 1973).

The majority of true seaweeds (a few types eg. Caulerpa spp possess rhizomes) depend on the presence of a solid substrate onto which they anchor themselves by means of a structure appropriately named a 'holdfast'. The seagrasses provide a suitable substrate for various forms of smaller algae and invertebrate animals (termed epiphytes), and bacteria (Millis, 1981) which otherwise would be unable to exist on the shifting muds and sands of our coastal waters. The seagrasses are also highly productive, having been compared with the best agricultural crops, producing up to 500 grammes organic matter dryweight/m^2/year in climates comparable to that of South Australia, and up to 8000g in tropical western Florida (Zieman and Wetzel, 1980). This suggests South Australian seagrass production is somewhere in the region of 4,500,000 tonnes dryweight per year. Although living plants are not actually eaten to any great extent, dead plant material and its film of micro-organisms contributes significantly to the diets of detritus feeders (Millis, ibid) and together with the attached flora and fauna forms an important food source for several species of fish which are of economic and recreational value.

These include the King-George Whiting Sillaginodes punctatus, Weedy Whiting Haletta semifasciata, and Garfish Hyporhamphus melanochir which together form up to 60% of the value of the commercial fish catch in the State (Scott et al 1974; I. Kirkegaard, Dept. Fisheries, pers. comm.).

Concern was expressed in the early 1970s (Shepherd, 1970) when it became apparent that the extent of seagrass beds along the metropolitan coast was declining (Figure 1.16). Consequently investigations were undertaken by the E & WS Department between 1972 and 1975 and by the DEP in 1982, in an attempt to quantify the rates of loss and to identify possible causative factors (E & WS 1975, DEP 1982, 1983). Subsequent to the initial findings, the E & WS has undertaken further investigation into the role played by the various factors seen as being possible contributors to the decline revealed by the earlier studies. These findings have been published and are currently awaiting release (E & WS 12/84, 1985).

The major factors seen as likely contributors to seagrass dieback in the metropolitan areas are as follows:

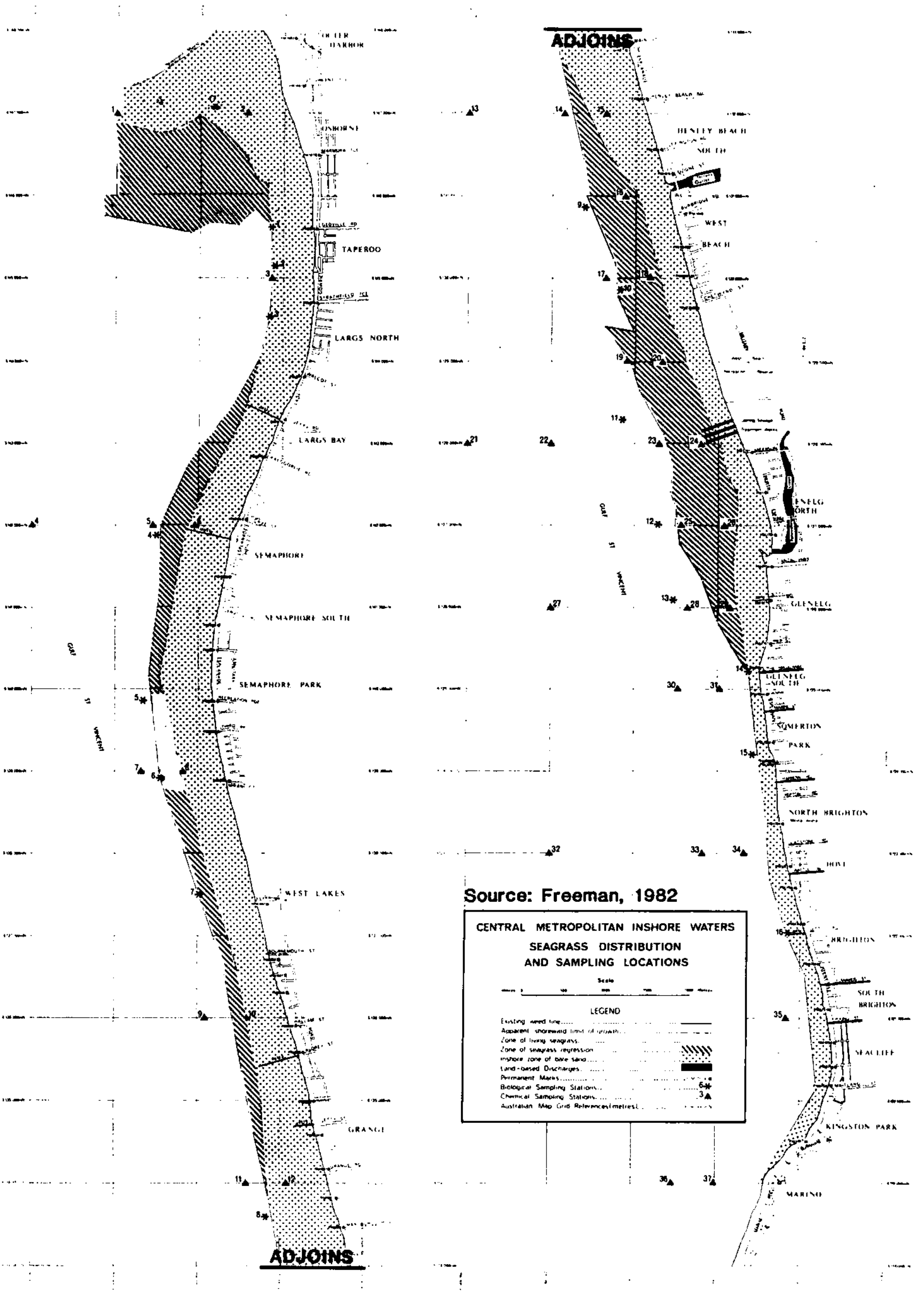
1. The changed sedimentary environments resulting from modifications to the shoreline for urban development and coast protection works, both of which have been intensive and extensive in the years since World War II (Moulds, 1982).

2. The changes in quantity and quality of natural freshwater discharges resulting from changed land use in catchments, and the increased discharge of flood waters from the major rivers running through the metropolitan areas. These have been extensively canalised (courses changed and channels deepened and lined with concrete) as flood mitigation measures.

3. An increase in the number of sewage effluent outflows and stormwater drains bearing urban runoff into coastal waters.

How these phenomena relate to seagrass should become clearer with the publication of the forthcoming E & WS report, but a combination of increased rates of sedimentation smothering the seagrass, a reduction of photosynthetic capacity stemming from increased water turbidity, increased nutrient content of the water resulting in excessive growth of epiphytes

FIGURE 1.16 EXTENT OF SEAGRASS DECLINE OFF ADELAIDE METROPOLITAN COAST



Source: Freeman, 1982

and epizooids on the seagrass leaves, changes in salinity levels (Gessner et al, 1960), and failure of the plants to colonise new areas at the same rate as natural erosion removes mature plants are all possible reasons.

The evidence accumulated to date points to the combined effects of locally enhanced nutrient status, a consequent increase in the growth of epiphytes on the seagrass leaves effectively reducing the seagrass's ability to photosynthesise and respire, resulting in a decreased ability to resist and recover from other forms of environmental stress such as the natural erosion cycle (S. Clarke, Dept. Fisheries, research in progress), and gradual loss from the nearshore areas subject to increased nutrient input.

The fact that local seas contain naturally low concentrations of essential plant nutrients (see 3.1.2 above), yet extensive beds of seagrass raises the possibility of local adaptation to low nutrient concentrations. The nature of tides and currents and the prevailing along shore winds combine to keep nutrient laden effluents in contact with inshore seagrass beds for lengthy periods (DEP, 1984). While the nutrient loadings resulting from sewage treatment works and stormwater outfalls do not approach those known to have resulted in eutrophication in other situations (E & WS, 1975), the threshold for significant effects upon local biota may be lower than that reported elsewhere (V.P. Neverauskus, E & WS, pers. comm.). A further long term study coordinated by the Department of Fisheries began in early 1984.

It is worth noting that seagrass dieback has occurred in other parts of Australia in recent years, particularly in Westernport Bay Victoria, Botany Bay New South Wales, and Moreton Bay Queensland. All these areas are subject to intensive use by man. Whereas dieback in Moreton Bay has been attributed to predominantly natural causes (Kirkman, 1978), a study in Westernport Bay (ACIL, 1984) shows a close correlation between declining area of seagrass, human interference and declining fish catches.

Although the decline of seagrass along the metropolitan coastline is a cause for concern, particularly regarding its potential implications for local fisheries, seagrass beds throughout the rest of the State are not seen as being under any significant threat at the moment (E & WS 12/84, 1985).

3.2.2 Seaweeds

As indicated above, most seaweeds require a solid substrate for their growth; the larger species are therefore confined to South Australia's rocky coasts. The occurrence of seaweeds has been well documented by Womersley (1947, 1950, 1953, 1955, 1956, 1967, 1971, 1981 and 1984) and the ecology of southern Australian forms (particularly their inter-tidal ecology) is well known. According to Womersley (1984) there are 1,126 species known from the Flindersian Province of the Southern Australian Coast. Of these 368 (32%) are endemic, and only 107 (10%) are widespread throughout the temperate oceans of the world. This makes the local marine flora as unique and interesting as that we are familiar with on land. They are generally classified according to prevailing colour (or more precisely the type of photosynthetic pigments they contain), and popular accounts have followed this practice. The recent publication of Part 1 of The Marine Benthic Flora of Southern Australia (Womersley, 1984) dealing with seagrasses and green seaweeds (the Chlorophyta), is a welcome update on two previously existing seaweed handbooks, the Green and Brown Seaweeds (Lucas, 1936), and the Red Seaweeds (Lucas et al, 1947) which are both out of print, and long out of date. Two further volumes covering the brown seaweeds (the Phasophyta), and the red seaweeds (the Rhadophyta) are planned.

However, quantitative aspects of seaweed ecology are not covered by such works, and interested parties will need to consult literature held by the E & WS Department, who have conducted a series of survey and monitoring programmes in coastal areas since the early 1970s including some quantitative data on seaweeds. The programmes have been carried out in the vicinity of effluent discharges at Glenelg, Christies Beach, Port Adelaide, Bolivar, Finger Point (South-East) and in the region of the Port Lincoln sewage outfall. In addition water pollution studies have been conducted in Gulf St. Vincent, around the Port Adelaide sewage treatment works sludge outfall (as opposed to the effluent outfall which carries basically fresh water), and at West Lakes. The relevant E & WS Departmental Reports are listed in Table 1.19.

TABLE 1.19: ENGINEERING AND WATER SUPPLY DEPARTMENT REPORTS CONTAINING REFERENCES TO SOUTH AUSTRALIAN SEAWEEDS, SEAGRASSES AND/OR PHYTOPLANKTON

1. Gulf St. Vincent Water Pollution Studies
   (a) Progress report, 1972, to 1973 (S.A. Lewis, 1973) EWS 3876/70
   (b) 1972 to 1975 (S.A. Lewis, 1975) EWS 75/14
   (c) Phase II. 1976 to 1983 (D.A. Steffensen, 1985) EWS 84/12

2. Port Adelaide Sewage Treatment Works Sludge Outfall - Effects of discharge on the adjacent marine environment
   (a) Phase I. Base-Line Study (D.A. Steffensen, 1981) EWS 81/8
   (b) Progress report (V.P. Neverauskas, 1985) EWS 85/6

3. West Lakes Monitoring
   (a) 1974 - 1978 (R.P. Walters, 1978) EWS 77/38
   (b) 1974 - 1984 (D.A. Steffensen, 1985) in preparation

4. Port Lincoln Wastewater Treatment and Disposal Study, Phase 1 (Caldwell Connell, 1976)

5. Mount Gambier sewage outfall. Physical oceanographic studies, March-April 1974 (Env. Resources Australia, 1974).

Source: E & WS, written communication, 1985.

3.2.3 Phytoplankton

There is little published information dealing specifically with South Australian marine phytoplankton. A recent review of knowledge relating to phytoplankton in the Australasian region (Jeffrey, 1981) had this to say:

> "The phytoplankton flora of the seas surrounding Australia is very poorly known. Studies .... have been spasmodic, opportunistic and with few exceptions, too fragmentary to fulfil modern requirements."

The work of E.J.F. Wood (see bibliography) is most often quoted in relation to Australian phytoplankton, and does refer to South Australian occurrences, although little if any of his work was directed specifically at southern Australian waters. Two studies of direct relevance to this state have been published in the previous decade (Motoda et al, 1978; Thomas, 1978). In a move to redress this lack of knowledge in fundamental marine biology, the Department of Fisheries is initiating a long-term research project aimed at identifying, describing, mapping and quantifying the South Australian planktonic flora and fauna. The commissioning of the marine research vessel Ngerin in June 1985 was a pre-requisite for such a project.

Several of the E & WS reports in Table 1.19 refer to marine phytoplankton in the context of its response to changed water conditions. The sudden influx of nutrients, stormwater (with a consequent lowering of salinity levels), and calm weather conditions have been closely linked with plankton blooms in West Lakes and the Port River (Steffensen, 1984). The interest in these occurrences centres around the known links between such blooms and toxic decay products (Klein, 1972), although no toxic effects have been identified locally. The taxonomy of the organisms in question is becoming more clearly understood as a result of the E & WS monitoring work.

3.2.4 Mangroves

Forests of the mangrove, Avicennia marina var. resinifera occur at a number of sheltered sites on the South Australian coast covering a total area of some 230km^2 (Galloway, 1979). The most significant stands occur near Ceduna on the West Coast, at Franklin Harbour near Cowell, around the heads of both gulfs, at Port Pirie on Spencer Gulf and between Port Adelaide and Point Gawler on Gulf St. Vincent. (see Figure 1.17)

Mangroves are usually found in protected coastal areas with low wave energy and are confined to the inter-tidal zone. The diurnal flushing of the tides supplies many of the nutrients the plants require. These nutrients result from the decay of marine organic matter and from the inflow of land-based discharges. Seaward of the mangroves are mudflats or seagrass beds. Landward there are usually extensive salt marshes or samphire flats (King, 1981).

Mangroves are becoming increasingly recognised as unique and valuable elements of coastal and estuarine ecosystems. They are an extremely productive base for aquatic detvital food chains and a nurturing habitat upon which fisheries depend. Mangrove communities act as a buffer protecting the terrestrial environment from erosion, and function as a sediment filter enhancing offshore water quality. They are of intrinsic scientific value, provide varied wildlife habitats, and are an interesting and scenically attractive landscape element. (NZ Nature Conservation Council, 1984)

Mangrove forests are recognised as one of the most productive ecosystems in the world (Larkum, 1981). Although local studies relating to productivity are still to be initiated, findings from other parts of the world indicate the regular stirring action of the tides to be important in maintaining high levels of nutrients (Mann, 1973 in Larkum, 1981);

extensive networks of roots at and just beneath the sediment surface enable rapid uptake of such nutrients (Saenger, 1979); and high densities of diatoms, filamentous algae, and nitrogen-fixing blue-green algae probably have important roles in trapping the stirred sediment, thereby making it available to the mangrove trees, as well as contributing their own productivity to that of the whole ecosystem (King, 1981; Larkum, 1981; Millis, 1981).

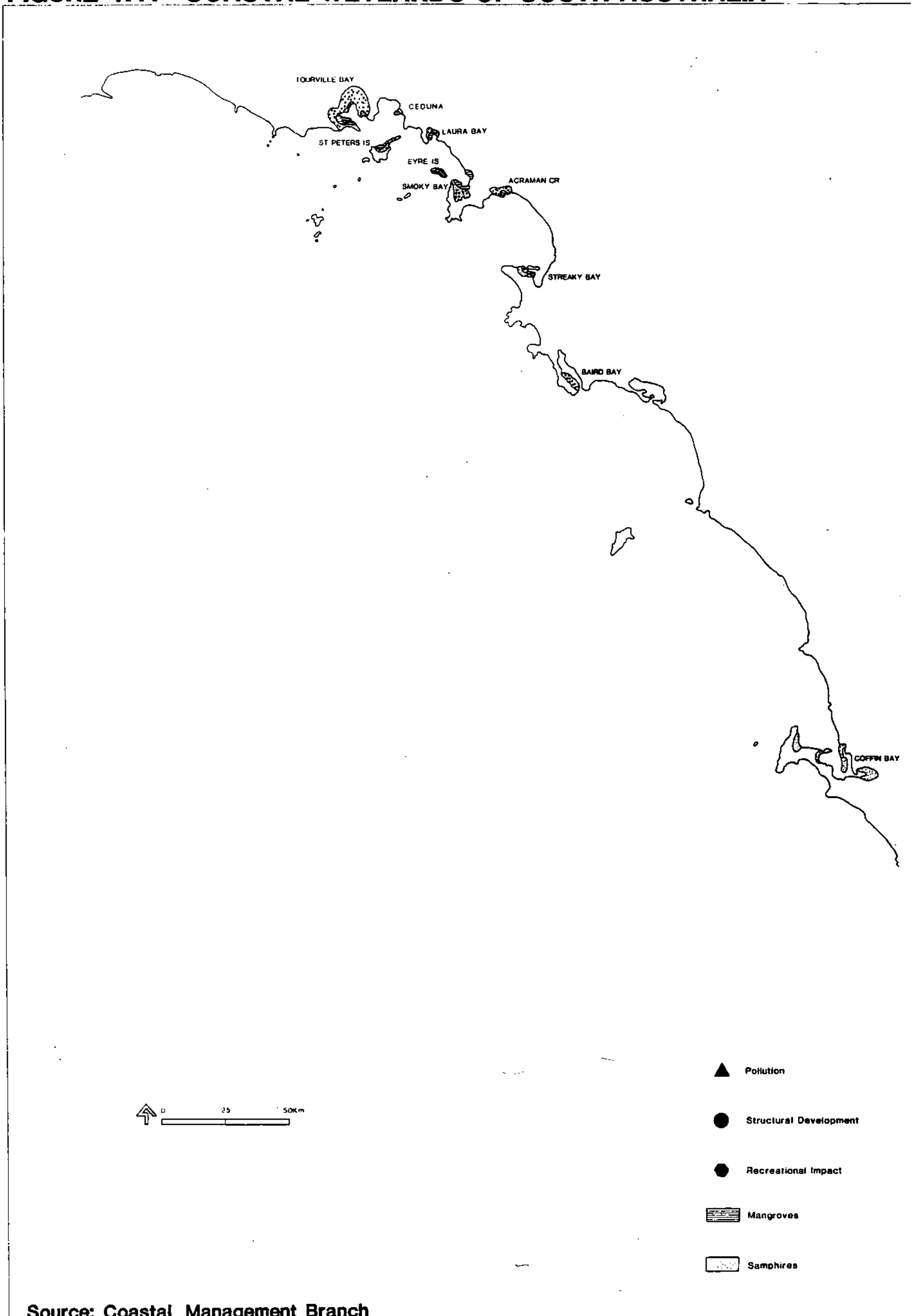
Plants and animals found in a mangrove swamp vary from place to place. Mangrove areas appear to support a wealth of different species, such as samphires, seagrasses, algae, ferns, diatoms, molluscs, annelid worms, arthropods, and many vertebrates, particularly fish and birds (King, 1981).

Many of the fish and crustacea which occur in or near South Australian mangroves are commercially exploited or are popular for recreational fishing. For example, the young Jumping Mullet, *Liza argentea* and Yellow-eyed Mullet *Aldrichetta forsteri* are found near Torrens Island (Butler, 1975). Western King-prawns *Penaeus latisulcatus* are also found in mangrove areas which seem likely to be crucial nursery areas for juvenile populations (SAFIC, 1985).

Studies of estuarine fisheries have shown that upwards of 90% of marine species in the region are predictably found in mangrove estuaries during one or more periods in their life cycles (Snedaker, 1978 cited in NZ NCC, 1984). Of the fish caught commercially, 80% were linked to food chains dependent ultimately on mangroves (Lear & Turner, 1977) although our knowledge of the biology of Australian mangrove ecosystems is not yet sufficiently developed to be able to determine the significance or local applicability of this general observation (Hutchings *et al* 1983; Milward 1982). Mangroves constitute a genetic reservoir of variability both in themselves and through the wide variety of species that derive benefit from them, including ourselves.

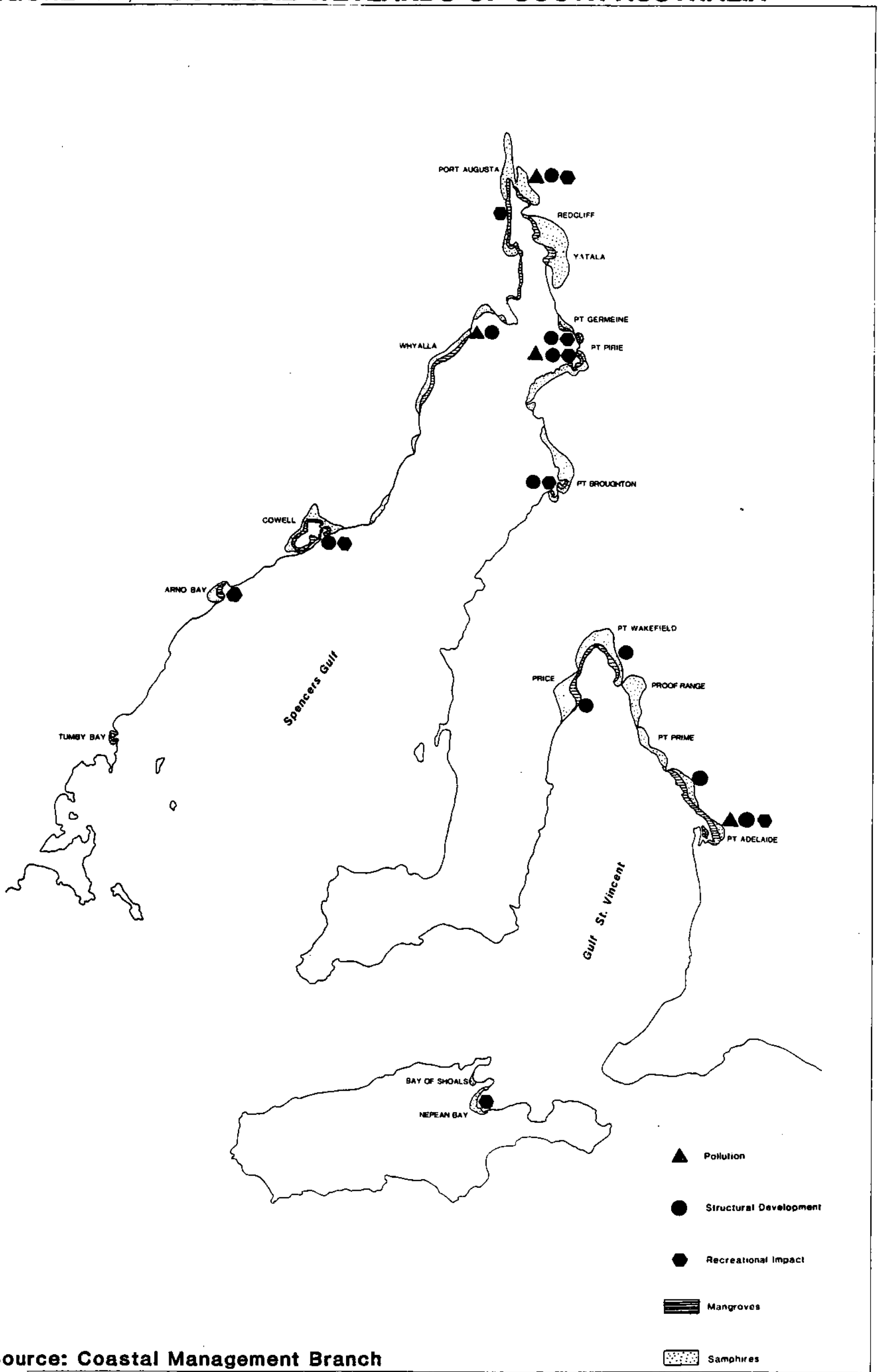
Mangroves are not only biologically significant but also geologically important to the coastal wetland environment. They can play an important role in maintaining the stability of the adjacent coastline, and are known to assist in the process of progradation (the seaward migration of the shore which results from the gradual accumulation of sediments). However, not all mangrove forests are moving seaward. Some are undergoing erosion by wave-action or encroachment by sand dunes. Mangroves are colonising in some areas, dying back in others and have disappeared altogether in some

FIGURE 1.17 COASTAL WETLANDS OF SOUTH AUSTRALIA



Source: Coastal Management Branch

FIGURE 1.17 COASTAL WETLANDS OF SOUTH AUSTRALIA



Source: Coastal Management Branch

places. Any decline in mangrove communities should be investigated to assess likely impact on both the coastal food chain and the geological stability of the adjacent coastline. (Burton, 1984)

Monitoring of mangrove growth is being carried out by DEP in a selected area between St. Kilda and Middle Beach, north of Adelaide. This involves a simple technique of collecting a series of photographs over a number of years from the same location (photopoint monitoring) and using them for visual comparison in order to determine changes in the health and distribution of the mangrove colony. While this method may not be absolutely accurate it has been useful in determining growth rate of trees, and extent of die-back or progradation.

Fisheries Department have a small monitoring project near Cowell where a roadworks project caused severe stress and dieback amongst the local mangroves. Every twelve months, the number of trees are counted to assess whether the mangrove community is recolonising. The trees are also measured to determine growth rates. Some work has also been carried out in conjunction with the Centre for Environmental Studies, University of Adelaide, using simulated oil spills to determine the possible impacts upon intertidal communities, particularly mangroves. (Wardrop, 1983).

It appears that there are no other mangrove monitoring programmes being carried out. However, the removal of mangroves is controlled by regulations under the Fisheries Act, 1982. The Harbors Act, 1936-81, provides legislation to control the development of coastal lands for harbours and the building of marinas, including control of development in mangrove areas.

There are many factors that can affect the well-being of mangroves causing stress which can eventually lead to die-back. They have been summarised as dynamic pollution, physical disturbance, and diseases and pests (Burton, 1984). Dynamic pollution is generally associated with populated areas and regions of industrial activity. It is the result of contamination, mixing or accumulation of any material which results in an anomalous quantity of that material or any compound of it. Forms of physical disturbance include structural development and some recreational activities. The former concerns rapid accretion or erosion of sediments caused by any development which alters the natural movement of sediment, and which would affect the surrounding environment to the detriment of the mangrove community. Recreational activities include bait digging, the use of trail-bikes and four-wheel drive vehicles on beaches and nearby dunes, and bank erosion caused by the wakes of power boats. Figure 1.17 shows areas which are influenced by pollution and physical disturbance. Little is known about the susceptibility of mangroves to attack by disease and pests.

Burton (1984) has identified nine sites in South Australia which are under stress of one form or another and require monitoring to determine any changes that may result in them becoming irreversibly degraded. The location of these and types of disturbance are listed in Table 1.20.

TABLE 1.20: MANGROVE SITES IN SOUTH AUSTRALIA CURRENTLY UNDER STRESS

LOCATION	TYPE OF DISTURBANCE
Arno Bay	Physical disturbance: Recreational activities
Cowell	Physical disturbance: Structural development
Whyalla South	Physical disturbance: Recreational activities
Pt. Augusta	Dynamic Pollution Physical disturbance
Pt. Augusta South	Physical disturbance
Pt. Pirie	Physical disturbance
Pt. Pirie South	Dynamic Pollution Physical disturbance
Pt. Broughton	Physical disturbance Recreational activities
St. Kilda	Physical disturbance

Source: Burton, 1984

3.3 **MARINE FAUNA**

Only within the last fifteen years or so has the ocean's finite capacity for supplying us with an abundant supply of food and raw materials been recognised. The sequential collapse of whaling industries, the anchovy fishery off the coast of Peru (Brown et al, 1976), herring, cod and other white fish fisheries in the North Atlantic (Holt, 1969), and a world-wide decline in amounts of fish caught per amount of effort expended since 1971 (Ehrlich et al, 1977) as a result of overfishing, have all made it clear that although there is a harvestable surplus of animals in the sea, if breeding stocks are exploited too heavily for too long, populations will collapse and the opportunity for sustained harvests will be lost. In South Australia the Southern Bluefin Tuna Thunnus maccoyii fishery did not commence on a commercial scale until the late 1960s, but it has been fished so heavily since then that the population is thought to have declined to only 20% of its original level and is now considered by the CSIRO to be at a critical level (Department of Fisheries, written communication). Clearly we still have some way to go in implementing lessons learned from past mistakes. Similarly the Native Mud Oyster, Ostrea angasi had been exploited to such an extent by the 1930's that its population is unlikely to recover to its former level and can now only support a diving fishery. The latest local example of a declining stock is that of the valuable Western King-prawn Penaeus latisulcatus in the Gulfs and along the West Coast. This fishery only commenced on a commercial basis in 1968. Declining catches had led to large areas being closed to fishing by June 1985, following evidence that reproduction rates had declined to a point where existing catch limits could no longer be maintained (N. Carrick, Fisheries Dept. pers. comm.). Overfishing, local environmental factors adversely affecting the prawns (which are a predominantly tropical genus), and possible adverse effects from additional hot water discharged by the recently expanded Northern Power Station at Port Augusta (it began operating a second boiler in October 1984), have been variously cited as causes. The power station theory could only have credence in the Spencer Gulf fishery where it is located. Overfishing or unidentified locally operating factors must be responsible in Gulf St. Vincent and along the West Coast.

Research on the marine fauna has been largely devoted to species of commercial importance. Even so our knowledge of the biology of most of these is still fairly limited. It follows that we know even less about non-commercial fish species and the many invertebrates found in our waters. Of the latter only a few mollusc species, the Rock Lobster Jasus novaehollandiae, and several species of prawns and crabs have been investigated to any extent.

3.3.1 Vertebrates

Fishes

Fishes are the most abundant vertebrates in the sea. In South Australia, there are more than 370 species known to occur (Scott et al, 1974) although an as yet unknown number are vagrants, sometimes known from only one or two specimens (Glover, S.A. Museum, unpublished); 77 species are utilized commercially and 15-20 of these contribute most of the annual commercial fish catch of 15-20000 tonnes (Department of Fisheries, written communication). Because of our limited knowledge, actual status of the various species is not known. Research by the Department of Fisheries based on tagging of fish to determine their movements, and 'catch and effort' statistics provided by commercial fishermen to detect overall trends in population levels, are beginning to yield results. No species is regarded as endangered as such, though the Bluefin Tuna gives cause for concern as explained above. The Blue Groper Achoerodus gouldii is a large attractive reef fish which has received rather a lot of attention from spearfishermen in the past for this reason. It now receives a degree of protection in South Australia, though apparently can still be caught and used as bait to catch other fish. The Leafy Seadragon Phycodurus eques is a very unusual looking fish resembling the fronds of the seaweeds amongst which it lives. It is now completely protected in South Australia because demand for aquarium specimens threatened the species with extinction. The School Shark Galeorhinus australis has been seriously depleted in recent years as a result of overfishing combined with its own slow growth rate and the late age at which it reaches sexual maturity. The month of November has now been proclaimed a closed season for this species as a conservation measure (Olsen, 1981). The infrequent failure of fresh water to flow through the Murray Mouth during dry years seems to prevent Mulloway Sciaena antarctica from spawning (Hall, 1985). This can mean an absence of adult fish three years later, by which time they would normally have reached maturity and returned to the Murray to breed, and can therefore eliminate a whole season's catch of the fish. Hydrological management of the Lower Murray River system should take this factor into consideration at such times.

Appendix 16 shows the known marine fishes and identifies species which are targets of commercial fishing operations (Department of Fisheries, written communication). Most species are taken at some time by the State's estimated 250-300,000 sports anglers (Department of Recreation and Sport, 1984), approximately 30% of the fresh fish eaten in South Australia comes from this source (P.A. Consultants, 1978). In addition there is an unknown catch of non-commercial species incidental to commercial operations. These are known as 'trash fish'. Crabs and squid are retained but the remainder are thrown overboard. Sharks and other predatory fishes that follow fishing boats suggest that mortality for these species is quite high after they are returned to the sea (R. Lewis, Dept. of Fisheries, pers. comm.). No data on the species composition or numbers of the trash fish catch have been collected.

Mammals

The 31 recorded species of marine mammals (Appendix 12) are largely known from occasional sightings and stranded specimens. However there are insufficient data available to quantify their occurrence in our waters. A report detailing all recorded whale strandings in the State has recently been compiled (Stopp, 1985). The earless seals recorded from South Australia are all primarily Antarctic species. Australia is the northernmost limit of their distribution, hence their status being given as K*, although most are known to have large populations in the major parts of their range (Barnes, 1982).

The larger whales which have been subject to commercial exploitation in the past are now almost entirely protected and are considered endangered or vulnerable on a world-wide basis. A similar status is given here as our waters are not known to hold above average populations for any of these species, although all whales, dolphins and porpoises are afforded legal protection in Australian waters under the Commonwealth Whale Protection Act 1980. Similarly the Antarctic seals are afforded either partial or complete protection (depending on the species) in the major parts of their range under the terms of the Convention for the Conservation of Antarctic Seals to which Australia is a contracting party (Barnes, 1982).

Two species of dolphin are commonly sighted in coastal waters, the Bottlenose Dolphin, *Tursiops truncatus* and the Common Dolphin, *Delphinus delphis*, both of which have a cosmopolitan distribution. Two species of eared seal maintain successful breeding colonies on South Australia's coastline. They are the New Zealand fur-seal, *Arctocephalus forsteri*, and the Australian Sea-lion, *Neophoca cinerea*. The South Australian populations of both these species represent a major proportion of their total world populations.

The illegal shooting of seals and dolphins by fishermen has been a problem in some coastal areas in recent years (CCSA, 1982).

TABLE 1.21 STATUS OF MARINE MAMMALS IN SOUTH AUSTRALIA

	Species Status[1]									
	X	E**	E*	V**	V*	R**	R*	K	C	Total
Species (n)	0	3	0	1	2	0	1	22	2	31
Species (%)	0	9.6	0	3.2	6.5	0	3.2	71.0	6.5	100
		9.6		9.7		3.2				

[1]See appendix 2 for explanation of coding

Birds

Seabirds are obliged to nest and rear their young on land. It is this part of their life cycle which has been most intensively studied. Even so for many seabirds recorded from South Australia, particularly those which are predominantly oceanic, their life histories are not well known owing to a common preference for uninhabited islands as nesting sites. The oceanic component of their lives is understandably less well known. Much information on the seasonal movements of birds, has been gleaned from the ringing of chicks while still at the nest and the subsequent recovery of the rings when the birds are washed up on the shore. Blakers et al (1984) summarises currently available information on distribution of all Australian birds including seabirds in map form. Status categories in Appendix 14 have been derived after lengthy consultation with Julian Reid of the National Parks and Wildlife Service and Shane Parker of the State Museum. Both are ornithologists of recognised National standing.

Two unpublished reports containing mention of local seabird distribution and abundance have come to light during the course of this review. An employee of the E & WS at Bolivar Sewage Treatment Works, located near the coast north of Adelaide, kept a detailed record of birds visiting the compound and its surrounds for sixteen years. The results of these observations are available in summary form from the water quality laboratory at the works (B. Glover, 1982).

The second report is an account of changes to the bird fauna brought about by dredging of the Port Pirie River and Harbour, and the dumping of dredge spoil in Spencer Gulf (Roeters and McKie, 1984). A decline in seabird species diversity was noted during the course of operations, followed by a gradual return to pre-dredging diversity after the work was completed. These observations were the result of a monthly marine monitoring programme carried out by Broken Hill Associated Smelters Pty. Ltd. (operators of a lead and zinc smelter) since 1980.

No doubt there are other unpublished reports and observations which could contribute to an understanding of the State's flora and fauna.

It is interesting to note for example, that there have been no known breeding records for Ospreys Pandion haliaetus or White-breasted Sea Eagles Haliaeetus leucogaster in the upper Spencer Gulf area since 1890 (S. Parker, S.A. Museum pers. comm.). The first lead and zinc smelter on the Gulf began operations at Port Pirie in 1889. That many heavy metals have adverse biological consequence for organisms when present in elevated concentrations is well documented, hence the move toward unleaded petrol for example. It is also well known that animals high up the food chain, such as predatory birds including ospreys and eagles, are the first to show symptoms resulting from environmental contamination (Cooke, 1973). Perhaps there are other undocumented factors such as physical disturbance levels and previous resting locations, relating to these coincidental observations?

Reptiles

Three species of marine turtles are recorded from South Australian waters, the Loggerhead Caretta caretta, the Green Turtle Chelonia miydas, and the Leathery Turtle Dermochelys coriacea. All three species have the major parts of their ranges in tropical and sub-tropical waters, and specimens encountered here are likely to be vagrant individuals. Their status here is not known, although all are considered under threat on a world-wide basis owing to human predation of adults and eggs and disturbance of their breeding beaches.

3.3.2 Invertebrates

It was not until 1982 that a popular and widely available account of a representative portion of southern Australia's marine invertebrate fauna became available (Shepherd et al, 1982). Until then only the crustaceans (crabs, crayfishes, prawns, water lice) and three groups of the mollusc phylum (the pelecypods or bivalves, chitons, and a single order of gastropods) had been documented in the Flora and Fauna Handbook series (Cotton, 1959, 1961, 1964, and Hale 1927, 1929). It is now possible for the interested individual to identify a large proportion of the organisms encountered to at least order level - the equivalent of being able to tell the difference between a bug and a beetle. Whilst being a far cry from the ideal situation of a comprehensive series of identification keys, it is sufficient to stimulate interest in this fascinating and increasingly accessible component of the South Australian fauna.

Several invertebrates are of some economic importance and support both commercial and amateur fisheries. A list of such species is given in Table 1.22. Commercial catch and effort statistics for Rock Lobster, Western King-prawn, Greenlip and Blacklip Abalones, and Goolwa Cockle are published in the Fisheries Department magazine SAFIC. The figures reflect harvestable surpluses (kg) pre-determined by the Department. Catch per unit of effort (variously measured) gives an indication of whether the species is being harvested at an appropriate level, and it is these figures which provide the basis upon which decisions are made to change or maintain catch allocations in following seasons. From this data it is theoretically possible to determine approximate population levels for each species.

The remainder of the invertebrate fauna is known to a varying degree, with the more conspicuous and easily defined groups such as the jellyfish and echinoderms being better documented than those with variable growth forms, small size, or requiring specialist techniques for their identification including the sponges, acoelomate worms, and the various predominantly planktonic groups.

Table 1.23 indicates the variety of invertebrate life in our waters and the estimated extent of taxonomic knowledge on the various groups.

Estimates have been obtained for likely eventual species diversity for the five following phyla; Porifera, c.1000 spp; Bryozoa, c.500 spp; Annelida, c.500 spp; Urochordata, c.200 spp; and Echinodermata, c.100 spp (see Table 1.23). This represents a reasonable range of diversity between the five phyla of 100–1000 species, summing to 2300 species with a mean value of 460 per phylum. there are at least 14 known phyla represented in South Australia. If we assume the diversity of the remainder is likely to fall within the above range (which seems a reasonable premise), we can extrapolate for the total likely South Australian marine invertebrate species diversity as follows;

- 460 x 14 = c.6440 species estimated.

Only a third (35% with a standard deviation of 27) are estimated to have been collected and describd to date; the remainder are entirely unknown (figure 1.24c).

TABLE 1.22: COMMERCIALLY EXPLOITED MARINE INVERTEBRATES IN SOUTH AUSTRALIA

Phylum, Class	Species	Common Name	Comments
ANNELIDA			
Polychaeta (Bristleworms)	Diapatra dentata	Tubeworm	Bait digging hast unkown impact on intertidal worm population
	Glycera americana	Bloodworm	
	Unspecified	Beachworm	
MOLLUSCA			
Pelecypoda (Bivalves)	Ostrea angasi	Native Oyster	Much reduced population owing to over-exploitation in first 30 years of this century.
	Crassostrea gigas	Pacific Oyster	
	Pecten meridionalis	King Scallop	
	Equichlamays bifrons	Queen Scallop	
	Katylesia spp.	Mud Cockle	
	Donax deltoides	Goolwa Cockle	
	Mytilus planulatus	Mussel	
	Pinna bicolor	Razor Shell	
Gastropoda	Haliotis ruber	Blacklip Abalone	Commercial Fishery regulated by licence. Amateur catch controlled by size and bag limits.
	Haliotis laevigata	Greenlip Abalone	
	Haliotis roei	Roe's Abalone	
	Haliotis conicopora	Brownlip Abalone	
Cephalopoda (squid, octopus etc)	Nototodarus guoldi	Goulds Squid	
	Sepioteuthis australis	Southern Calamary	
	Octopus spp.	Octopus	
	Sepia spp.	Cuttlefish	
ECHINODERMATA **Echinoidea** (sea-urchins)	Heliocidiris erythrogramma	Sea Urchin	
ARTHROPODA			
Crustacea	Jasus novaehollandiae	Southern Rock Lobster	Fishery regulated by licences, size limits and closed seasons
	Ibacus incisus	Bug	
	Portunus pelagicus	Blue Swimming Crab	Taking of egg carrying females prohibited.
	Ovalipes australiensis	Sand Crab	
	Psudocarcinus gigas	King Crab	
	Nectocarcinus tuberculosus	Crown Crab	
	Peneaus latisulcatus	Western King Prawn	Prawn fishery regulated by licence. commercial prawn culture enterprises situated at Port Brouhgton, Spencer Gulf.
	Various spp.	Other Prawns	

Source: S.A. Department of Fisheries, unpublished.

TABLE 1.23: EXTENT OF KNOWLEDGE OF MARINE INVERTEBRATES

MAJOR GROUPS OF MARINE INVERTEBRATES	ESTIMATED PERCENTAGE OF GROUP DESCRIBED IN SOUTH AUSTRALIA	COMMENTS
Protozoa (single-celled organisms of many different phyla)	?	South Australia forms largely unresearched.
Porifera (sponges)	10%	100 of an estimated 1000 species described, remain largely unresearched
Ctenophora (Comb-jellies, Sea-goosberries)	?	Poorly known in Southern Australia mainly planktonic.
Cnidaria (Jellyfishes, sea -anemones, corals, hydroids)	50%	Sea-anemones and hydroids are poorly known.
Aschelminthes (including the phyla, Gastrotricha, Rotifera Kinorhyncha, Nematoda Nematomorpha and Gnathostomulida)	20%	Many are planktonic or live in the pore spaces between grains of substrate; they are not well known.
Platyhelminthes (Turbellarians-flatworms, Trematoda-Flukes, Cestoda-tapeworms, Mesozoa - internal parsites of cephalopod molluscs).	20%	Turbellarians live on or in the substrate, the remainder are parasitic. South Australian forms are not well documented.
Mollusca (bivalves, snails, chitons, squid and octopus etc)	60%	Well known except for the opisthobranch gastropods (sea hares, sea butterflies, and sea slugs).
Bryozoa (moss-animals)	50%	c500 species known. No serious research in S.A. Zinc pollution in upper Spencer Gulf appears to reduce numbers and species diversity (E&WS, pers. comm.).

MAJOR GROUPS OF MARINE INVERTEBRATES	ESTIMATED PERCENTAGE OF GROUP DESCRIBED IN SOUTH AUSTRALIA	COMMENTS
Urochordata or 'tunicates' (Ascidians or sea squirts, and Larvacea)	60%	200 sea squirt species estimated, c150 described. No information on the planktonic larvacea.
Other Deuterostomes (acorn worms, cephalochordates, pterobranchea)	?	No information available
Brachiopoda (lamp shells)	70%	
Annelida (Polychaeta - true marine worms)	30%	Separated into free -swimming or 'errant' polychaetes, and burrowing or 'sedentary' polychaetes. An estimated 500 species.
Echinodermata (starfish, brittle-stars sea urchins, crinoids, sea-cucumbers)	70%	100 species estimated. Brittle-stars and sea-cucumbers poorly known.
Crustacea (crabs, prawns, lobster, barnacles, ostracods, cladocerans, copepods, water lice)	50%	New families still being discovered, planktonic crustaceans poorly known

References: Barnes, 1980;
S.A. Shepherd, Department of Fisheries, pers. comm.
W. Zeidler, S.A. Museum, written communications.

Aspects requiring further research suggested by these findings are the collection of and taxonomic work on the major planktonic groups, and for further ecological study of the interactions between marine organisms in general, and particularly the roles and requirements of those species harvested for our own use.

Analysis of Findings and Recommendations

4 ANALYSIS OF FINDINGS AND RECOMMENDATIONS

It would now serve a useful purpose to draw together the findings which have emerged during the compilation of this report. There is an array of information presented, covering a great many subjects which generally tend to be compartmentalised under the wings of separate disciplines. It is perhaps difficult to see the wood for the trees!

As it is often easier to focus upon component parts of the environment, this section examines flora and fauna separately, thus departing from the ecosystem approach used in the body of the report. This will make it more practical to identify those aspects of the South Australian biota which have been least studied to date. One of the main aims of the exercise has been to provide a basis for planning future environmental management programmes and policies, and to help assess future research priorities.

An additional aim was to ascertain trends for any aspect of the biota where this was possible, in order to detect changing status over a period of time, and thus identify where resources might be urgently needed to prevent the disappearance of a habitat type or the extinction of a species of plant or animal. Other than in a few cases of a general nature, notably the trends in vegetation clearance in the agricultural region, this goal cannot be achieved owing to the absence of historical data. A future review may be able to use the information presented here to make comparisons of that nature.

4.1 FLORA

Although vegetation is still being cleared in the agricultural regions of South Australia (Figure 1.18) the Native Vegetation Management Act 1985 will further control the occurrence and extent of land clearing practices. As clearance applications are processed, it is expected that many of the areas where the application has been refused will be placed under Heritage Agreements. As this occurs much of the remaining vegetation in the southern regions of the State may be afforded legal protection. With provisions for its effective management in position, the remaining area of vegetated habitat should stabilise at between 15% and 20% of its original extent. As momentum for revegetation practices and for the regeneration of isolated and stressed trees develops, the trend toward denudation of the landscape may well be halted and possibly even reversed. If this were to happen,

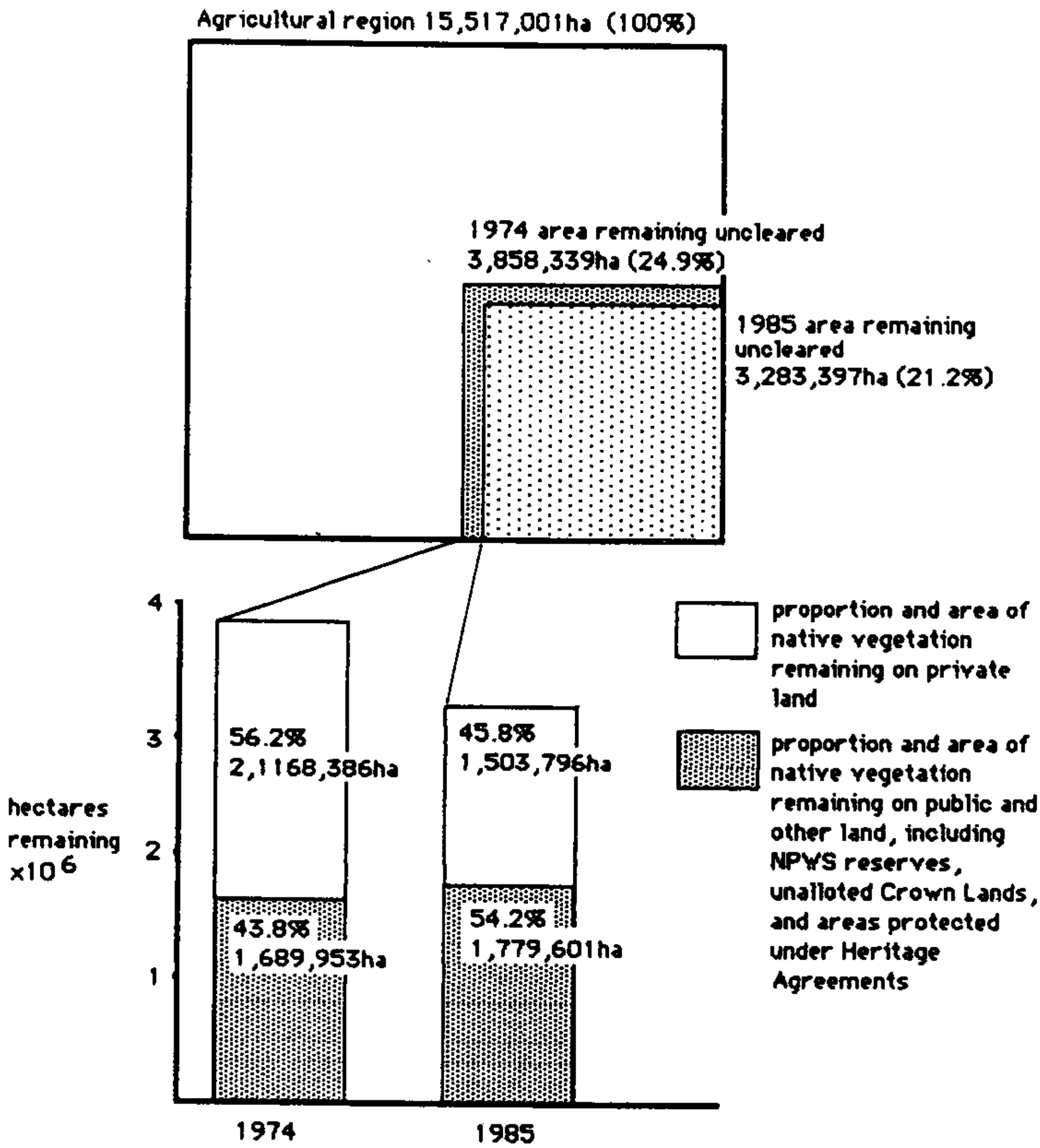


Figure 1.18 Trends in the clearance of native vegetation in the agricultural regions of South Australia.
See Figure 1.4 and Table 1.2. Additional information from S.A. NPWS (1984), and information held by the Department of Environment and Planning.

there would follow significant benefits in reducing the extent and rate of land degradation and in protecting the quality and quantity of water resources, as well as ecological and landscape benefits.

In 1982, the latest date for which figures are available, an average of 47% of the plant associations found in each of the State's eight environmental provinces (Table 1.7, Figure 1.19) were represented in NPWS parks or reserves. The vegetation in two regions is statistically better represented in reserves than the average; these are the South East, and Eyre and Yorke Peninsulas. Only in the Western Pastoral region is representation statistically poorer than average. However as much of this area is still unallotted crown land and not currently used in any exploitative way, the actual conservation status there is likely to be considerably better than indicated. The available information suggests that future land acquisition for the NPWS reserve system should give priority to those areas in which plant diversity and therefore habitat value are under-represented. The Mount Lofty Ranges and Kangaroo Island and the Northern Arid region appear to be the most significantly under-represented. This might seem surprising considering that some of the State's largest reserves occur in these regions. However, this simply reflects the fact that the larger parks contain extensive tracts of similar habitat.

Figure 1.20 summarises the conservation status of the State's 165 distinct vegetation associations. Slightly over half are adequately represented in the reserve system. In selecting areas for additional parks or upon deciding whether to approve or refuse an application for clearance, conservation priority should be afforded to areas containing viable examples of vegetation not already conserved. The plant associations falling into this category are described in Appendix 10.

The status of plant species is depicted in Figure 1.21. Just under 6% of the State's naturally occurring plants are under threat. The degree of threat for these 190 species is also shown. Once again priority should be given to protecting the habitat of the most threatened species where it is practical. However, care should be exercised in allocating resources in order that currently common species not yet represented in protected areas do not decline to a point where they too become threatened. Contrary to popular belief, conservation is not concerned exclusively with the saving of endangered species, although there is an element of truth in this. Its principal aim is to maintain viable self-perpetuating life support systems

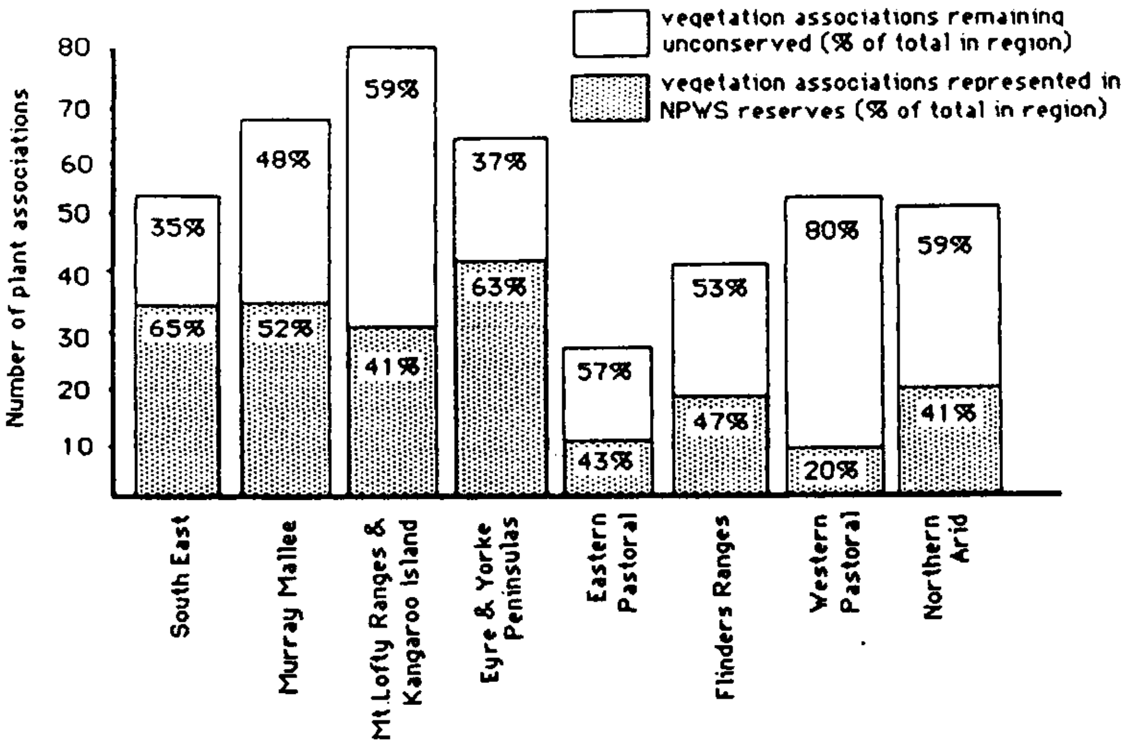


Figure 1.19 Relative abundance of plant associations by region, and their representation in National Parks and Wildlife Service reserves
Source: Davis 1982. See Table 1.7

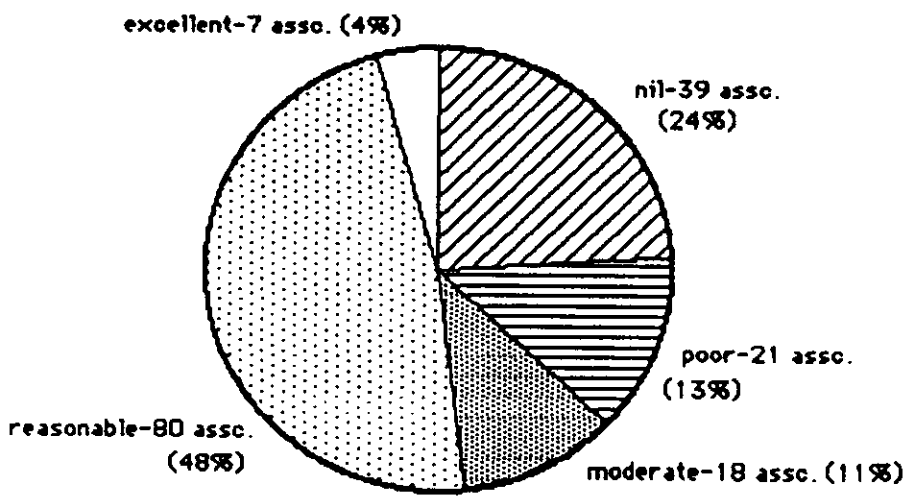


Figure 1.20 Conservation status of South Australia's 165 plant associations. See Table 1.6

(such as the cleansing of air and water, and the re-cycling of nutrients between plants and soil) and productive communities of organisms including our own species, throughout the biosphere. The reservation of areas of land for conservation purposes is one of many ways of fulfilling the requirements of this broad objective.

Once the objective of protecting plants or animals known to be under threat has been identified, it is a matter of waiting until resources became available so that approppriate action can be implemented. However for substantial groups of organisms we do not know enough about them to be able to determine whether they are threatened or not. The non-vascular plants fall into this category (Figure 1.22). It is generally true of the modern scientific approach that knowledge of a species' ecology and conservation requirements will not be significantly understood before its relationship to similar kinds of organisms have been established, its distinguishing characteristics described, and a unique scientific name ascribed to it. This initial procedure is called taxonomy. From Figure 1.22 it is clear that the taxonomy of the lower plants is only partly understood. It follows that the ecology and status of many of these is even less well known at present. To date these species have not been considered during surveys of botanical conservation significance. It is not possible to say to what extent they might be represented along with the higher plants whose status we are more familiar with, because our knowledge of their distribution and specific habitat requirements remains largely unknown. More research on the taxonomy and ecology of most of the non-vascular plants is necessary. Even where these are well understood, as for the marine algae, their conservation status remains largely unknown.

4.2 FAUNA

All things considered the vertebrate fauna is probably the best understood element of the South Australian biota. There are only 1208 species recorded to date including 58 birds which only visit the State occasionally (Figure 1.23). Many species amongst the mammals and birds have been extensively studied to the point where their distribution, seasonal movements, breeding and feeding habits, and conservation status are known, if to varying degrees. The fishes of inland waters and those marine species of commercial importance are also coming under more intense scrutiny. However, unless a co-ordinated and systematic marine ecology programme is established, the status and ecology of non-commercial marine fishes is not likely to improve greatly. The great depths at which many are found, or the open ocean habitat of others makes observation and study at

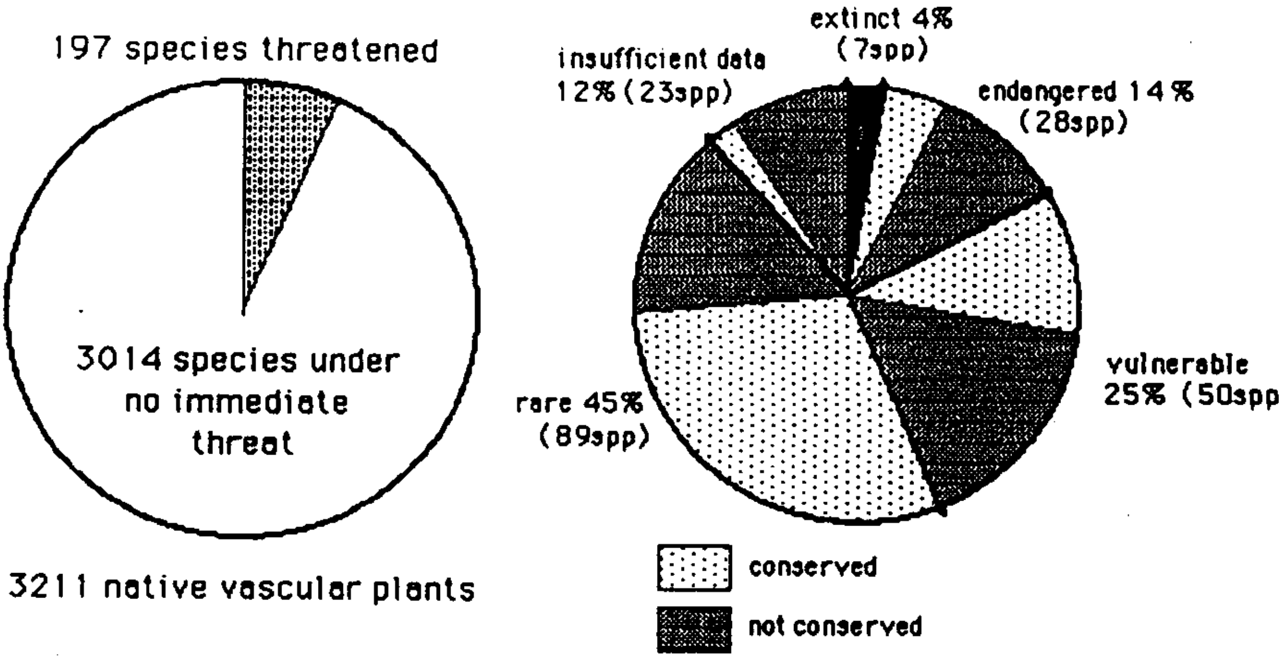


Figure 1.21 Conservation status of South Australian vascular plant species (See Tables 1.4 & 1.5)

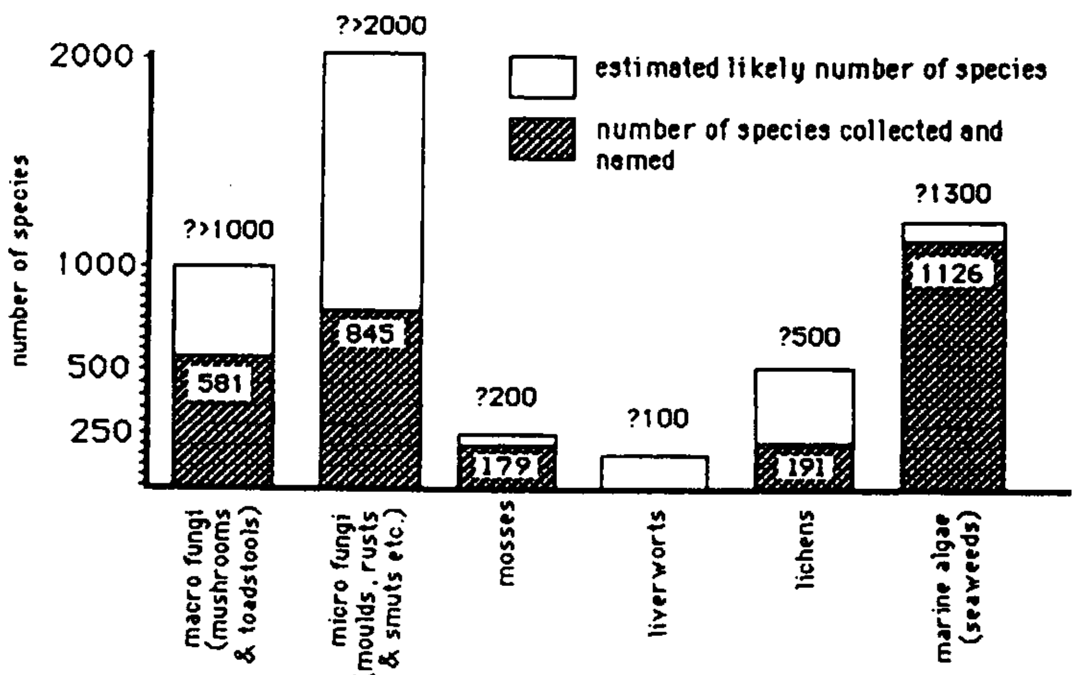


Figure 1.22 Taxonomic status of non-vascular plants in South Australia (See chapter 1.2.2)

first hand largely impractical. The expense of tagging experiments prohibits their use on non-commercial species. More may be discovered as commercial enterprise exploits the largely ignored species inhabiting the deeper waters of the continental slope and beyond.

A further source of readily available information not generally tapped is the fish caught but not valued by commercial trawlers. These trash fish are dumped overboard. It seems likely that mortality is high so there would be little objection to recovering sample trash catches for study.

Contrary to the picture presented by the figures on our state of knowledge concerning the reptile fauna (Figure 1.23), distributions and some ecological information is known for many. The State's reptile authority at the Museum is of the opinion that conservation status is only valid when based upon irrefutable evidence, but because knowledge on most of our reptiles is not complete, status estimates have not been provided. However, most South Australians will be familiar with the Blue-tongue and Sleepy lizards which frequent urban gardens. These would have to be considered at least locally common. A best available estimate of status would at least shed light on some of the more well known species. It is hoped such information will be available if the Museum/Department of Environment and Planning 'List of the Vertebrates of South Australia' (Aslin, 1985) is revised at a future date.

Australia's most active amphibian research team headed by Mike Tyler is based at the Zoology Department at the University of Adelaide. The State's limited amphibian fauna is comparatively well known although there could be additional species living in the arid zone which have not yet come to light owing to the vastness of the area. The Adelaide team have a prominent display of arid zone frogs and toads located at the Moomba oil and gas fields recreation centre. They ask for any unusual creatures to be brought to their attention thus potentially enlisting the aid of thousands of field observers as a means of overcoming the problems of isolation and remoteness. This method has obvious potential for other research groups, especially if promoted by a visit and an interesting audio-visual presentation. The companies involved in development of the arid zone resources could be approached to provide logistic support for concerted field expeditions in the region. It would be excellent publicity for them at little cost or inconvenience.

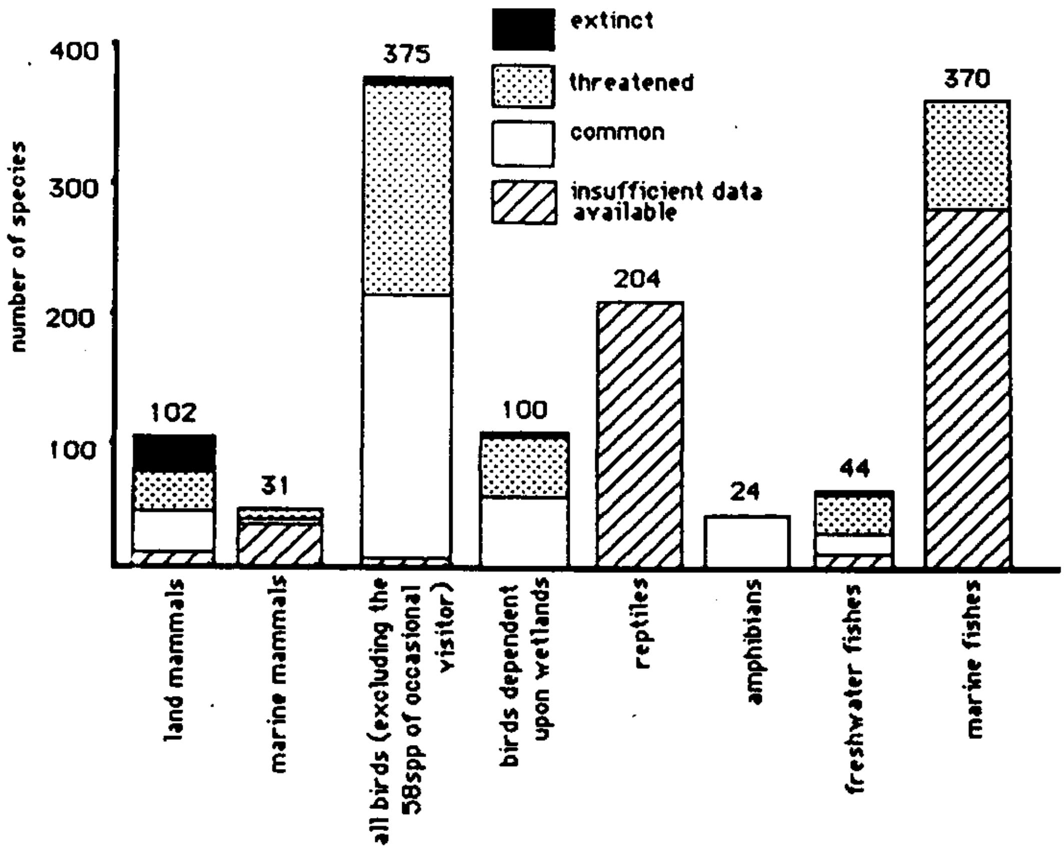


Figure 1.23 Status and diversity of the native South Australian vertebrate fauna.
See Tables 1.8, 1.9, 1.10, 1.14, 1.15, and 1.21 for data.

The **bird fauna** is probably the best known of all, owing to the efforts of many amateur ornithologists over the years. Information from this source is collated by the Royal Australian Ornithologists Union at a national level, and by the State Museum and the South Australian Ornithological Association in South Australia. Comprehensive guides to Australian bird distribution and ecology are regularly produced in popular book form incorporating the latest information. The oceanic sea birds are the least well understood. There is possibly more scope for bird banding of these species by National Parks and Wildlife Service personnel, especially on their infrequent visits to offshore island conservation parks. Otherwise there would appear to be little need for additional research effort. Most of the information necessary for planning bird conservation efforts is available, and requires only co-ordinated action. Current initiatives at increasing the representation of wetland areas in the reserve system and improving their management elsewhere are likely to be of substantial benefit to birdlife in South Australia.

Marine mammals are poorly known, but this is true throughout the world. As many species are cosmopolitan in distribution, our own knowledge is likely to proceed at a similar pace to that at the international level. The Museum and the National Parks and Wildlife Service are closely involved in recording sightings of the larger whales in an effort to build up a picture of their seasonal movements and local habitat requirements. The endangered southern right whale is increasing in numbers, and visits coastal waters each year. In the United States similar behaviour by grey whales has become a major drawcard and generates millions of dollars in tourist revenue each year. Should the local whales become popular as a tourist attraction, more research into their ecology would be necessary so that appropriate measures could be taken to protect both tourists and whales at times and in areas where crucial stages of the whales life cycles occur (such as giving birth and nursing the young). Measures to protect the colony of Australian Sea Lions at Seal Bay on Kangaroo Island have become necessary because of their popularity with tourists and the consequent risks posed by the aggressive bulls during the mating season.

Land mammals are known to a varying degree. There is little to be done about the large number of extinct species on the mainland. NPWS efforts to reintroduce some species to offshore islands free from introduced predators have been generally successful and should be continued as the opportunity presents itself. Those species still classified as common are likely to remain so under any foreseeable changes which are likely to occur, having proved to be highly adaptable and resilient. Of the 36 threatened mammals, only nine appear to be under threat as a result of adverse human influences. Of these, only the Swamp Antechinus and Southern Brown Bandicoot are under threat owing to direct destruction of habitat or predation in the agricultural zone. Moves are underway to protect the Swamp Antechinus' remaining south-east wetland habitat inside an extension of Canunda National Park. The bandicoot is largely confined to dense vegetation already under some degree of protection. Feral cats, foxes and goats pose the largest threat to the continued survival of this and other less threatened small native mammals. Efforts to control or preferably eradicate these pests is a desirable management objective.

The other seven species are confined to the arid zone and have suffered as a result of habitat changes. Owing to the continuing pressures and lengthy periods required for vegetation recovery, and possibly the removal of traditional Aboriginal land management practices to which the animals may have been better adapted, it seems unlikely that management efforts would meet with significant success. Efforts could be made to reserve areas where populations of threatened species are discovered and appear to be stable and healthy. Such areas are likely to be identified during the course of the continuing ecological surveys of the Museum and the DEP.

The **invertebrate fauna** is poorly known. Invertebrates are a vital component in the functioning of virtually all ecosystems. An increased knowledge of the South Australian invertebrate fauna would be a major step forward for its environmental data base. It is calculated that over half of the 27000 different species of land, inland water, and marine invertebrates estimated to occur in South Australia are as yet unknown to science. Of those which are known, approximately half still await cataloguing, description, and a name, most of which are terrestrial insects. A concerted effort to close the enormous gap in knowledge (Figure 1.24) should be a high priority. The Museum's upgraded facilities are ideally suited to accommodate the staff necessary for the task. The Department of Fisheries and the Engineering and Water Supply Department have staff with expertise who could make significant contributions in the marine and inland water fields respectively. An objective to aim for might be the production of illustrated field guides to the more common species in each major group, aimed for use by the informed layperson, by 1995. This would allow time for the collection of field data where it is currently missing. The Museum's Special Education Bulletin series would be an ideal format on which to base such a project. It would likely involve employing taxonomists from other parts of the country or from overseas to compile the necessary information in addition to the expertise available locally. These would need to be

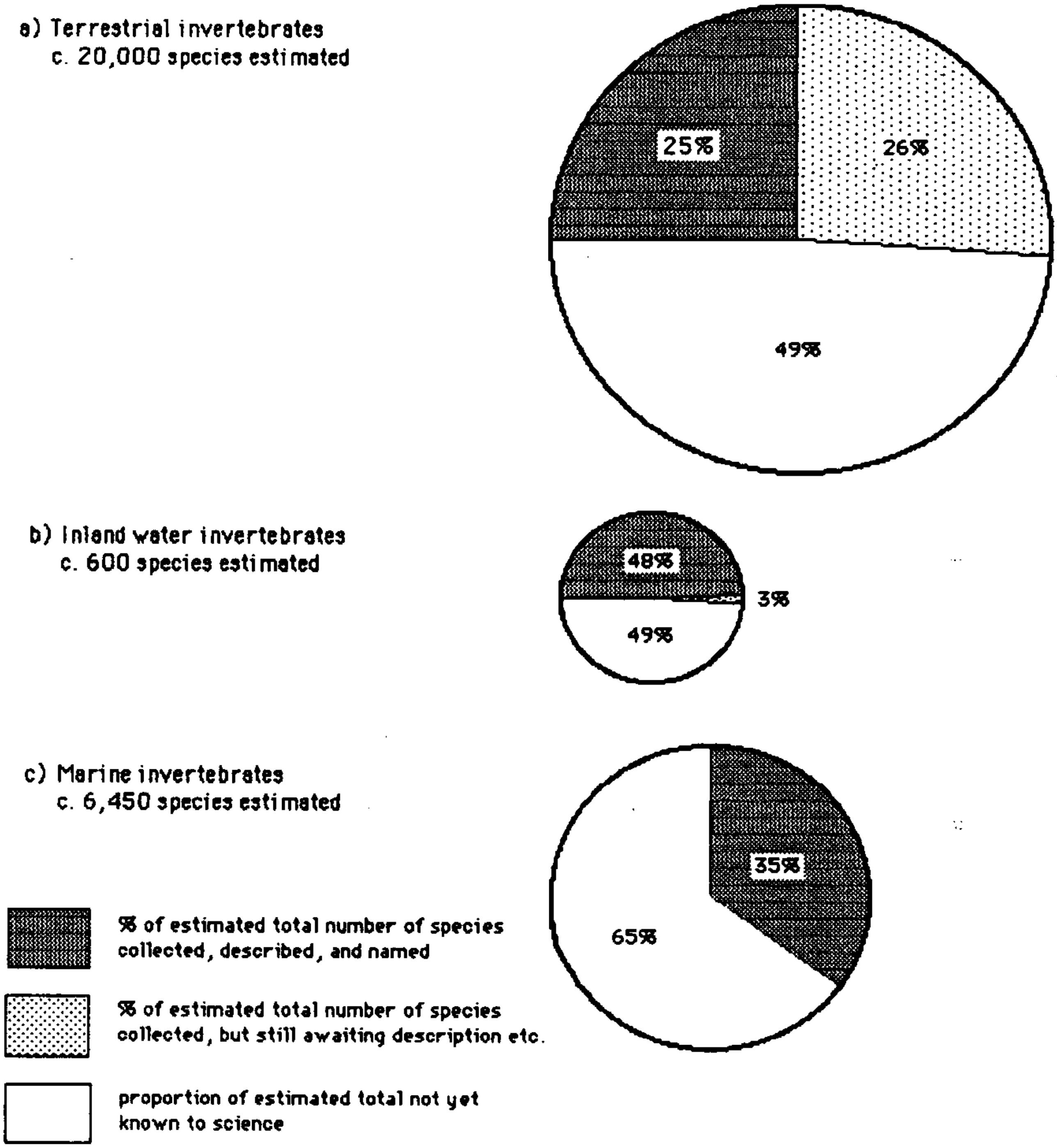
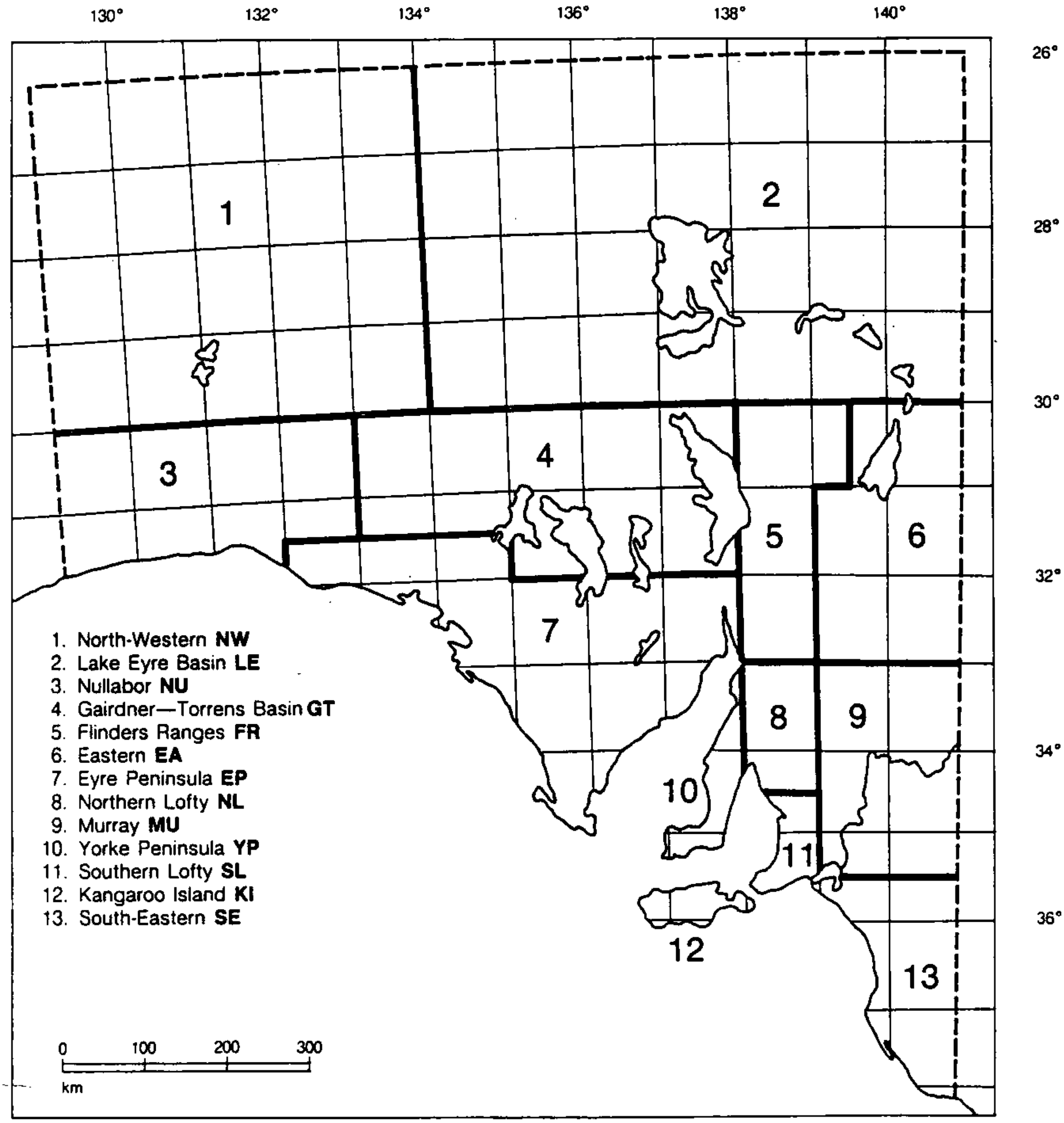


Figure 1.24 Taxonomic status of invertebrate animals in South Australia (See Tables 1.11, 1.17, and 1.23).

in addition to existing staff, possibly on terminating three year contracts. Without such a commitment, we are likely to remain largely in the dark about the most varied and numerous major group of our biological resources for some time to come.

Appendices

APPENDIX I STATE HERBARIUM REGIONS OF SOUTH AUSTRALIA



APPENDIX 2: CODING SYSTEM FOR NATIVE FLORA AND FAUNA

The allocation of conservation status in these appendices is based on the following categories, modified slightly from Leigh, Boden, and Briggs (1984).

Distribution Category (numeric code)- Flora only

1. Species known only from the type collection. Further study may sometimes be desirable to confirm the taxonomic status of the species and field surveys are often needed to ascertain present distribution.

2. Species with a very restricted distribution in Australia and with a maximum geographic range of less than 100 kilometres. This category may also include a few species which also occur outside Australia. The 100 kilometre distribution limit is arbitrary. Species listed in this category are not necessarily rarer than those listed in category 3, but in general are probably at greater risk from more localized threats such as fire, industrial and residential development, mining and hydro-electricity projects than are species spread over a wider range. Often these factors may produce major environmental changes within a short space of time, rapidly threatening a localized species.

3. Species with a range over 100 kilometres in Australia but occurring only in small populations which are mainly restricted to highly specific habitats. This category also includes a few species which occur outside Australia. Species in this category are often subject to localized threats such as prolonged drought, grazing by introduced animals, damage by pests or diseases, or extensive land clearing in favourable agricultural areas.

'X' Species presumed extinct. These have either not been found in recent years despite thorough searching, or have not been collected for at least 50 years and were known only from areas which are now well settled.

This category covers two different concepts. The corresponding IUCN category (Ex) is restricted to 'species which are no longer known to exist in the wild after repeated searches of the type localities and other known or likely places'. It would be difficult, and probably meaningless, to restrict the category to this concept in Australia. In the first place, few of the Australian species believed to be extinct have been subject to such rigorous repeated searches. Secondly, some species have vanished for long periods due to prolonged droughts and other causes, only to reappear when conditions became more favourable. It has therefore been thought desirable to include as 'presumed extinct' species which have not been collected for at least 50 years, provided they were originally recorded in localities which are now well settled, and where there is an a priori expectation that they would have been found had they still existed. This would not include species from remote regions such as many parts of northern and central Australia, where the environment has not greatly changed since the arrival of Europeans and there is no obvious cause for the apparent disappearance of the species. Such species, although not collected for 50 years, would be coded 'K'. Although this procedure will doubtless lead to the inclusion as 'presumed extinct' of a few species which will subsequently be re-discovered, it has the advantage of stimulating interest in the search for such species.

'E' Endangered species in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate. This includes species with populations possibly too small to ensure survival even if present in proclaimed reserves.

This definition is in general accordance with that of IUCN with the addition of an approximate time scale for potential extinction to meet the criticism that the IUCN definition lacks precision in this respect. It is recognized that the time scale used may not necessarily be applicable elsewhere, but it has helped to ensure uniformity in the treatment of Australian data. The definition indicates that the presence of a species in a national park or reserve need not necessarily preclude its listing as 'endangered' if the population is very small (about 50 plants or less, for animals the critical population level for most species is unknown and is likely to vary considerably), or it is otherwise at serious risk.

'V' Vulnerable species not presently endangered but at risk over a longer period through continued depletion, or species which largely occur on sites likely to experience changes in land use which would threaten the survival of the species in the wild.

'R' Species which are rare in Australia but which are not currently considered endangered or vulnerable. Such species may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wider range or some intermediate combination of distribution pattern.

'K' Poorly known species that are suspected, but not definitely known, to belong to any of the categories. This category and its definition are as used by IUCN. The key word in the definition is 'suspected' which recognizes that information is often inadequate to enable a species to be placed in one of the other conservation categories with certainty. A species designated 'K' can always be transferred to another category when further information becomes available.

'U' Species generally with a wide range which are not recorded regularly throughout, but which are not considered to be rare.

'C' Common, recorded regularly throughout its known range.

'/loc' Refers to a species whose status is significantly different from its statewide classification on a regional basis, usually because of locally operating factors.

'O' Occasional visitor to South Australian territory, not forming an essential part of the species range (birds only).

'Br' Species using South Australia as part of its breeding range (birds only).

'(S)'Seasonal visitors in Australian summer species commonly breed here, (birds only).

'(W)'Seasonal visitors in Australian winter, South Australia forms an important part of the species non-breeding range (birds only).

'∼' Identifies bird species closely associated with wetland habitats.

Because this study is confined within the political boundary of South Australia, the natural distribution of many animal and plant species is concealed. In an attempt to overcome some of the consequent problems of interpretation, two qualifying symbols are appended to the conservation status categories where appropriate:

'*' Denotes a species considered to be under the specified degree of threat within South Australia primarily owing to it being on the edge of a natural range falling largely outside South Australia, or because it is considered to have only existed here in small numbers or in a restricted habitat type at the time of settlement.

'**' Denotes a species under threat owing to some form of human influence, such as habitat destruction, past and present persecution, or predation by introduced species.

Distributional data for fauna refer to the environmental province(s) in which the species is known to occur or to have occurred during the period of European settlement. The provinces are based on those of Laut *et. al.* (1977) in Environmental Provinces of South Australia.

Appendix 11 shows the boundaries of each province. No distributonal data are available for marine fishes.

Information was primarily compiled by the curators at the South Australian Museum, from their extensive specimen holdings. Where a species is unrepresented in the Museum collections or is believed to currently have a wider distribution than that indicated by specimen holdings the number(s) of province(s) in which it is thought to occur are placed in brackets. Doubtful locality records are accompanied by a query (Aslin 1985).

APPENDIX 3: NATIVE VEGETATION SPECIES PRESUMED EXTINCT IN SOUTH AUSTRALIA: THREATS AND FORMER OCCURRENCE

SPECIES	DATE OF LAST COLLECT	CODE	REGION Leigh	Herbarium	Laut	VEGETAION TYPE	THREAT
Festuca benthamiana	1850	3X	27 28	5 8,11	6 3	unknown	possibly agric. & grazing d
Hemichroa mesembryanthema	1872	1X	25	2	8	"	possibly grazing d,
Phlegmatospermum richardsii	1879	2X	23	3,4	7	"	possibly grazing d,
Senecio behrianus	1925	3X	31	9	2	open woodland	agric, grazing d,f
S. georgianus	?	3X	28	8,11	3	woodland	possible agric, grazing d,f
Veronica parnkalliana	1909	1X	24	7	4	unknown	poss. agric

Source: Leigh *et al* 1984

Note: Information for all areas is in the process of being updated and is expected to be published early 1986.
The regions used by Leigh *et al* have been roughly translated into the regions used by The Herbarium and Laut *et al* (1977). The three systems are comparable but because of slight differences in boundaries some inaccuracies may occur in placement of species.

Grazing: d - domestic animals
f - feral animals
n - native animals

APPENDIX 4: ENDANGERED NATIVE PLANTS IN SOUTH AUSTRALIA - THREATS & OCCURRENCE

SPECIES	CODE	REGION Leigh	Herb	Laut	VEGETATION TYPE	PAST THREAT	PRESENT AND FUTURE THREAT
Acacia araneosa	2EC	27	5	6	Scrub,shrubland	grazing f	grazing f
A. menzelii	3EC	27 31	5 9	6 2	woodland, scrub	agriculture grazing of	agriculture, competition grazing d,f
A. pinguifolia	3E	24 31	7 9	4 2	scrub	agric	competition, roadworks
Achnophora tatei	2E	30	12	3	swampy river banks	agric collecting	collecting, competition
Acrotriche halmaturina	2EC	30	12	3	heath	none	àgric, grazing d
Atriplex kochiana	2E	23	3,4	7	shrubland	grazing d,f,n	grazing d,f,n
Beyeria subtecta	2E	30	12	3	scrub, heath	agric	agric, roadworks competition, low numbers
Brachycome muelleri	2E	23	3,4	7	scrub	possibly agric. grazing d,f	agric, grazing d,f
Cheiranthera volubilis	2EC	30	12	3	scrub	agric	roadworks, competition
Diuris brevifolia	3EC	28 30	8,11 12	3 3	open forest forestry	agric,	grazing f, collecting
Eragrostis infecunda	2E	28	8,11	3	river & lagoon banks	agric. competition	agric, competition
Eriocaulin carsonii	2E	26	6	5	herbland (sedgeland around saline spring)	agric grazing d	agric, grazing d
Frankenia granulata	2E	22	1	8	shrubland?	possibly grazing d,f	possibly grazing d,f
F. plicata	3E	22	1	8	shrubland?	possibly grazing d	possibly grazing d
Haloragis eyreana	2E	24	7	4	scrub	agric	competition
Hibbertia paeninsularis	3EC	24	7	4	heath	agric	agric.
Lepyrodia valliculae	2E	28 30	8,11 12	3 3	swamp (in open forest)	agric.	agric. roadwoarks competition
Logania insularis	2E	30	12	3	scrub	unknown	low numbers, roadworks local disturbance

SPECIES	CODE	REGION Leigh	Herb	Laut	VEGETATION TYPE	PAST THREAT	PRESENT AND FUTURE THREAT
Myoporum refractum	3E	26 27	6 5	5 6	salt lake	grazing d,f,n	grazing d,f,n
Prostanthera eurybioides	2E	31	9	2	scrub?	agric. grazing d	grazing d,f
Pseudanthus micranthus	2E	28	8,11	3	woodland heath	agric.	grazing d,f agric.
Psoralea parva	3E	28	8,11	3	herbland	agric. grazing d	agric, railway maintenance fire frequency, urban development, grazin
Ptilotus beckerianus	3EC	24 30	7 12	4 3	woodland	agric.	roadworks
Sclerolaena aellenii	1E	29	10	4	heath	agric.	agric. recreation
Senecio megaglossus	3E	27 28	5 8,11	6 3	open woodland	grazing d,f	grazing d,f collecting
Stackhousia annua	2EC	24 29	7 10	4 4	open woodland	agric. recreation	grazing d
Swainsona laxa	3EC	24	7	4	scrub	agric. grazing d,f	grazing d,f competition
Thelymitra epipactoides	3EC	24 28 31 32	7 8,11 9 13	4 3 12 1	scrub heath	agric. urban development	grazing, f collecting,competit
Thysanotos wangariensis	2EC	24	7	4	heath	agric. grazing d,f	agric. competition grazing d,f

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Source: Leigh, et al 1984

Notes: Minor amendments have been supplied by J. Leigh, CSIRO, Canberra. Information all areas is in the process of being updated and is expected to be published e 1986.

The regions used by Leigh et al have been roughly translated into the regions by the Herbarium and by Laut et al 1977. The three systems are comparable but because of differences in boundaries some inaccuracies may occur in placement species.

Grazing:

d - domestic animals
f - feral animals
n - native animals

APPENDIX 5: RARE OR THREATENED PLANTS IN SOUTH AUSTRALIA

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Proteaceae				
Grevillea	parviflora	2RC	S	30
Grevillea	muricata	2V	S	30
Grevillea	parallelinervis	2V	S	23 24
Grevillea	quinquenervis	2VC	S	30
Hakea	baxteri	3R	WS	23
Petrophile	multisecta	2RC	S	30
Loranthaceae				
Amyema	biniflorum	3K	SQ	24 25
Gyrostemonaceae				
Codonocarpus	pyramidalis	3VC	SN	26 27 48
Aizoaceae				
Gunniopsis	kochii	2R	S	27
Sarcozona	bicarinata	3V	S	24 29 31
Portulacaceae				
Calandrinia	disperma	3R	YS	21 23
Calandrinia	volubilis	3RC	S NV	23
Chenopodiaceae				
Atriplex	eichleri	3R	S	22 26 27
Atriplex	kochiana	2E	S	27
Atriplex	papillata	3RC	S NV	31
Atriplex	acutibractea ssp. karoniensis	1K	S	24
Maireana	melanocarpa	3V	S	27
Malacocera	gracilis	3V	S	26 27
Sclerolaena	aellenii	1E	S	29
Sclerolaena	bicuspis	3R	WS	23 27
Sclerolaena	cristata	1K	S	22
Sclerolaena	holtiana	2K	S	22
Sclerolaena	lanata	3R	YS	20 21 22
Sclerolaena	nitida	1K	S	27
Amaranthaceae				
Hemichroa	mesembryanthema	1X	S	25
Ptilotus	beckerianus	3E	S	24 30
Ptilotus	aristatus var. eichleranus	3R	S	22
Ptilotus	robynsianus	1K	S	27
Ptilotus	symonii	2R	S	23
Dilleniaceae				
Hibbertia	crispula	2V	S	23
Hibbertia	paeninsularis	2E	S	24
Droseraceae				
Drosera	whittakeri	2V	S	28
Cruciferae				
Lepidium	pseudo-papillosum	3X	S V	27
Lepidium	pseudo-ruderale	3R	WS	23 26 27 31
Lepidium	strongylophyllum	3R	YSQ	22 25
Menkea	lutea	2R	WS	22
Microlepidium	alatum	2V	S	24
Microlepidium	pilosulum	3RC	SV	24 30

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Phlegmatospermum	eremaeum	3V	W S NV	24
Phlegmatospermum	richardsii	2X	W S	23
Pittosporaceae				
Cheiranthera	volubilis	2E	S	30
Leguminosae				
Acacia	araneosa	2EC	S	26
Acacia	barattensis	2R	S	26
Acacia	carnei	3R	S N	26 27
Acacia	confluens	2V	S	27
Acacia	dodonaeifolia	3RC	S	24 28 29
Acacia	enterocarpa	3V	S V	24 28
Acacia	gillii	2V	S	24
Acacia	glandulicarpa	3V	S V	28
Acacia	gracilifolia	3VC	S	27 28
Acacia	imbricata	2V	S	24
Acacia	iteaphylla	3RC	S	23 24 27
Acacia	menzelii	2E	S	31
Acacia	pickardii	3V	YS	21 25
Acacia	pinguifolia	3E	S	24 31
Acacia	quornensis	2V	S	27
Acacia	rhetinocarpa	3VC	S	24 29 31
Acacia	rhigiophylla	3V	S N	24 28 31
Acacia	rivalis	3RC	S N	27
Acacia	symonii	3V	S	22
Acacia	wattsiana	2RC	S	28
Daviesia	benthamii spp. benthamii	3RC	S	31
Daviesia	pectinata	3RC	S V	24
Gastrolobium	tomentella	2V	S	25
Glycine	latrobeana	3VC	S VT	28
Phyllota	remota	3R	S V	24 31
Psoralea	parva	3E	S V	32
Pultenaea	acerosa	3RC	S V	24 28 30
Pultenaea	densifolia	3K	S V	24 28 30 31
Pultenaea	involucrata	3RC	S	24 28
Pultenaea	quadricolor	2VC	S	28
Pultenaea	trichophylla	2V	S	24
Pultenaea	trifida	2VC	S	30
Pultenaea	trinervis	3VC	S	24 28
Pultenaea	viscidula	3RC	S	28 30
Swainsona	laxa	3EC	S NV	24
Swainsona	minutiflora	2V	S	27
Swainsona	tephrotricha	3V	S	27 28
Swainsona	viridis	3VC	S N	26 27
Zygophyllaceae				
Zygophyllum	crassissimum	2V	S	22
Zygophyllum	humillimum	3K	S N	22 26 27
Zygophyllum	hybridum	3R	S	22 26 27
Zygophyllum	kochii	3R	S	23 26 27
Euphorbiaceae				
Bertya	rotundifolia	2RC	S	30
Beyeria	subtecta	2E	S	30
Micrantheum	demissum	3RC	S	28 30
Pseudanthus	micranthus	2E	S	28

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Rutaceae				
Boronia	edwardsii	3RC	S	28 30
Boronia	filifolia	3RC	S V	30 32
Correa	calycina	2VC	S	28
Correa	decumbens	3RC	S	28 30
Phebalium	brachyphyllum	3VC	S	24 29 31 32
Phebalium	hillebrandii	2EC	S	28 29
Phebalium	lowanense	3VC	S V	31
Urocarpus	muricatus	2V	S	30
Tremandraceae				
Tetratheca	insularis	3RC	S	30
Stackhousiaceae				
Stackhousia	annua	2E	S	24
Rhamnaceae				
Cryptandra	hispidula	2RC	S	28 30
Cryptandra	waterhousii	2RC	S	30
Pomaderris	flabellaris	2V	S	24
Pomaderris	halmaturina	2V	S	30
Spyridium	coactilifolium	2V	S	28
Spyridium	halmaturinum	2RC	S	30
Spyridium	leucopogon	2V	S	24
Spyridium	spathulatum	3RC	S V	24 28 30
Sterculiaceae				
Commersonia	tatei	3RC	S	24
Thymelaeaceae				
Pimelea	macrostegia	2RC	S	30
Pimelea	octophylla spp. subvillifera	3K	W S	23
Frankeniaceae				
Frankenia	cinerea	3R	W S	23
Frankenia	crispa	3R	S V	24 26 27
Frankenia	cupularis	3E	S	25 26
Frankenia	granulata	2E	S	22
Frankenia	muscosa	3K	YS	22
Frankenia	plicata	3E	S	22
Frankenia	subteres	2K	S	27
Myrtaceae				
Darwinia	homoranthoides	2V	S	24
Darwinia	micropetala	3RC	S V	24 30 32
Eucalyptus	cneorifolia	2RC	S	28 30
Eucalyptus	lansdowneana	2V	S	23
Eucalyptus	pimpiniana	2R	S	23
Eucalyptus	remota	2VC	S	30
Lhotzkya	smeatoniana	2RC	S	30
Melaleuca	corrugata	3R	YS	22
Verticordia	whilhelmii	3VC	S	24 29
Haloragidaceae				
		3V	WS	24
Haloragis	eichleri	3VC	S	24 30 31 32
Haloragis	eyreana	2E	S	24

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Umbelliferaceae				
Eryngium	supinum	3K	SQ	25 29
Hydrocotyle	comocarpa	2EC	S	30
Hydrocotyle	crassiuscula	2VC	S	30
Neosciadium	glochidiatum	3K	W S	23
Epacridaceae				
Acrotriche	fasciculiflora	2RC	S	28
Acrotriche	halmaturina	2EC	S	30
		1EC	S	30
Loganiaceae				
Logania	insularis	2E	S	30
Logahia	recurva	3RC	S	28 29
Menyanthaceäe				
Villarsia	reniformis	1X	S	32
Convolvulaceae				
Cuscuta	victoriana	2V	S	28
Boraginaceae				
Embadium	jonhstonii	2V	S	22
Embadium	stagnense	2K	S	23
Embadium	uncinatum	2K	S	23 24 27
Heliotropium	gossei			
Labiatae				
Prostanthera	calycina	2K	S	24
Prostanthera	eurybiodes	2E	S	31
Prostanthera	nudula	2K	S	22
Solanaceae				
Anthocercis	angustifolia	3RC	S	27 28
Anthocercis	anisantha	3R	W S	24
Cyphanthera	anthocercidea	3R	S	32
Grammosolen	truncatus	2R	S	23
Scrophulariaceae				
Euphrasia	collina spp. muelleri	3X	S NV	28
Veronica	parnkalliana	1X	S	24
Myoproaceae				
Eremophila	hillii	3R	W S	3
Eremophila	parvifolia	3R	W S	23
Eremophila	pentaptera	2E	S	23
Myoporum	refractum	2E	S	27
Goodeniaceae				
Goodenia	chambersii var. chambersii	3R	S	22 26
Goodenia	lobata	2V	S	22
Scaevola	bursariifolia	2V	S	23
Stylidiaceae				
Stylidium	tepperanum	2RC	S	30

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Compositae				
Achnophora	tatei	2E	S	30
Pleuropappus	phyllocalymmeus	3VC	S	24 29
Basedowia	tenerrima	2V	S	22
Brachycome	eriogona	3R	SQ	26 36
Brachycome	muelleri	3X	S	23 28
Brachycome	tatei	3K	W S	23
Elachanthus	glaber	2V	S	26
Helichrysum	monochaetum	3R	S	23 24 26
Haeckeria	cassiniaeformis	2RC	S	24
Olearia	grandiflora	2RC	S	28
Olearia	hookeri	3RC	S T	31
Olearia	microdisca	3V	S	29 30
Senecio	georgianus	3X	W S V	28
Senecio	megaglossus	3E	S	27 28
Juncaginaceae				
Triglochin	muelleri	3K	W S	24 32
Triglochin	ovoideum	3V	S	31
Zosteraceae				
Zostera	mucronata	3K	W S	24 28 29
Zannichelliaceae				
Zannichellia	palustris	2R	S N	28 31
Liliaceae				
Lomandra	fibrata	2RC	S	28
Thysanotus	fractiflexus	2VC	S	30
Thysanotus	wangariensis	2EC	S	24
Ericaulaceae				
Eriocaulon	carsonii	2E	S	26
Restionaceae				
Lepyrodia	valliculae	2E	S	28
Gramineae				
Danthonia	clelandii	2RC	S	28
Echinochloa	inundata	3K	SQN	25
Eragrostis	infecunda	2E	S	28
Festuca	bethamiana	3X	S	27 28
Poa	halmaturina	2RC	S	28 30
Poa	umbricola	2RC	S	28
Stipa	densiflora	2KC	S	28
Stipa	eremophila	2V	S	23 24
Stipa	multispiculis	2V	S	28 29
Stipa	mundula	3KC	S	24 28 29 31
Stipa	plumigera	3V	S	22
Triodia	lanata	3RC	S	23 24
Cyperaceae				
Ghania	hystrix	2RC	S	30
Schoenus	discifer	3VC	S	28 30 32
Schoenus	racemosus	3RC	S	24 31 32

FAMILY GENUS	SPECIES	RISK CODE	STATE	REG. SUBDIV. NOS. FOR SA
Orchidaceae				
Caladenia	gladiolata	3VC	S	27 28
Caladenia	leptochila	3RC	S	27 28 30 31
Caladenia	rigida	2V	S	28
Diuris	brevifolia	3E	S	28 30
Prasophyllum	goldsackii	3RC	S	24 29
Prasophyllum	pallidum	3RC	S V	27 28 31 32
Pterostylis	cucullata	3VC	S VT	28
Thelymitra	epipactoides	3EC	S V	24 28 31
Thelymitra	mathewsii	3V	W S V	3 30 32

Source: Leigh et al, 1981

N.B. Names have been changed in accordance with Jessop 1984
States(s) or Territory in which species occur

- S – South Australia
- W – Western Australia
- Y – Northern Territory
- Q – Queensland
- N – New South Wales
- V – Victoria
- T – Tasmania

APPENDIX 6: THREATENED PLANT SPECIES OF THE MOUNT LOFTY RANGES AND KANGAROO ISLAND, SOUTH AUSTRALIA

PRESUMED EXTINCT	CODE	REGION	NO. OF SPECIES
**Festuca benthamiana	3x	21.2f	(1)
ENDANGERED			
Olearia microdisca	2EC	30	
**Pomaderris halmaturina	2E	30	
Psoralea parva	3E	28, Vic	
Pterostylis cucullata	3EC	28, 32 Vic	
Ptilotus beckerianus	3EC	30, 24	
**Pultenaea quadricolor	3E	28	
*Senecio macrocarpus	3E	28, Vic	
*S. megaglossus	3E	27, 28	
**Thelymitra merranae	2E	28, Vic	(9)
VULNERABLE			
Acacia glandulicarpa	3VC	28, Vic	
Beyeria subtecta	2VC	30	
Caladenia gladiolata	3VC	27, 28	
C. ovata	3VC	28, 30	
C. rigida	2V	28	
Cheiranthera volubilus	2VC	30	
Eragrostis infecunda	2V	28	
*Glycine latrobeana	3VC	28, 32, Vic	
Grevillea muricata	2VC	30	
*Hydrocotyle crassiuscula	2VC	30	
Logania insularis	2VC	30	
Prasophyllum pallidum	3VC	27, 28	
**P. Validum	2V	28	
Pseudanthus micranthus	2VC	28	
Spyridium coactilifolium	2VC	28	
*Stipa multispiculis	2VC	28	
*Swainsona tephroticha	3V	27, 28	
**Thelymitra matthewsii	3V	30, 32, Vic	
Urocarpus muricatus	3VC	28, 30	(19)
RARE			
Achnophora tatei	2RC	30	
Acrotriche halmaturina	2RC	30	
Diuris brevifolia	2RC	28, 30	
Eucalyptus cneorifolia	2RC	28, 30	
E. lansdowneana	3RC	23, 24, 30	(12)
Grevillea quinquenervis	2RC	30	
Hakea aenigma	2RC	30	
Haloragis eichleri	3RC	24, 30, 32	
Lepyrodia valliculae	3RC	28,30	
Pultenaea trifida	2RC	30	
Schoenus discifer	3RC	28, 30	
Thysanotus fractiflexus	2RC	30	
			TOTAL(40)

NOTE: * Requires more field searching to confirm threat code
** Requires more taxonomic research

Source: Davies, R.J.P (in press).

APPENDIX 7: SOUTH AUSTRALIAN RARE OR THREATENED PLANTS IN CULTIVATION AT BOTANIC GARDENS OF ADELAIDE

PROTEACEAE	RISK CODE*	REGIONS*
Grevillea muricata	2V	30
LEGUMINOSAE (formerly mimosaceae)		
Acacia araneosa	2EC	26
A. barattensis	2R	26
A. gillii	2V	24
A. glandulicarpa	3V	28
A. gracilifolia	3VC	27, 28
A. imbricata	2V	24
A. menzelii	2E	31
A pinguifolia	3E	24, 31
A. quornensis	2V	27
A. rhetinocarpa	3VC	24, 29, 31
A. rhigiophylla	3V	24, 28, 31
A. rivalis	3RC	27, 48
Pultenaea viscidula	3RC	28, 30
RUTACEAE		
Correa decumbens	3RC	28, 30
STACKHOUSIACEAE		
Stackhousia annua	2E	24
RHAMNACEAE		
Spyridium coactilifolium	2V	28
FRANKENIACEAE		
Frankenia granulata	2E	22
MYRTACEAE		
Darwinia homoranthoides	2V	24
Eucalyptus cneorifolia	2RC	28, 30
E. lansdowneana	2V	23
E. pimpiniana	2R	23
LABIATAE (formerly LAMIACEAE)		
Prostanthera eurybioides	2E	31
SOLANACEAE		
Anthocercis augustifolia	3RC	27, 28

COMPOSITAE (formerly ASTERACEAE)

Brachycome tatei	3K	11, 23
Haeckeria cassiniaeformis	2RC	24
(formerly Humea cassiniaeformis)		
Olearia microdisca	3V	29, 30
+Olearia pannosa		

ERIOCAULACEAE

Eriocaulon carsonii	2E	28

ORCHIDACEAE

Pterostylis cucullata	3VC	28
+Sarcachilus hartmannii		

SOURCE: Botanic Gardens of Adelaide
* Risk Code & Regions after Leigh et al (1981)
+ Not included on original list of Leigh et al (1981) (code and Region not supplied)

APPENDIX 8: RARE PLANTS IN CULTIVATION AT BLACK HILL NATIVE FLORA RESEARCH UNIT

PROTEACEAE	Grevillea halmaturina G. muricata G. quinquenervis Petrophile multisecta
AMARANTHACEAE	*Ptilotus beckeranus
DILLENIACEAE	*Hibbertia paeninsularis
PITTOSPROACEAE	*Cheiranthera volubilis
LEGUMINOSAE (formerly MIMOSACEAE)	*Acacia areneosa A. confluens A. dodonaeifolia A. gillii A. gracilifolia A. imbricata A. iteaphylla *A. menzelii *A. pinguifolia A. rhetinocarpa A. rivalis A. wattsiana Daviesia pectinata Glycine latrobeana *Psoralea parva Pultenaea quadricolor P. trifida P. viscidula *Swainsona laxa
EUPHORBIACEAE	Bertya rotundifolia *Beyeria subtecta
RUTACEAE	Boronia edwardsii B. filifolia Correa decumbens Urocarpus muricatus
TREMANDRACEAE	Tetratheca insularis
STACKHOUSIACEAE	*Stackhousia annua
RHAMNACEAE	Spyridium halmaturinum
STERCULIACEAE	Commersonia tatei
THYMELAEACEAE	Pimelea macrostegia
MYRTACEAE	Darwinia homoranthoides D. micropetala Eucalyptus cneorifolia E. lansdowneana Melaleuca corrugata Verticordia wilhelmii
HALORAGIDACEAE	Haloragis eichleri

EPACRIDACEAE	*Acrotriche halmaturina
LOGANIANCEAE	*Logania insularis
LABIATAE (formerly LAMIACEAE)	Prostanthera calycina *P. eurybioides
SOLANACEAE	Anthocercis anisantha
STYLIDIANCEAE	Stylidium tepperanum
COMPOSITAE (formerly ASTERACEAE)	*Achnophora tatei Angianthis phyllocalymmeus *Brachycome muelleri Olearia microdisca
LILIACEAE	Thysanotus fractiflexus *T. wangariensis
RESTIONACEAE	*Lepyrodia valliculae

NOTE: * Species listed by Leigh, Boden & Briggs 1984 as being endangered species in cultivation at Botanic Gardens of Adelaide

APPENDIX 9: RESEARCH PROJECTS UNDERWAY AT BLACK HILL NATIVE FLORA RESEARCH UNIT DEALING WITH RARE OR ENDANGERED SPECIES OF NATIVE PLANTS

- **Tissue Culture**
  Correa decumbens
  Prostanthera eurybioides
  Boronia edwardsii
  Commersonia tatei
  Todea barbara
  Dicksonia antartica

- **Pollination biology** of *Swainsona laxa*

- **Immature Ovule Culture** e.g. *Acacia quornensis*

- **Survey and Conservation Status Assessment of Native ferns**
  (1985 Wildlife Conservation Fund/CEP Project)

- **Replanting in the wild**
  Todea barbara (Adelaide Hills)
  Prostanthera eurybioides (Monarto, Mt. Monster)
  Acacia pinguifolia (Eyre Peninsula)

APPENDIX 10: AN INDEX OF CONSERVATION PRIORITIES FOR PLANT ASSOCIATION CATEGORIES NOT CONSERVED OR POORLY CONSERVED IN SOUTH AUSTRALIA

A. ASSOCIATION CATEGORIES OF THE AGRICULTURAL REGIONS

1. Poorly conserved or not conserved interstate or only occur in South Australia

Nil conservation in South Australia

Very rare and endangered in South Australia PRIORITY 1

- *Eucalyptus behriana* ± *E. odorata* ± *E. dumosa* Open-scrub (a)
- *E. cneorifolia* - *E. rugosa* and/or *E. dumosa* spp. *conglobata* Open-scrub (b)
- *Lomandra effusa* ± *L. dura* (Open) Tussock grassland

Greatly depleted and becoming rare and endangered but a few good examples still remaining. PRIORITY 2

- *E. cneorifolia* Open-scrub (b)

Poorly conserved in South Australia

Very rare and endangered in South Australia PRIORITY 3

- *Danthonia* spp. - *Themeda australis* Tussock grassland

Most remaining examples are small and/or degraded and/or a typical PRIORITY 4

- *E. rubida* Open-forest
- *E. odorata* ± E. porosa (Low) Woodland
- *Banksia marginata* Low woodland
- *E. flocktoniae* - *E. dumosa* Open-scrub (c)

Much depleted but a few large examples still remaining in South Australia PRIORITY 5

- *E. microcarpa* Woodland
- Wet heath (non-saline soils) i.e. *Hakea rostrata* - + *Allocasuarina paludosa* - *Xanthorrhoea australis* - *Banksia ornata* Open-heath

Numerous moderately large examples still remain in South Australia but many examples have degraded understoreys and/or are currently under threat of being cleared PRIORITY 6

- *E. porosa* (Low) Woodland
- *Callitris preissii* Low Woodland

2. Moderately conserved Interstate

Nil conservation in South Australia

Very rare and endangered in South Australia — PRIORITY 7

- + Allocasuarina luehmannii Low Woodland
- E. ovata Low Woodland with savannah understorey.

Poorly Conserved in South Australia

Several examples still remaining in South Australia but most are only small and frequently invaded by exotics and/or degraded — PRIORITY 8

- Leptospermum juniperinum and/or L. lanigerum Closed-heath
- Potamogeton pectinatus and/or + Myriophyllum variifolium and/or Azolla filiculoides and/or + Lemna disperma (and other submerged and floating freshwater aquatics) Closed-herbland

Several good examples still remaining in South Australia but threat of too frequent fires reducing species richness of understorey — PRIORITY 9

- E. ovata Low open-forest and Low Woodland (heath understorey)

3. Not conserved or poorly conserved in South Australia but similar association categories moderately conserved in South Australia — PRIORITY 10

- E. macrorhyncha Low open-forest
- E. odorata - E. leucoxylon ± E. fasciculosa Low woodland

4. As above but similar association categories reasonably conserved in South Australia — PRIORITY 11

- E. goniocalyx ± E. obliqua (± E. fasciculosa) Open-forest
- E. oleosa/E. socialis - E. gracilis - E. dumosa Low open-forest
- Melaleuca lanceolata Low Woodland
- E. dumosa ssp. conglobata Low woodland
- E. cosmophylla - M. uncinata Open-scrub
- E. dumosa ssp. dumosa Open-scrub
- Beyeria lechenaultii - Eutaxia microphylla Low shrubland

5. As above but similar association categories excellently conserved in South Australia — PRIORITY 12

- E. diversifolia Low open-forest

B. ASSOCIATION CATEGORIES OF THE NON AGRICULTURAL REGIONS (Not Conserved or Poorly Conserved in South Australia)

1. Poorly conserved or not conserved interstate or only occurs in South Australia. (Specht et al 1974) PRIORITY 13

- Hakea leucoptera Low open-woodland
- H. ivoryi Low open-woodland
- E. gamophylla - E. oxymitra Open-scrub
- E. pyriformis ssp. youngiana - E. socialis Tall shrubland
- Acacia tarculensis Tall shrubland
- Atriplex vesicaria - Ixiolaena leptolepis Low shrubland
- Atriplex rhagodioides Low shrubland
- Maireana pyramidata Low shrubland
- Atriplex nummularia Low shrubland (a) (e)
- Maireana aphylla Low shrubland (e) ?
- Chenopodium auricomum Low shrubland (a)
- C. nitrariaceum Low shrubland
- Astrebla pectinata (Open) Tussock grassland (a) (e)
- Eragrostis australiasica Tussock grassland
- Enneapogon avenaceus ± Aristida nitidula Ephemeral community
- Erodium spp., Helichrysum spp., Brachycome spp, Calocephalus spp, Calotus spp. Ephemeral community
- Atriplex spongiosa ± Atriplex holocarpa, Sclerolaena spp. etc. ephemeral community
- Ephemeral grasses and herbs of flood plains of Diamantina & Warburton Rivers and ephemeral lake basins.

2. Reasonably or excellently conserved interstate (Specht et al 1974) PRIORITY 14

- E. microtheca Low Woodland (d)
  (low open-woodland is Reasonably conserved in Western Australia)
- \+ Allocasuarina decaisneana Low open-woodland
  (Open-woodland is Excellently conserved in Northern Territory)
- E. aff. dichrompphloia - E. terminalis Low open-woodland
  (E. dichromophloia Low open-woodland is reasonably conserved Western Australia)
- Atriplex angulata - Atriplex velutinella Atriplex leptocarpa - Sclerolaena intricata - Sclerolaena limbata - Frankenia serpyllifolia Low shrubland (Halosarcia spp. - Atriplex spp. - Scleroleana spp. Low open-shrubland of the Simpson Desert in Queensland is reasonably conserved).

3. Poorly conserved in South Australia but similar association categories Moderately conserved in south Australia PRIORITY 15

- Heterodendrum oleaefolium Low open-woodland

4. Not conserved or poorly conserved in South Australia but similar association categories reasonably conserved in South Australia PRIORITY 16

- Acacia papyrocarpa Low woodland
- E. dumosa ssp. dumosa + E. socialis Open-scrub
- Stipa nitida - Sclerolaena spp Ephemeral community

NOTES: (a) Despite its moderate conservation status in Victoria, E. behriana etc. is placed in Priority 1 due to its disjunct, relic nature and rarity in S.A.

(b) Eucalyptus cneorifolia - E. rugosa and/or E. dumosa spp. conglobata open-scrub, and E. cneorifolia open-scrub will be conserved in Kangaroo Island on land acquired by NPWS but not yet dedicated.

(c) E. flocktoniae - E. dumosa open-scrub is now conserved in Verran Tanks Conservation Park on Eyre Peninsula.

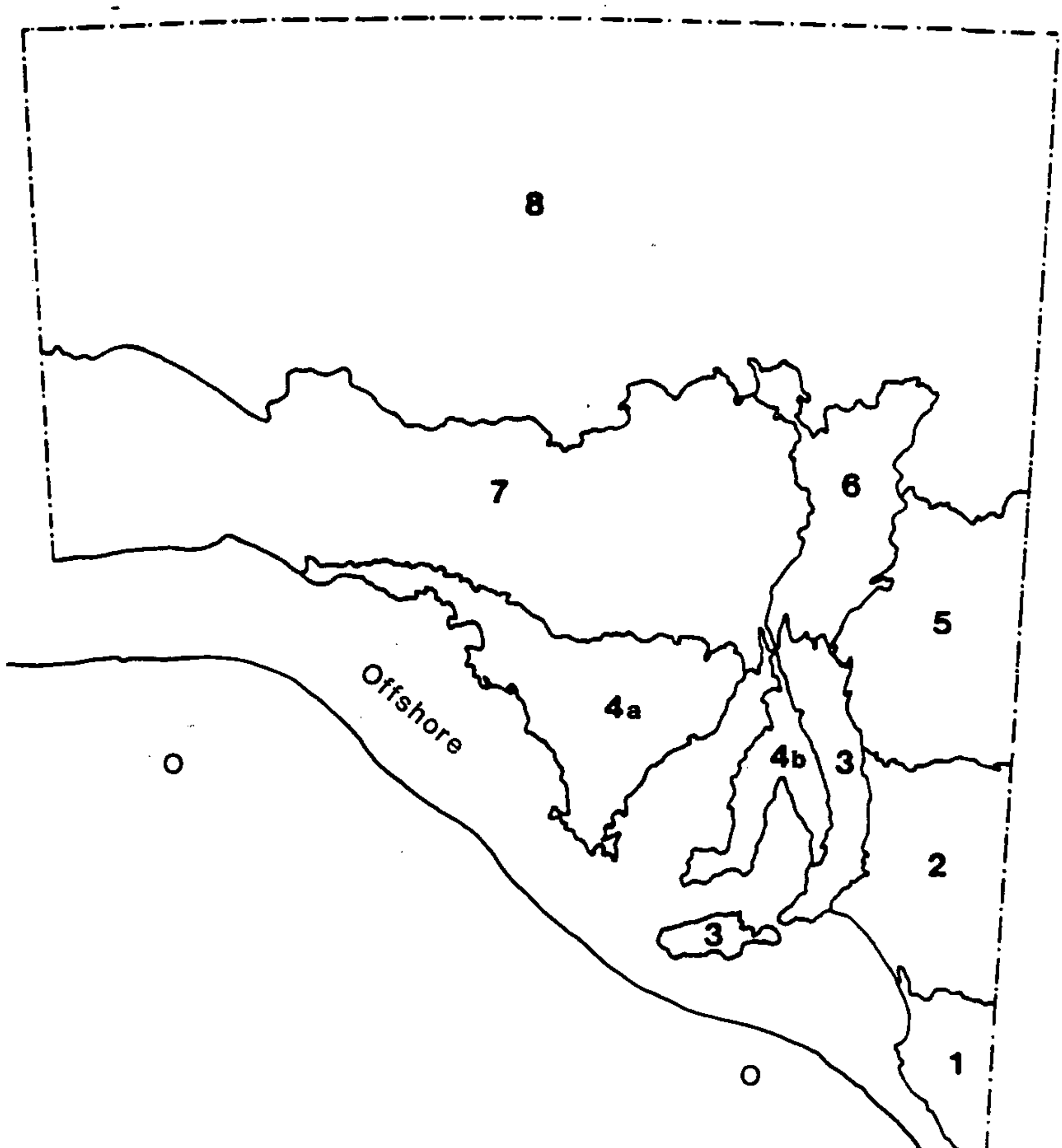
(d) Species conserved in Mount Dare Station acquired by NPWS but not yet dedicated.

(e) Species conserved in the Balcanoona Lowlands.

\+ Indicates taxonomic revision in accordance with Jessop, 1984.

SOURCE: Davies RJ-P, 1982

APPENDIX II ENVIRONMENTAL PROVINCES OF SOUTH AUSTRALIA



Source: Modified after Laut et al (1977)

PROVINCES

1 South East
2 Murray Mallee
3 Mount Lofty Block and Kangaroo Island
4 Eyre and Yorke Peninsulas
4a Eyre Peninsula
4b Yorke Peninsula and the Adelaide Plains
5 Eastern Pastoral
6 Flinders Ranges
7 Western Pastoral
8 Northern Arid
O Open Ocean

APPENDIX 12: MAMMALS

NAME	DISTRIBUTION	STATUS
MONOTREMATA – MONOTREMES		
ORNITHORHYNCHIDAE – PLATYPUS		
Ornithorhynchus anatinus (Shaw and Nodder, 1799) – Platypus	1, 2, (R. Murray), 3 (introduced to Kangaroo Is.)	X
TACHYGLOSSIDAE – ECHIDNAS		
Tachyglossus aculeatus (Shaw and Nodder, 1792) – Short-beaked Echidna (Spiny Anteater)	(1), 2, 3, 4, (5), (6), (7) (8)	C
MARSUPIALIA – MARSUPIALS		
BURRAMYIDAE – PYGMY-POSSUMS AND FEATHERTAIL GLIDER		
Acrobates pygmaeus (Shaw, 1793) Feathertail Glider	1, 2	R *
Cercartetus concinnus (Gould, 1845) Western Pygmy-Possum	1, 2, 3, 4, 7	C
Cercartetus lepidus (Thomas, 1888) Little Pygmy-Possum	1, 2, 3 (Kangaroo Is)	R *
Cercartetus nanus (Desmarest, 1818) Eastern Pygmy-Possum	1	R *
DASYURIDAE – DASYURIDS		
Antechinomys laniger (Gould, 1856) Kultarr	4, 7, 8	R *
Antechinus flavipes (Waterhouse, 1838) Yellow-footed Antechinus	1 3 (mainland only)	C
Antechinus minimus (Geoffroy, 1803) Swamp Antechinus	1	R **
Dasycercus cristicauda (Krefft, 1866) Mulgara	8	K

NAME	DISTRIBUTION	STATUS
Dasyuroides byrnei (Spencer, 1896) Kowari	8	K
Dasyurus geoffroii (Gould, 1841) Western Quoll (Western Native-cat)	1?, 8	X
Dasyurus maculatus (Kerr, 1792) Spotted-tailed Quoll (Tiger Cat)	1, 2 (R. Murray)	X
Dasyurus viverrinus (Shaw, 1800) Eastern Quoll (Eastern Native-cat)	1, (2), 3	X
Ningaui ridei (Archer, 1975) - Wongai Ningaui	(7), 8	R **
Ningaui yvonneae (Kitchener, 1983) Southern Ningaui	2, 4, 5, 6, 7	C
Phascogale calura (Gould, 1844) Red-tailed Phascogale	(3), (8)	X
Phascogale tapoatafa (Meyer, 1793) Brush-tailed Phascogale	1, 4	R *
Planigale gilesi (Aitken, 1972) Paucident Planigale (Giles' Planigale)	7, 8	R *
Planigale tenuirostris (Troughton, 1928) - Narrow-nosed Planigale	6, 7, 8	R *
Sminthopsis aitkeni (Kitchener, Stoddart and Henry, 1984) - Sooty Dunnart	3 (Kangaroo Is only)	K
Sminthopsis crassicaudata (Gould, 1844) Fat-tailed Dunnart	1, 2, 3, 4, 5, 6, 7, 8	C
Sminthopsis dolichura (Kitchener, Stoddart and Henry, 1984)	4, 7	K
Sminthopsis hirtipes (Thomas, 1898) Hairy-footed Dunnart	8	R *
Sminthopsis longicandata (Spencer, 1908) - Long-tailed Dunnart		K
Sminthopsis macroura (Gould, 1845) Stripe-faced Dunnart	4, 5, 6, 7, 8	R
Sminthopsis murina (Waterhouse, 1837) Common Dunnart	1, 2, 3, 5? (mainland only)	C
Sminthopsis ooldea (Troughton, 1965) Ooldea Dunnart	7, 8	C
Sminthopsis psammophila (Spencer, 1895) - Sandhill Dunnart	4	E **

NAME	DISTRIBUTION	STATUS
MACROPODIDAE - KANGAROOS AND WALLABIES		
Bettongia lesueuri (Quoy and Gaimard, 1824) - Burrowing Bettong	3, 4, 7, 8	X
Bettongia penicillata (Gray, 1837) - Brush-tailed Bettong	4, 7, 8 (St Francis Is, Wedge Is, Venus Bay, Bairds Bay Is all reintroduced)	X
Caloprymnus campestris (Gould, 1843) Desert Rat-kangaroo	8	X
Lagorchestes hirsutus (Gould, 1844) Rufous Hare-wallaby	8	X
Lagorchestes leporides (Gould, 1840) Eastern Hare-wallaby	1, (2?)	X
Macropus eugenii (Desmarest, 1817) Tammar (Dama Wallaby)	3, 4	C
Macropus fuliginosus (Desmarest, 1817) - Western Grey Kangaroo	1, 2, 3, 4, 5, (6), 7, (8)	C
Macropus giganteus (Shaw, 1790) Eastern Grey Kangaroo	(1), (2), (5), 8	V *
Macropus greyi (Waterhouse, 1846) Toolache Wallaby	1, 2	X
Macropus robustus (Gould, 1840) Common Wallaroo (Euro)	3, 4, 5, 6, 7, 8	C
Macropus rufogriseus (Desmarest, 1817) - Red-necked Wallaby	1, 2	R *
Macropus rufus (Desmarest, 1822) Red Kangaroo	(2), (3), (4), 5, 6, 7, 8	C
Onychogalea lunata (Gould, 1840) Crescent Nailtail Wallaby	(8)	X
Petrogale lateralis (Gould, 1842) Black-footed Rock-wallaby	4 (Pearson Is), 8	E **
Petrogale xanthopus (Gray, 1854) Yellow-footed Rock-wallaby	5, 6, (7), 8	C
Potorous tridactylus (Kerr, 1792) Long-nosed Potoroo	(1?)	X
Thylogale billardierii (Desmarest, 1822) Tasmanian Pademelon	(1)	X

NAME	DISTRIBUTION	STATUS
PHASCOLARCTIDAE - KOALA		
Phascolarctos cinereus (Goldfuss, 1817) Koala	1, 3 (re-introduced mainland, introduced Kangaroo Is)	X
THYLACOMYIDAE - BILBIES		
Macrotis lagotis (Reid, 1836) Rabbit Bandicoot, Greater Bilby, Dalgyte	2, 3, 5, 7, 8	X
Macrotis leucura (Thomas, 1887) Lesser Bilby	8	X
VOMBATIDAE - WOMBATS		
Lasiorhinus latifrons (Owen, 1845) Hairy-nosed Wombat	2, 3, 4, 6, 7	C
Vombatus ursinus (Shaw, 1800) Common Wombat	1, 2	V *
RODENTIA - RODENTS		
MURIDAE - RATS AND MICE		
Conilurus albipes (Lichtenstein, 1829) White-footed Rabbit-rat or Rabbit-eared Tree-rat	(3?)	X
Hydromys chrysogaster (Geoffroy, 1804) Water Rat	1, 2, 3, 4, 8	C
Leggadina forresti (Thomas, 1906) Forrest's Mouse	6, 7, 8	R *
Leporillus apicalis (Gould, 1851) Lesser Stick-nest Rat	8	X
Leporillus conditor (Sturt, 1849) Greater Stick-nest Rat	4, 7, 8	E **
Notomys alexis (Thomas, 1922) Spinifex Hopping-mouse	7, 8	C
Notomys cervinus (Gould, 1851) Fawn Hopping-mouse	7, 8	C

NAME	DISTRIBUTION	STATUS
Notomys fuscus (Wood Jones, 1925) Dusky Hopping-mouse	7, 8	R **
Notomys mitchellii (Ogilby, 1841) Mitchell's Hopping-mouse	2, 4, 7, 8	R **
Pseudomys apodemoides (Finlayson, 1932) Silky Mouse (Ashy-grey Mouse)	1, 2	C
Pseudomys balami (Troughton, 1932)	4, 5, 7	K
Pseudomys australis (Gray, 1832) Plains Mouse (Plains Rat)	(2), 7, 8	R *
Pseudomys desertor (Troughton, 1932) Desert Mouse (Brown Desert Mouse)	8	E **
Pseudomys hermannsburgensis (Waite, 1896) - Sandy Inland Mouse	5, 7, 8	C
Rattus fuscipes (Waterhouse, 1839) Bush Rat	1, 3, 4	C
Rattus lutreolus (Gray, 1841) Swamp Rat	1, 2, 3	C
Rattus tunneyi (Thomas, 1904) Pale Field-Rat (Tunney's Rat)	(4?)	X
Rattus villosissimus (Waite, 1897) Long-haired Rat (Plague Rat)	(5), 8	R *
MYRMECOBIIDAE - NUMBAT		
Myrmecobius fasciatus (Waterhouse, 1836) Numbat	2?, 8	X
NOTORYCTIDAE - MARSUPIAL MOLE		
Notoryctes typhlops (Stirling, 1889) Marsupial Mole	7, 8	R *
PERAMELIDAE - BANDICOOTS		
Chaeropus ecaudatus (Ogilby, 1838) Pig-footed Bandicoot	(2), (7), 8	X
Isoodon auratus (Ramsay, 1887) Golden Bandicoot	8	X
Isoodon obesulus (Shaw, 1797) Southern Brown Bandicoot	1, 3, 4 (Nuyts Archipelago)	V **

NAME	DISTRIBUTION	STATUS
Perameles bougainville (Quoy and Gaimard, 1824) - Western Barred Bandicoot	(2), (3), 7, 8	X
Perameles eremiana (Spencer, 1897) Desert Bandicoot	7, 8	X
Perameles gunnii (Gray, 1838) Eastern Barred Bandicoot	1, 2	X
PETAURIDAE - GLIDERS AND RINGTAILS		
Petaurus australis (Shaw, 1791) Yellow-bellied Glider	(1)	E *
Petaurus breviceps (Waterhouse, 1839) Sugar Glider	1, 2	E *
Petaurus norfolcensis (Kerr, 1792) Squirrel Glider	2	X
Pseudocheirus peregrinus (Boddaert, 1785) - Common Ringtail	1, 2, 3 (intro. Kangaroo Is)	C
PHALANGERIDAE - BRUSHTAILS		
Trichosurus vulpecula (Kerr, 1792) Common Brushtail	1, 2, 3, 4, (6), 7, 8	C
CHIROPTERA - BATS		
PTEROPODIDAE - FRUIT BATS		
Pteropus scapulatus (Peters, 1862) Little Red Flying-fox	3, 6, 8	R *
EMBALLONURIDAE - SHEATHTAIL BATS		
Saccolaimus flaviventris (Peters, 1866) Yellow-bellied Sheathtail Bat	(1), 2, 3, 8	R *
Taphozous georgianus (Thomas, 1915) Common Sheathtail Bat	(7), (8)	E *
MEGADERMATIDAE - GHOST BAT		
Macroderma gigas (Dobson, 1880) Ghost Bat	(8)	X

NAME	DISTRIBUTION	STATUS
MOLOSSIDAE - MASTIFF BATS		
Mormopterus planiceps (Peters, 1866) Flat-headed Mastiff-Bat	1, 2, 3, 4, 5, 6, 7, 8	C
Tadarida australis (Gray, 1838) White-striped Mastiff-Bat	1, 2, 3, 4, 5, 6, 7, 8	C
VESPERTILIONIDAE - VESPER BATS		
Chalinolobus gouldii (Gray, 1841) Gould's Wattled Bat	1, 2, 3, 4, 5, 6, 7, 8	C
Chalinolobus morio (Gray, 1841) Chocolate Wattled Bat	1, 2, 3, 4, (5), 6, 7, (8)	C
Chalinolobus picatus (Gould, 1852) Little Pied Bat	5	R *
Eptesicus pumilus (Gray, 1841) Little Cave Eptesicus	6, (7), (8)	C
Eptesicus regulus (Thomas, 1906) King River Eptesicus	(1), (2), (3)	K
Eptesicus sagittula (McKean, Richards and Price, 1978) - Large Forest Eptesicus	(1), (2), 3	R *
Eptesicus vulturnus (Thomas, 1914) Little Forest Eptesicus	(1), (2), 3, (4), (5), (6), (7), (8)	C
Miniopterus schreibersii (Kuhl, 1819) Bent-winged Bat	1, (2), 3, 4	R *
Myotis adversus (Horsfield, 1824) Large-footed Mouse-eared Bat (Large-footed Myotis)	(1)	E *
Nycticeius balstoni (Thomas, 1906) Western Broad-nosed Bat	(2), (3), (5)	K
Nycticeius greyii (Gray, 1844) Little Broad-nosed Bat	(1), 2, 3, (4), (5), 6, 7, 8	C
Nyctophilus geoffroyi (Leach, 1821) Lesser Long-eared Bat	1, 2, 3, 4, 5, 6, 7, 8	C
Nyctophilus gouldi (Tomes, 1858) Gould's Long-eared Bat	(1?)	R *
Nyctophilus timoriensis (Geoffroy, 1806) Greater Long-eared Bat	4, 5, 7	R *

NAME	DISTRIBUTION	STATUS
PINNIPEDIA - SEALS AND SEA-LIONS		
OTARIIDAE - EARED SEALS		
Arctocephalus forsteri (Lesson, 1828) New Zealand Fur-seal	3 (Kang. Is), 4 (Sth. Neptune Is)	V *
Arctocephalus pusillus (Schreber, 1776) South African Fur-seal (Australian Fur-seal)	1, 2, 3, 4	K
Neophoca cinerea (Peron and Le Sueur, 1816) - Australian Sea-lion	1, 2, 3, 4	V *
PHOCIDAE - EARLESS SEALS		
Hydrurga leptonyx (Blainville, 1820) Leopard Seal	3	K *
Leptonychotes weddelli (Lesson, 1826) Weddell Seal	3	K *
Lobodon carcinophagus (Hombron and Jacquinot, 1842) - Crab-eater Seal	1, 4	K *
Mirounga leionina (Linnaeus, 1758) Southern Elephant Seal	(3)	K *
Ommatophoca rossi (Gray, 1844) Ross Seal	(1)	K *
CETACEA - WHALES AND DOLPHINS		
BALAENIDAE - RIGHT WHALES		
Balaena glacialis (Muller, 1776) Right Whale	1, (2), (3), (4), (7)	E **
Caperea marginata (Gray, 1846) Pygmy Right Whale	2, 3 (Kangaroo Is.)	R *
BALAENOPTERIDAE - RORQUALS		
Balaenoptera acutorostrata (Lacepede, 1804) - Minke Whale (Piked Whale)		K
Balaenoptera edeni (Anderson, 1878) Bryde's Whale (Tropical Whale)	3 (Kang. Is.)	K
Balaenoptera musculus (Linnaeus, 1758) Blue Whale	1	E **

NAME	DISTRIBUTION	STATUS
Balaenoptera physalus (Linnaeus, 1758) Fin Whale	(3)	V **
Megaptera novaeangliae (Borowski, 1781) Humpback Whale	Locality unknown	E **
DELPHINIDAE - KILLER WHALES AND DOLPHINS		
Delphinus delphis (Linnaeus, 1758) Common Dolphin	1, 2, 3, 4	C
Globicephala melaena (Traill, 1809) Pilot Whale	1, 3, 4	K
Grampus griseus (Cuvier, 1812) Risso's Dolphin	4	K
Orcinus orca (Linnaeus, 1758) Killer Whale	(4)	K
Pseudorca crassidens (Owen, 1846) False Killer Whale	4	K
Tursiops truncatus (Montagu, 1821) Bottle-nosed Dolphin	1, 2, 3, 4	C
PHYSETERIDAE - SPERM WHALES		
Kogia breviceps (Blainville, 1838) Pygmy Sperm Whale	2, 3, 4	K *
Kogia simus (Owen, 1866) Dwarf Sperm Whale	3	K *
Physeter macrocephalus (Linnaeus, 1758) Sperm Whale	1, 3, 4	K
ZIPHIIDAE - BEAKED WHALES		
Berardius arnouxi (Duvernoy, 1851) Arnoux's Beaked Whale	(4)	K
Hyperoodon planifrons (Flower, 1882) Southern Bottle-nosed Whale	(3), 4	K
Mesoplodon bowdoini (Andrews, 1908) Andrews' Beaked Whale	3	K
Mesoplodon grayi (Von Haast, 1876) Gray's Beaked Whale	1, 2, 3	K
Mesoplodon layardi (Gray, 1865) Strap-toothed Whale	3, 4	K

NAME	DISTRIBUTION	STATUS
Tasmacetus shepherdi (Oliver, 1937) Shepherd's Beaked Whale (Tasman Whale)	(1)	K
Ziphius cavirostris (Cuvier, 1823) Cuvier's Beaked Whale	3	K

INTRODUCED MAMMALS HAVING ESTABLISHED FERAL BREEDING POPULATIONS

LAGOMORPHA - PIKAS, HARES AND RABBITS

LEPORIDAE - HARES AND RABBITS

Lepus capensis (Linnaeus, 1758) Brown Hare	(1), 2, 3 (not Kang Is.), (4), (5), (6), (7)	
Oryctolagus cuniculus (Lilljeborg, 1874) - Rabbit	1, 2, 3 (not Kang Is.), 4, 5, (6), 7, (8)	

CARNIVORA - CARNIVORES

CANIDAE - DOGS, FOXES, WOLVES

Canis familiaris (Linnaeus, 1758) Dog	1, 2, (4), 5, 6, 7, 8	
Canis familiaris dingo (Blumenbach, 1780) - Dingo	1, 2, (4), 5, 6, 7, 8	
Vulpes vulpes (Linnaeus, 1758) Fox (Red Fox)	1, 2, 3 (ex. Kang. Is.), 4, 5, 6, 7, 8	

FELIDAE - CATS

Felis catus (Linnaeus, 1758) Cat	(1), (2), 3, 4, (5), 6, (7), (8)	

PERISSODACTYLA - ODD-TOED UNGULATES

HORSES AND DONKEYS

Equus asinus (Linnaeus, 1758) Donkey	(6), (8)	
Equus caballus (Linnaeus, 1758) Horse	(4), (5), (7), (8)	

ARTIODACTYLA - EVEN-TOED UNGULATES

CAMELIDAE - CAMELS

Camelus dromedarius (Linnaeus, 1758) Arabian Camel	(4), (7), (8)	

NAME	DISTRIBUTION	STATUS
BOVIDAE - CATTLE, SHEEP AND GOATS		
Bos taurus (Linnaeus, 1766) Cattle	(1), (4), (8)	
Capra hircus (Linnaeus, 1758) Goat	(2), (3), (4), (5), 6, (7), (8)	
Ovis aries (Linnaeus, 1758) Sheep	4 (Waldegrave & Reevesby Is.)	
CERVIDAE - TRUE DEER		
Cervus dama (Linnaeus, 1758) Fallow Deer	(1), (3), (4)	
Cervus elaphus (Linnaeus, 1758) Red Deer	(1)	
SUIDAE - PIGS		
Sus scrofa (Linnaeus, 1758) Pig	(2), (3), (5), (8)	
RODENTIA		
MURIDAE - RATS AND MICE		
Mus musculus (Linnaeus, 1758) House Mouse	1, 2, 3, 4, 5, 6, 7, 8	
Rattus norvegicus (Berkenhaut, 1769) Brown Rat, Sewer Rat, Norway Rat	3	
Rattus rattus (Linnaeus, 1758) Black Rat, Ship Rat	1, 2, 3, 4	

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APPENDIX 13: BIRDS

NAME	DISTRIBUTION	STATUS
STRUTHIONIFORMES - CASSOWARIES AND EMUS		
Dromaius novaehollandiae - Emu	1,2,3(mainland, introduced KI) 4,5, 6,7,8	C
Dromaius baudinianus - Kangaroo Island Emu	3(KI) Extinct	X
PODICIPEDIFORMES - GREBES		
Podiceps cristatus - Great Crested Grebe	1,2,3,4,8,	R
Poliocephalus poliocephalus - Hoary-headed Grebe	1,2,3,4,5,6,7,8	C
Tachybaptus novaehollandiae- Australasian Grebe	1,2,3,4,5,6,7,8	C
SPHENISCIFORMES - PENGUINS		
Eudyptes chrysocome - Rockhopper Penguin	O	O
Eudyptes pachyrhynchus - Fiordland Penguin	O	O
Eudyptes robustus - Snares Penguin	O	O
Eudyptes sclateri - Erect-crested Penguin	O	O
Eudyptes chrysolophus - Royal (Macaroni) Penguin	O	O
Eudyptula minor - Little Penguin	1,2,3,4,(offshore and coast)(7)	C
PROCELLARIIFORMES - OCEANIC BIRDS		
Diomedea exulans - Wandering Albatross	O	U
Diomedea epomophora - Royal Albatross	O	O
Diomedea melanophrys - Black-browed Albatross	1,2,3,4,(offshore);7,O	C
Diomedea bulleri - Buller's Albatross	O	O

NAME	DISTRIBUTION	STATUS
Diomedea chrysostoma - Grey-headed Albatross	0	0
Diomedea chlororhynchos - Yellow-nosed Albatross	1,2,3,4,(offshore); 0	C,(W)
Diomedea cauta - Shy Albatross	1,2,3,4,(offshore); 0	C
Phoebetria fusca - Sooty Albatross	0	0
Phoebetria palpebrata - Light-mantled Sooty Albatross	0	0
Macronectes giganteus - Southern Giant-Petrel	1,2,3,4,(offshore); 0,	C,(W)
Macronectes halli - Northern Giant-Petrel	1,2,3,4,(offshore); 0	U,(W)
Fulmarus glacialoides - Southern Fulmar	1,2,3,4,(offshore); 0	U,(W)
Thalassoica antarctica - Antarctic Petrel	0	0
Daption capense - Cape Petrel	1,2,3,4,(offshore); 0	C,(W)
Pterodroma macroptera - Great-winged Petrel	0	U
Pterodroma lessoni - White-headed Petrel	0	U
Pterodroma brevirostris - Kerguelen Petrel	0	0
Pterodroma mollis - Soft-plumaged Petrel	0	0
Pterodroma inexpectata - Mottled Petrel	0	0
Pterodroma leucoptera - Gould's Petrel	0	0
Halobaena caerulea - Blue Petrel	0	0
Pachyptila turtur - Fairy Prion	1,2,3,4,(offshore); 0	C
Pachyptila belcheri -Slender-billed Prion	0	U,(W)
Pachyptila vittata - Broad-billed Prion	0	C,(W)
Pagodroma nivea - Snow Petrel	3 (offshore)	0

NAME	DISTRIBUTION	STATUS
Procellaria cinerea - Grey Petrel	O	O
Procellaria aequinoctialis - White-chinned Petrel	O	O
Puffinus carneipes - Fleshy-footed Shearwater	1,2,3,4,(offshore)	K,(S)
Puffinus griseus - Sooty Shearwater	1,2,3,4,(offshore); O	O
Puffinus tenuirostris - Short-tailed Shearwater	1,2,3,4,(offshore); O	C,(S)
Puffinus puffinus		
a) Puffinus puffinus puffinus - Manx Shearwater	O	O
b) Puffinus puffinus gavia - Fluttering Shearwater	1,2,3,4,(offshore)	C
c) Puffinus puffinus huttoni - Hutton's Shearwater	1,2,3,4,(offshore)	U
Puffinus assimilis - Little Shearwater	O	O
Oceanites oceanicus - Wilson's Storm-Petrel	1,2,3,4,(offshore); O	C,(W)
Oceanites nereis - Grey-backed Storm-Petrel	O	O
Pelagodroma marina - White-faced Storm-Petrel	1,2,3,4,(offshore); O	C,(S)
Pelecanoides urinatrix - Common Diving-Petrel	1,2,3,4,(offshore)	O
PELECANIFORMES PELICANS, CORMORANTS AND SHAGS, GANNETS		
Pelecanus conspicillatus - Australian Pelican	1,2,3,4,5,6,7,8	C
Sula serrator - Australasian Gannet	1,2,3,4,(offshore)	C
Anhinga melanogaster - Darter	2,3,4,5,8	R
Leucocarbo fuscescens - Black-faced Shag	1,2,3,4,(offshore and coast)	C
Phalacrocorax carbo - Great Cormorant	1,2,3,4,5,6,7,8	C
Phalacrocorax varius - Pied Cormorant	1,2,3,4,5,6,7,8	C

NAME	DISTRIBUTION	STATUS
Phalacrocorax sulcirostris - Little Black Cormorant	1,2,3,4,5,6,7,8	C
Phalacrocorax melanoleucos - Little Pied Comorant	1,2,3,4,5,6,7,8	C
Phaethon rubricauda - Red-tailed Tropic bird	1,2,3,4,(offshore); O	O
ARDEIFORMES HERONS, BITTERNS, STORKS, IBISES, SPOONBILLS		
Ardea pacifica - Pacific Heron	1,2,3,4,5,6,7,8	C
Ardea novaehollandiae - White-faced Heron	1,2,3,4,5,6,7,8	C
Ardea picata - Pied Heron	8	O
Ardea alba - Great Egret	1,2,3,4,5,6,7,8	C
Ardea garzetta - Little Egret	1,2,4b,8	V
Ardea intermedia - Intermediate Egret	1,2,4b,8	R
Ardea sacra - Eastern Reef Egret	1,3,4, (coast)	R
Bubulcus ibis - Cattle Egret	1,2,3,7,8	U
Nycticorax caledonicus - Rufous Night Heron	1,2,3,4,5,6,8	U/loc V
Ixobrychus minutus - Little Bittern	1,2,4,6	E,(S)
Botaurus poiciloptilus - Australasian or Brown Bittern	1,2,3(KI),4	V
Plegadis falcinellus - Glossy Ibis	1,2,3,4,6,7,8	R
Threskiornis aethiopicus - Sacred Ibis	1,2,3,4,6,8	C
Threskiornis spinicollis - Straw-necked Ibis	1,2,3,4,5,6,7,8	C
Platalea regia - Royal Spoonbill	1,2,3,4,7,8	C
Platalea flavipes - Yellow-billed Spoonbill	1,2,3,4,5,6,7,8	C
ANSERIFORMES - DUCKS, GEESE, and SWANS		
Anseranas semipalmata - Magpie Goose	1,2,3(KI),4b,8 (re-introduced to Bool Lagoon Game Reserve)	X

NAME	DISTRIBUTION	STATUS
Dendrocygna eytoni - Plumed Whistling-Duck	1,2,4b,5,8	R,(S) ~
Cygnus atratus - Black Swan	1,2,3,4,5,6,7,8	C ~
Stictonetta naevosa - Freckled Duck	1,2,3(KI),4a,7,8	V ~
Cereopsis novaehollandiae - Cape Barren Goose	1,2,3,4	V ~
Tadorna tadornoides - Australasian Shelduck or Mountain Duck	1,2,3,4,5,6,7,8	C ~
Anas superciliosa - Pacific Black Duck	1,2,3,4,5,6,7,8	C ~
Anas gracilis - Australasian Grey Teal	1,2,3,4,5,6,7,8	C ~
Anas castanea - Chestnut Teal	1,2,3,4,5,6,7,8	C ~
Anas clypeata - Northern Shoveler	8	O ~
Anas rhynchotis - Australasian or Blue-winged Shoveler	1,2,3,4,5,6,7,8	R ~
Malacorhynchus membranaceus - Pink-eared Duck	1,2,3,4,5,6,7,8	C ~
Aythya australis - Hardhead	1,2,3,4,5,6,7,8	U ~
Chenonetta jubata - Maned Duck	1,2,3,4,5,6,7,8	C ~
Oxyura australis - Blue-billed Duck	1,2,3,4,5,6,7,8	R ~
Biziura lobata - Musk Duck	1,2,3,4,5,6,7,8	C/loc V ~
FALCONIFORMES - BIRDS OF PREY		
Pandion haliaetus - Osprey	1,2,3,4, (coast)	R/loc E ~
Elanus caeruleus - Black-shouldered Kite	1,2,3,4,5,6,7,8	C
Elanus scriptus - Letter-winged Kite	1,2,3,4,5,6,7,8,mainly 8	R
Milvus migrans - Black Kite	1,2,4,5,6,7,8	C
Lophoictinia isura - Square-tailed Kite	1,2,3,4,7 (Null. Pl.)	V,(S)
Hamirostra melanosternon - Black-breasted Kite	6,7,8	R
Haliastur sphenurus - Whistling Kite	1,2,3,4,5,6,7,8	C
Accipiter fasciatus - Brown Goshawk	1,2,3,4,5,6,7,8	C
Accipiter cirrhocephalus - Collared Sparrowhawk	1,2,3,4,5,6,7,8	C

NAME	DISTRIBUTION	STATUS
Accipiter novaehollandiae - Grey Goshawk	1,2,3,4b	O
Haliaeetus leucogaster - White-bellied Sea-Eagle	1,2,3,4, (coast)	U/loc V
Aquila audax - Wedge-tailed Eagle	1,2,3,4,5,6,7,8	C
Hieraaetus morphnoides - Little Eagle	1,2,3,4,5,6,7,8	C
Circus assimilis - Spotted Harrier	1,2,3,4,5,6,7,8, (mainly 5,6,7,8)	C
Circus approximans - Marsh Harrier	1,2,3,4,6,7,8, (mainly 1,2,3,4)	C
Falco subniger - Black Falcon	Mainly 1,2,3,4,5,6,7,8	U
Falco peregrinus - Peregrine Falcon	1,2,3,4,5,6,7,8	R
Falco longipennis - Australian Hobby	1,2,3,4,5,6,7,8	U
Falco hypoleucos - Grey Falcon	2,3,4b,5,6,7,8	V
Falco berigora - Brown Falcon	1,2,3,4,5,6,7,8	C
Falco cenchroides - Australian Kestrel	1,2,3,4,5,6,7,8	C
GALLIFORMES - FOWLS, PHEASANTS, MOUND BUILDERS AND QUAILS		
Leipoa ocellata - Malleefowl	1,2,4,5,7,8 (unsuccessfully introduced to KI)	V
Coturnix novaezelandiae - Stubble Quail	1,2,3,4,5,6,7,8	C,(S)
Coturnix ypsilophore - Brown Quail	1,2,3,4b,8	V
Coturnix chinensis - King Quail	1,3, 4	X
GRUIFORMES - BUTTON QUAILS, RAILS, CRAKES, BUSTARDS AND CRANES		
Turnix varia - Painted Button-quail	1,2,3,4,5,7	V
Turnix velox - Little Button-quail	1,2,3,4,5,6,7,8	C,(S),
Turnix pyrrhothorax - Red-chested Button-quail	1,2,3,4b,8	R,(S)
Pedionomus torquatus - Plains-wanderer	2,3,4,5,6,7,8	R

NAME	DISTRIBUTION	STATUS
Gallirallus philippensis - Buff-banded Rail	1,2,3,4,7,8	U
Rallus pectoralis - Lewin's Rail	1,2,3,4	R
Porzana pusilla - Baillon's Crake	1,2,3,4b,8	R,(S)
Porzana fluminea - Australian Spotted Crake	1,2,3,4,6,7,8	C
Porzana tabuensis - Spotless Crake	1,2,3,4b,7,8	C
Gallinula ventralis - Black-tailed Native-hen	1,2,3,4,5,6,7,8	C
Gallinula tenebrosa - Dusky Moorhen	1,2,3,4,8	C
Porphyrio porphyrio - Purple Swamphen	1,2,3,4,5,7,8	C
Fulica atra - Common Coot	1,2,3,4,5,6,7,8	C
Grus rubicundus - Brolga	1,2,3,4b,5,6,8	V
Ardeotis australis - Australian Bustard	1,2,4,5,6,7,8	V
CHARADRIIFORMES - WADERS, GULLS AND TERNS		
Burhinus grallarius - Bush Thick-Knee or Southern Stone Curlew	1,2,3,4,6,7,8	E
Rostratula benghalensis - Painted Snipe	1,2,3,4b,5,6	V
Haematopus fuliginosus - Sooty oystercatcher	1,2,3,4 (coast), 7	C
Haematopus ostralegus - Pied Oystercatcher	1,2,3,4, (coast)	C
Vanellus miles - Masked Lapwing	1,2,3,4,5,6,7,8	C
Vanellus tricolor - Banded Lapwing	1,2,3,4,5,6,7,8	C
Pluvialis squatarola - Grey Plover	1,2,3,4, (coast); River Murray	C,(S)
Pluvialis dominica - Lesser Golden Plover	1,2,3,4, (coast); 8	C,(S)
Erythrogonys cinctus - Red-kneed Plover	1,2,3,4,5,6,7,8	C
Charadrius rubricollis - Hooded Plover	1,2,3,4, (coast)	R
Charadrius dubius - Little Ringed Plover	1,4b	O
Charadrius hiaticula - Ringed Plover	4b	O

NAME	DISTRIBUTION	STATUS
Charadrius mongolus - Mongolian Plover	1,2,4, (coast); 8	U,(S)
Charadrius bicinctus - Double-banded Plover	1,2,3,4, (coast), River Murray	C,(W)
Charadrius leschenaultii - Large-billed Sand Plover	1,2,3,4, (coast), River Murray	U,(S)
Charadrius veredus - Oriental Plover	1,2,4,7,8	U, (S)
Charadrius ruficapillus - Red-capped Plover	1,2,3,4,5,6,7,8	C
Erythrogonys melanops - Black-fronted Plover	1,2,3,4,5,6,7,8	C
Peltohyas australis - Inland Dotterel	2,3,4,5,6,7,8	U
Himantopus leucocephalus - Black-winged Stilt	1,2,3,4,5,6,7,8	C
Cladorhynchus leucocephalus - Banded Stilt	1,2,3,4,5,7,8	C
Recurvirostra novaehollandiae - Red-necked Avocet	1,2,3,4,5,6,7,8	C
Arenaria interpres - Ruddy Turnstone	1,2,3,4 (coast)	C,(S)
Numenius madagascariensis - Eastern Curlew	1,2,3,4 (coast)	V,(S)
Numenius phaeopus - Whimbrel	1,2,3,4 (coast); 8	R,(S)
Numenius minutus - Little Curlew	2,3,4b,8	O
Tringa glareola - Wood Sandpiper	1,2,3,4,6,8	U,(S)
Tringa brevipes - Grey-tailed Tattler	1,2,3,4 (coast), 8	U,(S)
Tringa hypoleucos - Common Sandpiper	1,2,3,4,7,8	C,(S)
Tringa nebularia - Greenshank	1,2,3,4,6,7,8	C,(S)
Tringa totanus - Redshank	4b	O
Tringa stagnatilis - Marsh Sandpiper	1,2,4,5,7,8	U,(S)
Xenus cinereus - Terek Sandpiper	1,2,4, (coast), 8	U,(S)
Gallinago hardwickii - Latham's Snipe	1,2,3,4,5,6,7,8	V,(S)
Limosa limosa - Black-tailed Godwit	1,2,3,4, (coast), 8 River Murray	U,(S)
Limosa lapponica - Bar-tailed Godwit	1,2,3,4, (coast), 7	C,(S)

NAME	DISTRIBUTION	STATUS
Calidris canutus - Red Knot	1,2,3,4, (coast), 8	C,(S)
Calidris tenuirostris - Great Knot	1,2,4 (coast)	C,(S)
Calidris acuminata - Sharp-tailed Sandpiper	1,2,3,4,5,6,7,8	C,(S)
Calidris melanotos - Pectoral Sandpiper	1,2,4b, Lower Murray, 8	U,(S)
Calidris paramelanotus - Cox's Sandpiper	2,4b	O
Calidris ruficollis - Red-necked Stint	1,2,3,4,5,6,7,8	C,(S)
Calidris subminuta - Long-toed Stint	1,2,4, River Murray, 8	U,(S)
Calidris minuta - Little Stint	4b	O
Calidris ferruginea - Curlew Sandpiper	1,2,3,4,5,6,7,8	C,(S)
Calidris alba - Sanderling	1,2,3,4, (coast), 7	R,(S)
Limicola falcinellus - Broad-billed Sandpiper	4b	O
Philomachus pugnax - Ruff	1,2,4b	U,(S)
Phalaropus lobatus - Red-necked Phalarope	2,4a,Lake Alexandrina	O
Glareola maldivarum - Oriental Pratincole	2,3,5,7 (Null. Pl.), 8	O
Stiltia isabella - Australian Pratincole	1,2,3,4, Mainly 5,6,7,8	C
Catharacta antartica - Great Skua	1,2,3,4, (offshore); O	U,(W)
Catharacta maccormicki - South Polar Skua	4, (offshore)	O
Stercorarius parasiticus - Arctic Jaeger	1,3,4, (offshore); O	U,(S)
Stercorarius pomarinus - Pomarine Jaeger	1,3,4, (offshore); O	U,(S)
Stercorarius longicauds - Long-tailed Jaeger	1, (offshore)	O
Larus novaehollandiae - Silver Gull	1,2,3,4,5,6,7,8	C
Larus pacificus - Pacific Gull	1,2,3,4, (coast)	C
Larus dominicanus - Kelp Gull	1,2,3,4, (coast)	R
Chlidonias hybridus - Whiskered Tern	1,2,3,4,5,6,7,8	C
Chlidonias leucopterus - White-winged Black Tern	1,2,4b, Lower Murray	R,(S)

NAME	DISTRIBUTION	STATUS
Gelochelidon nilotica - Gull-billed Tern	1,2,4,7,8	U ~
Hydroprogne caspia - Caspian Tern	1,2,3,4,6,7,8	C ~
Sterna hirundo - Common Tern	1,2,3,4, (coast)	U,(S)
Sterna paradisaea - Arctic Tern	2,4, (offshore); 0	O
Sterna vittata - Antarctic Tern	0,3, (offshore)	O
Sterna striata - White-fronted Tern	1,2,3,4,(offshore)	U,(W)
Sterna fuscata - Sooty Tern	1,2,3,4,(offshore); 0	O
Sterna anaethetus - Bridled Tern	1,4, (offshore); 0	O
Sterna albifrons - Little Tern	2,4, (coast)	E
Sterna nereis - Fairy Tern	1,2,3,4, (coast)	V
Thalasseus bergii - Crested Tern	1,2,3,4, (offshore); 7	C
COLUMBIFORMES - DOVES AND PIGEONS		
Geopelia placida - Peaceful Dove	1,2,3,4,5,6,8	C/loc E
Geopelia cuneata - Diamond Dove	2,3,4,5,6,7,8	C
Phaps chalcoptera - Common Bronzewing	1,2,3,4,5,6,7,8	C
Phaps elegans - Brush Bronzewing	1,2,3,4	C
Phaps histrionica - Flock Bronzewing	8	R
Ocyphaps lophotes - Crested Pigeon	1,2,3,4,5,6,7,8	C
Geophaps plumifera - Spinifex Pigeon	8	V
PSITTACIFORMES - PARROTS AND COCKATOOS		
Calyptorhynchus magnificus - Red-tailed Black-Cockatoo	1,2,8	E
Calyptorhynchus lathami - Glossy Black-Cockatoo	3	E
Calyptorhynchus funereus - Yellow-tailed Black-Cockatoo	1,2,3,4	V
Callocephalon fimbriatum - Gang-gang Cockatoo	1,3(KI) introduced	O
Cacatua roseicapilla - Galah	1,2,3,4,5,6,7,8	C
Cacatua tenuirostris - Long-billed Corella	1,2	C

NAME	DISTRIBUTION	STATUS
Cacatua sanguinea - Little Corella	2,3,4,5,6,7,8	C
Cacatua leadbeateri - Pink Cockatoo	2,4,5,6,7,8	V
Cacatua galerita - Sulphur-crested Cockatoo	1,2,3,4	C
Trichoglossus haematodus - Rainbow Lorikeet	1,2,3,4	C
Glossopsitta concinna - Musk Lorikeet	1,2,3,4	C
Glossopsitta porphyrocephala - Purple-crowned Lorikeet	1,2,3,4	C
Glossopsitta pusilla - Little Lorikeet	1,2,3,4b	V
Aprosmictus erythropterus - Red-winged Parrot	2,5,8	O
Polytelis anthopeplus - Regent Parrot	2	V
Polytelis alexandrae - Alexandra's Parrot	8	E
Nymphicus hollandicus - Cockatiel	1,2,3,4,5,6,7,8	C,(S)
Pezoporus wallicus - Ground Parrot	1,3,4b	X
Pezoporus occidentalis - Night Parrot	7,8	E
Melopsittacus undulatus - Budgerigar	1,2,3,4,5,6,7,8	C,(S)
Lathamus discolor - Swift Parrot	1,2,3	V,(W)
Platycercus elegans elegans - Crimson Rosella	1,3(KI)	C
Platycercus elegans adelaidae - 'Adelaide Rosella'	2,3,4b,6	C
Platycercus elegans flaveolus - Yellow Rosella	2	U
Platycercus eximius - Eastern Rosella	1,2,3,4b	C
Barnardius zonarius barnardi - Mallee Ringneck	2,4b(Probably escapee), 5,6,8	C
Barnardius zonarius - Ringnecked parrot	4a,7,8	C
Psephotus haematonotus - Red-rumped Parrot	1,2,3,4b,5, 6,8	C

NAME	DISTRIBUTION	STATUS
Psephotus varius - Mulga Parrot	Mainly 2,4,5,6,7,8	C
Northiella haematogaster - Blue Bonnet	2,4,5,7,8	C
Northiella narethae - Naretha Bluebonnet	7	V
Neophema bourkii - Bourke's Parrot	6,7,8	U
Neophema chrysostoma - Blue-winged Parrot	Mainly 1,2,4,8	V
Neophema elegans - Elegant Parrot	1,2,3,4,6	K
Neophema petrophila - Rock Parrot	1,2,3,4, (coast)	C
Neophema chrysogaster - Orange-bellied Parrot	1,2,4, Coorong	E,(W)
Neophema splendida - Scarlet-breasted Parrot	2,4,5,7	R
CUCULIFORMES - CUCKOOS		
Cuculus pallidus - Pallid Cuckoo	1,2,3,4,5,6,7,8	C,(S)
Cacomantis flabelliformis - Fan-tailed Cuckoo	1,2,3,4,5	C
Chrysococcyx osculans - Black-eared Cuckoo	1,2,4,5,6,7,8	U
Chrysococcyx basalis - Horsfield's Bronze-Cuckoo	1,2,3,4,5,6,7,8	C,(S)
Chrysococcyx lucidus - Shining Bronze-Cuckoo	1,2,3,4	R,(S)
Scythrops novaehollandiae - Channel-billed Cuckoo	8	O
STRIGIFORMES - OWLS		
Ninox strenua - Powerful Owl	1	O
Ninox novaeseelandiae - Southern Boobook	1,2,3,4,5,6,7,8	C
Ninox connivens - Barking Owl	1,6,3,4b,5,8	R/E loc
Tyto alba - Barn Owl	1,2,3,4,5,6,7,8	C
Tyto novaehollandiae - Masked Owl	1,2,3,4,5,6,7,8	E
Tyto capensis - Grass Owl	8	O

NAME	DISTRIBUTION	STATUS
CAPRIMULGIFORMES - NIGHTJARS AND FROGMOUTHS		
Podargus strigoides - Tawny Frogmouth	1,2,3,4,5,6,7,8	C
Aegotheles cristatus - Australian Owlet-nightjar	1,2,3,4,5,6,7,8	C
Eurostopodus argus - Spotted Nightjar	1,2,3,4,5,6,7,8	C/V loc
APODIFORMES - SWIFTS		
Hirundapus caudacutus - White-throated Needletail	1,2,3,4	C,(S)
Apus pacificus - Fork-tailed Swift (= spine-tailed Swift)	2,3,4	C,(S)
CORACIIFORMES - KINGFISHERS		
Ceyx azureus - Azure Kingfisher	1,3,4	E
Dacelo novaeguineae - Laughing Kookaburra	1,2,3,4	C
Halcyon pyrrhopygia - Red-backed Kingfisher	1,2,3,4, Mainly 5,6,7,8	C,(S)
Halcyon sancta - Sacred Kingfisher	1,2,3,4,5,6,8	C,(S)
Merops ornatus - Rainbow Bee-eater	1,2,3,4,5,6,7,8	C,(S)
Eurystomus orientalis - Dollarbird	1,2,3,4b,8	O
PASSERIFORMES - PERCHING BIRDS		
Mirafra javanica - Singing Bushlark	1,2,3,4,5,6,8	C
Cheramoeca leucosternum - White-backed Swallow	2,3,4,5,6,7,8	C
Hirundo rustica - Barn Swallow	3	O
Hirundo neoxena - Welcome Swallow	1,2,3,4,5,6,7,8	C
Hirundo nigricans - Tree Martin	1,2,3,4,5,6,7,8	C,(S)
Hirundo ariel - Fairy Martin	1,2,3,4,5,6,7,8	C,(S)
Motacilla cinerea - Grey Wagtail	3	O
Anthus novaeseelandiae - Richard's Pipit	1,2,3,4,5,6,7,8	C
Coracina novaehollandiae - Black-faced Cuckoo-shrike	1,2,3,4,5,6,7,8	C

NAME	DISTRIBUTION	STATUS
Coracina papuensis - White-bellied Cuckoo-shrike	1,2,3,4	R,(S)
Coracina tenuirostris - Cicadabird	3	O
Pteropodocys maxima - Ground Cuckoo-shrike	1,2,3,4,5,6,7,8	U
Lalage sueurii - White-winged Triller	1,2,3,4,5,6,7,8	C,(S)
Zoothera lunulata - Mountain Thrush	1,3	R
Drymodes brunneopygia - Southern Scrub-robin	1,2,4,5,6,7	C
Petroica rosea - Rose Robin	3,4	R,(W)
Petroica rodinogaster - Pink Robin	1,2	O
Petroica phoenicea - Flame Robin	1,2,3,4b,5	R,(W)
Petroica multicolor - Scarlet Robin	1,2,3,4	C
Petroica goodenovii - Red-capped Robin	1,2,3,4,5,6,7,8	C
Melanodryas cucullata - Hooded Robin	1,2,3,4,5,6,7,8	C
Eopsaltria australis - Eastern Yellow Robin	1, Coorong	V
Eopsaltria griseogularis - Western Yellow Robin	4a,7	C
Microeca leucophaea - Jacky Winter	1,2,3,4,5,6,7,8	C
Falcunculus frontatus - Crested Shrike-tit	1,2,3	U
Pachycephala olivacea - Olive Whistler	1, 2, Coorong	V
Pachycephala rufogularis - Red-lored Whistler	2,3	V
Pachycephala inornata - Gilbert's Whistler	1,2,4,5,6,7,8	R
Pachycephala pectoralis - Golden Whistler	1,2,3,4,6,7	C
Pachycephala rufiventris - Rufous Whistler	1,2,3,4,5,6,7,8	C
Colluricincla harmonica - Grey Shrike-thrush	1,2,3,4,5,6,7,8	C
Oreoica gutturalis - Crested Bellbird	1,2,4,5,6,7,8	C
Myiagra rubecula - Leaden Flycatcher	3	O

NAME	DISTRIBUTION	STATUS
Myiagra cyanoleuca - Satin Flycatcher	1,2,3,4,8	V,(S)
Myiagra inquieta - Restless Flycatcher	1,2,3,4,5,6,7,8	C
Rhipidura rufifrons - Rufous Fantail	1,2	O
Rhipidura fuliginosa - Grey Fantail	1,2,3,4,5,6,7,8	C,(S)
Rhipidura leucophrys - Willie Wagtail	1,2,3,4,5,6,7,8	C
Psophodes nigrogularis - Western Whipbird	2,3(KI),4a,4b	R
Psophodes cristatus - Chirruping Wedgebill	3,5,6,7,8	C
Psophodes occidentalis - Chiming Wedgebill	7,8	C
Cinclosoma punctatum - Spotted Quail-thrush	1,3	E
Cinclosoma castanotum - Chestnut Quail-thrush	2,4a,5,6,7,8	U/V loc
Cinclosoma cinnamomeum - Cinnamon Quail-thrush	5,7,8	C
Cinclosoma alisteri - Nullarbor Quail-thrush	7 (Null. Plain)	R
Pomatostomus temporalis - Grey-crowned Babbler	1,2,8	E
Pomatostomus superciliosus - White-browed Babbler	1,2,3,4,5,6,7,8	C
Pomatostomus ruficeps - Chestnut-crowned Babbler	2,5,6,7,8	C
Acrocephalus stentoreus - Clamorous Reed Warbler	1,2,3,4,5,6,8	C,(S)
Megalurus gramineus - Little Grassbird	1,2,3,4,5,6,7,8	C
Cisticola exilis - Golden-headed Fantail Warbler	1,2,3,4b	R/E loc
Cincloramphus mathewsi - Rufous Songlark	1,2,3,4,5,6,7,8	C,(S)
Cincloramphus cruralis - Brown Songlark	1,2,3,4,5,6,7,8	C,(S)

NAME	DISTRIBUTION	STATUS
Malurus cyaneus - Superb Blue Wren	1,2,3,4	C
Malurus splendens - Splendid Fairy-wren	2,4a,5,6,7,8	C
Malurus lamberti - Variegated Wren	1,2,4,5,6,7,8	C
Malurus leucopterus - White-winged Wren	2,4b,5,6,7,8	C
Malurus puchevrimus - Blue-breasted Wren	4a	V
Stipiturus ruficeps - Rufous-crowned Emu-wren	8	U
Stipiturus ruficeps mallee - Mallee Emu-wren	2	V
Stipiturus malachurus - Southern Emu-wren	1,2,3,4a	R/E loc
Amytornis striatus - Striated Grasswren	2,4,5,6,7,8	V
Amytornis goyderi - Eyrean Grasswren	8	C
Amytornis barbarus - Grey Grasswren	8	R
Amytornis textilis - Thick-billed Grasswren	4a,5,6,7,8	V
Amytornis purnelli - Dusky Grasswren	8	C
Dasyornis broadbenti - Rufous Bristlebird	1,2, Coorong	V
Sericornis frontalis - White-browed Scrubwren	1 Coorong	C
Sericornis maculatus - Spotted Scrubwren	2,4,7	C
Hylacola pyrrhopygia - Chestnut-rumped Hylacola	1,3	V
Hylacola cauta - Shy Heathwren or Hylacola	1,2,3(KI),4,5,6	C/V loc
Pyrrholaemus brunneus - Redthroat	2,3,4,5,6,7,8	R
Calamanthus fuliginosus - Eastern Fieldwren	1	U
Sericornis campestris - Western Calamanthus	2,3,4,5,6,7,8	C/E loc
Smicrornis brevirostris - Weebill	1,2,3,4,5,6,7,8	C
Gerygone fusca - Western Gerygone	3,4a,8	R

NAME	DISTRIBUTION	STATUS
Gerygone olivacea - White-throated Gerygone	1,2,3	R,(S)
Acanthiza pusilla - Brown Thornbill	1,2,3, Coorong, 3(KI)	C
Acanthiza apicalis - Inland Brown Thornbill	2,4,5,6,7,8	C
Acanthiza uropygialis - Chestnut-rumped Thornbill	2,3,4,5,6,7,8	C
Acanthiza robustirostris - Slate-backed Thornbill	8	U
Acanthiza reguloides - Buff-rumped Thornbill	1,2,3,4	C
Acanthiza iredalei - Samphire of Slender-billed Thornbill	1,2,3,4,5,6,7,8	V
Acanthiza chrysorrhoa - Yellow-rumped Thornbill	1,2,3,4,5,6,7,8	C
Acanthiza nana - Yellow Thornbill	2,3,4b,5,6	U
Acanthiza lineata - Striated Thornbill	1,2, Coorong, 3	C
Aphelocephala leucopsis - Southern Whiteface	1,2,3,4,5,6,7,8	U/E loc
Aphelocephala pectoralis - Chestnut-breasted Whiteface	7,8	V
Aphelocephala nigricincta - Banded Whiteface	7,8	R
Daphoenositta chrysoptera - Varied Sittella	1,2,3,4,5,6,7,8	C
Cormobates leucophaea - White-throated Treecreeper	1,2,3	C
Climacteris affinis - White-browed Treecreeper	2,4,5,6,7,8	R
Climacteris picumnus - Brown Treecreeper	1,2,3,4,5,6,	C
Climacteris rufa - Rufous Treecreeper	4a,7,8	R
Anthochaera carunculata - Red Wattlebird	1,2,3,4,5,6,7	C
Anthochaera chrysoptera - Little Wattlebird	1,2, Coorong,3,4b	C

NAME	DISTRIBUTION	STATUS
Acanthagenys rufogularis - Spiny-cheeked Honeyeater	1,2,3,4,5,6,7,8	C
Plectorhyncha lanceolata - Striped Honeyeater	2,4b,5	V
Philemon corniculatus - Noisy Friarbird	2,5,(Upper Murray)	O
Philemon citreogularis - Little Friarbird	1,2	R
Xanthomyza phrygia - Regent Honeyeater	1,3,4b,5	E
Entomyzon cyanotis - Blue-faced Honeyeater	1,2,3,	R
Manorina melanocephala - Noisy Miner	1,2,3,4b,5,Murray River	C
Manorina flavigula - Yellow-throated Miner	2,3,4,5,6,7,8	C
Manorina melanotis - Black-eared Miner	2	E
Meliphaga chrysops - Yellow-faced Honeyeater	1,2,3,4,6	C
Meliphaga virescens - Singing Honeyeater	1,2,3,4,5,6,7,8	C
Meliphaga leucotis - White-eared Honeyeater	1,2,3,4a,5,6,7,8 1,7,8	C
Meliphaga melanops - Yellow-tufted Honeyeater	1	O
Meliphaga cratitia - Purple-gaped Honeyeater	1,2,3,4	C/V loc
Meliphaga keartlandi - Grey-headed Honeyeater	8	K
Meliphaga ornata - Yellow-plumed Honeyeater	2,3,4,6,7	C/V loc
Meliphaga plumula - Grey-fronted Honeyeater	1,2,3,5,6,7,8	U
Meliphaga fuscus - Fuscous Honeyeater	1	R,(W)
Meliphaga penicillata - White-plumed Honeyeater	1,2,3,4,5,6,8	C
Melithreptus gularis - Black-chinned Honeyeater	1,2,3	R

NAME	DISTRIBUTION	STATUS
<u>Melithreptus brevirostris</u> - Brown-headed Honeyeater	1,2,3,4,5,6	C
<u>Melithreptus laetior</u> - White-naped Honeyeater	1,2,3,4,8	C
<u>Lichmera indistincta</u> - Brown Honeyeater	7,8	R,(S)
<u>Grantiella picta</u> - Painted Honeyeater	1,8	O
<u>Phylidonyris pyrrhoptera</u> - Crescent Honeyeater	3	C
<u>Phylidonyris novaehollandiae</u> - New Holland Honeyeater	1,2,3,4	C
<u>Phylidonyris albifrons</u> - White-fronted Honeyeater	1,2,3,4,5,6,7,8	C
<u>Phylidonyris melanops</u> - Tawny-crowned Honeyeater	1,2,3,4	C
<u>Conopophila whitei</u> - Grey Honeyeater	8	R
<u>Acanthorhynchus tenuirostris</u> - Eastern Spinebill	1,2,3	C
<u>Sugomel niger</u> - Black Honeyeater	2,3,4,5,6,7,8	R
<u>Certhionyx variegatus</u> - Pied Honeyeater	2,5,6,7,8	R
<u>Ephthianura tricolor</u> - Crimson Chat	2,3,4,5,6,7,8	C
<u>Ephthianura aurifrons</u> - Orange Chat	2,3,4,5,6,7,8	C
<u>Ephthianura crocea</u> - Yellow Chat	8	V
<u>Ephthianura albifrons</u> - White-fronted Chat	1,2,3,4b	C
<u>Ashbyia lovensis</u> - Gibberbird	2,6,8	U
<u>Dicaeum hirundinaceum</u> - Mistletoebird	1,2,3,4,5,6,7,8	C
<u>Pardalotus punctatus</u> - Spotted Pardalote	1,2,3,4	U
<u>Pardalotus xanthopygus</u> - Yellow-tailed Pardalote	1,2,3,4,6,5,6,7	C
<u>Pardalotus rubricatus</u> - Red-browed Pardalote	6,8	C
<u>Pardalotus striatus</u> - Striated Pardalote	1,2,3,4,5,6,7,8	C
<u>Zosterops lateralis</u> - Silvereye	1,2,3,4,5,6,7	C

NAME	DISTRIBUTION	STATUS
Aegintha temporalis - Red-browed Firetail or Finch	1,3	C
Emblema bellum -Beautiful Firetail	1,2 Coorong 3	R/E loc
Emblema pictum - Painted Firetail	4a, 6,7,8	R
Emblema guttatum - Diamond Firetail	1,2,3,4a,6	R/E loc
Poephila guttata - Zebra Finch	2,3,4,5,6,7,8	C/V loc
Oriolus sagittatus - Olive-backed Oriole	1,2,3,4	R
Dicrurus megarynchus - Spangled Drongo	3	O
Chlamydera maculata - Spotted Bowerbird	2	X
Chlamydera guttata - Western Bowerbird	8	R
Corcorax melanorhamphos - White-winged Chough	1,2,3,4,5	V
Struthidea cinerea - Apostlebird	1,2,4b,5	R/E loc
Grallina cyanoleuca - Magpie-lark	1,2,3,4,5,6,7,8	C
Artamus leucorhynchus - White-breasted Woodswallow	1,2,3,Mainly 5,6,7,8	C,(S)
Artamus personatus - Masked Woodswallow	1,2,3,4,5,6,7,8	C,(S)
Artamus superciliosus - White-browed Woodswallow	1,2,3,4,5,6,7,8	C,(S)
Artamus cinereus - Black-faced Woodswallow	2,3,(KI),4a,5,6,7,8	C
Artamus cyanopterus - Dusky Woodswallow	1,2,3,4,5,6,7,8	C
Artamus minor Little Woodswallow	2,5,6,7,8	R,(S)
Cracticus torquatus - Grey Butcherbird	1,2,4,5,6,7,8 (north west only)	C
Cracticus nigrogularis - Pied Butcherbird	2,8,Upper Muray	U
Gymnorhina tibicen - Australian Magpie		
Gymnorhina tibicen tibicen - Black-backed Magpie	1,2,3,4,5,6,7,8	C
Gymnorhina tibicen leuconota - White-backed Magpie	1,2,3,4,5,6,7,8	C
Strepera versicolor - Grey Currawong	1,2,3,4,5,6,7,8	U/E loc

NAME	DISTRIBUTION	STATUS
Corvus coronoides - Australian Raven	1,2,3,(KI),4a,5,6,7,8	C
Corvus tasmanicus - Forest Raven	1	C
Corvus mellori - Little Raven	1,2,3,4,5,6,7	C
Corvus bennetti - Little Crow	2,3,4,5,6,7,8	C
Corvus orru - Torresian Crow	8	C

INTRODUCED BIRD SPECIES BREEDING IN SOUTH AUSTRALIA

STRUTHIORUFORMES

Struthio camelus - Ostrich	2,7

ANSERIFORMES

Anas platyrhynchos - Mallard	1, 2, 3, 4, 6

GALLIFORMES

Alectura lathami - Australasian Brush-turkey	3(KI only)

COLUMBIFORMES

Columba livia - Feral Pigeon	1, 2, 3, 4, 5, 6, 7, 8
Streptopelia chinensis - Spotted Turtle-dove	1, 2, 3, 4

PASSERIFORMES

Alauda arvensis - Skylark	1, 2, 3, 4
Turdus merula - Blackbird	1, 2, 3, 4
Carduelis carduelis - Goldfinch	1, 3, 4b
Sturnus vulgaris - Common Starling	1,2,3,4,5,6,7,8
Acridotheres tristis - Common Myna	4b
Passer domesticus - House Sparrow	1,2,3,4,5,6,7,8

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APPENDIX 14: REPTILES AND AMPHIBIANS

NAME	DISTRIBUTION	STATUS
TESTUDINES - TURTLES AND TORTOISES		
CHELONIIDAE - SEA TURTLES		
Caretta caretta - Loggerhead Turtle	3, 4	K
Chelonia mydas - Green Turtle	1, 4	K
DERMOCHELYIDAE - LEATHERY TURTLE		
Dermochelys coriacea - Leathery (Luth) Turtle	3, 4	K
CHELIDAE - SIDE-NECKED TORTOISES		
Chelodina expansa - Broad-shelled River Turtle	2	K
Chelodina longicollis - Eastern Snake-necked Turtle (Long-necked Tortoise)	1, 2, 3, 4	K
Emydura sp. (Undescribed species)	8	K
Emydura macquarii - Murray Turtle	2, 3	K
SQUAMATA - LIZARDS AND SNAKES		
SAURIA - LIZARDS		
GEKKONIDAE - GECKOS		
Crenadactylus ocellatus - Clawless Gecko	8	K
Diplodactylus byrnei	2, 5, 6, 7, 8	K
Diplodactylus ciliaris - Spiny-tailed Gecko	4, 7, 8	K
Diplodactylus conspicillatus - Fat-tailed Diplodactylus (Fat-tailed Gecko)	(5), (6), 7, 8	K
Diplodactylus elderi - Jewelled Gecko	2, (3), 4, 5, 6, 7, 8	K
Diplodactylus galeatus	8	K
Diplodactylus granariensis	4, 7	K
Diplodactylus intermedius - Eastern Spiny-tailed Gecko	2, 3, 4, 5, 6, 7, 8	K

NAME	DISTRIBUTION	STATUS
Diplodactylus pulcher	7	K
Diplodactylus stenodactylus	4, (5), 6, 7, 8	K
Diplodactylus tessellatus - Tessellated Gecko	2, 4, 5, 6, 7, 8	K
Diplodactylus vittatus - Wood Gecko	1, 2, 3, 4, 5, 6, 7, 8	K
Diplodactylus williamsi	2, 5	K
Gehyra australis - Northern Dtella	(8)	K
Gehyra montium	(8)	K
Gehyra punctata - Spotted Dtella	8	K
Gehyra purpurascens	8	K
Gehyra variegata - Tree Dtella	2, 3, 4, 5, 6, 7, 8	K
Heteronotia binoei - Bynoe's Gecko	2, 3, 4, 5, 5, 6, 7, 8	K
Lucasium damaeum - Beaded Gecko	1, 2, (3), 4, 5, 6, 7, 8	K
Nephrurus deleani	7	K
Nephrurus laevissimus	4?, 7, 8	K
Nephrurus levis	2, 3, (4), 5, 6, 7, 8	K
Nephrurus stellatus	4, 7	K
Oedura marmorata - Marbled Velvet Gecko	(5), 6, (8)	K
Phyllodactylus marmoratus - Marbled Gecko	1, 2, 3, 4, (5), 6, 7	K
Rhynchoedura ornata - Beaked Gecko	2, 4, 5, 6, 7, 8	K
Underwoodisaurus milii - Thick-tailed Gecko	2, 3, 4, 5, 6, 7, 8	K
PYGOPODIDAE - LEGLESS LIZARDS		
Aprasia inaurita	2, 3, 4, (5), (7)	K
Aprasia pseudopulchella	1, 2, 3, 4, 5, 6	K

NAME	DISTRIBUTION	STATUS
Aprasia striolata	1, 2, 3, 4	K
Delma australis	2, 3, 4, 5, 6, 7, 8	K
Delma borea	(8)	K
Delma fraseri	4, 7	K
Delma impar	1	K
Delma inornata	(1), 2, 3, 7	K
Delma molleri	2, 3, 4, 6	K
Delma nasuta	2, 3, 4, 5, 6, 7, (8)	K
Delma tincta	6, 8	K
Lialis burtonis - Burton's Snake-lizard	2, 3, 4, 5, 6, 7, 8	K
Ophidiocephalus taeniatus	8	K
Pygopus lepidopodus - Common Scaly-foot	1, 2, 3, 4, 5, 6, 7	K
Pygopus nigriceps - Hooded Scaly-foot	(2), 3, (4), (5), 6, 7, 8	K
AGAMIDAE - DRAGON LIZARDS		
Amphibolurus adelaidensis	4	K
Amphibolurus caudicinctus - Ring-tailed Dragon	(8)	
Amphibolurus clayi	8	K
Amphibolurus decresii	3, 5, 6	K
Amphibolurus gibba	8	K
Amphibolurus isolepis	7, 8	K
Amphibolurus maculosus - Lake Eyre Dragon	7, 8	K
Amphibolurus nobbi	2, 3, 5, 6	K
Amphibolurus nuchalis - Central Netted Dragon	4, 5, 6, 7, 8	K
Amphibolurus nullarbor	7	K
Amphibolurus reticulatus - Western Netted Dragon	7, 8	K

NAME	DISTRIBUTION	STATUS
Amphibolurus ruffscens	8	K
Amphibolurus vadnappa	6, 8	K
Ctenophorus cristatus - Crested Dragon	4, 7, 8	K
Ctenophorus fionni	4, 7	K
Ctenophorus fordi - Mallee Dragon	2, 4, 5, 6, 7, 8	K
Ctenophorus pictus - Painted Dragon	1, 2, 3, 4, 5, 6, 7, 8	K
Ctenophorus maculatus - Spotted Dragon	4, 7	K
Ctenophorus mckenziei	7	K
Ctenophorus scutulatus - Lozenge-marked Dragon	8	
Diporiphora linga	4, 7	K
Diporiphora winneckei	6, (7), 8	K
Gemmatophora muricatus	1, 2, 3, (5)	K
Gemmatophora norrisi	4, 7	K
Lophognathus gilberti	7, 8	K
Lophognathus longirostris	(7), 8	K
Moloch horridus - Thorny Devil (Moloch)	4, 7, 8	K
Pogona barbatus - Bearded Dragon (Jew Lizard)	1, 2, 3, 4, 7, 8	K
Pogona minor - Dwarf Bearded Dragon	4, 6, 7, 8	K
Pogona vitticeps	2, 3, 4, 5, 6, 7, 8	K
Tympanocryptis cephalus	8	K
Tympanocryptis intima	5, 6, 7, 8	K
Tympanocryptis lineata	1, 2, 3, 4, 5, (6), 7, 8	K
Tympanocryptis tetraporophora	3, 5, 6, 7, 8	K

NAME	DISTRIBUTION	STATUS
VARANIDAE - GOANNAS		
Varanus acanthurus - Ridge-tailed Monitor	(8)	K
Varanus brevicauda	(8)	K
Varanus eremius	7, 8	K
Varanus giganteus - Perentie	(7), 8	K
Varanus gilleni - Pygmy Mulga Monitor	(4), 6, 7, 8	K
Varanus gouldii - Gould's Goanna (Sand Monitor)	(1), 2, 3, 4, 5, 6, 7, 8	K
Varanus rosenbergi	1, 2, 3, 4, (7)	K
Varanus tristis	7, 8	K
Varanus varius - Lace Monitor	(2), 3, 6?	K
SCINCIDAE - SKINKS		
Cryptoblepharus carnabyi	2, 3, 5, 6, 8	K
Cryptoblepharus plagiocephalus	(2), 4, 5, 6, 7, 8	K
Cryptoblepharus virgatus	(1), (2), (3), 4, 6, (7)	K
Ctenotus atlas	2, 4, 5, (6), 7, 8	K
Ctenotus brachyonyx	2, 5	K
Ctenotus brooksi	1, 2, 4, 5, 6, 7, 8	K
Ctenotus helenae	8	K
Ctenotus leae	4, (6), 7, 8	K
Ctenotus leonhardii	6, 7, 8	K
Ctenotus pantherinus	4, (6), 7, 8	K
Ctenotus piankai	(8)	K
Ctenotus quattuordecimlineatus	8	K
Ctenotus reguis	2, 3, 4, 5, 6, 7, 8	K
Ctenotus robustus	1, 2, 3, 4, 5, 6, 7, 8	K

NAME	DISTRIBUTION	STATUS
Ctenotus saxatilis	6, 8	K
Ctenotus schomburgkii	2, 4, 5, 6?, 7, 8	K
Ctenotus strauchii	(5), 6, 7, 8	K
Ctenotus uber	1, 2, 3, 4, 5, 6, 7, 8	K
Egernia carinata	4, 7	K
Egernia coventryi	1, (2)	K
Egernia cunninghami - Cunningham's Skink	2, 3, (4)	K
Egernia depressa - Pygmy Spiny-tailed Skink	(8)	K
Egernia inornata - Desert Skink	1, 2, 4, 5, (6), 7, 8	K
Egernia kintorei - Great Desert Skink	(8)	K
Egernia margaretae	3, (4), (5), 6	K
Egernia multiscutata	1, 2, 3, 4, 6	K
Egernia slateri	8	K
Egernia stokesii - Gidgee Skink	4, 5, 6, 7, 8	K
Egernia striata	8	K
Egernia striolata - Tree Skink	2, 3, 4, 5, 6, 7, 8	K
Egernia whitii - White's Skink	1, 2, 3, 4	K
Eremiascincus fasciolatus -Narrow-banded Sand Swimmer	(2), (4), (5), (6), (7), 8	K
Eremiascincus richardsonii - Broad-banded Sand Swimmer	(2), (4), (5), (6), 7, 8	K
Hemiergis decresiensis	1, 2, 3, 4, 5, 6	K
Hemiergis initialis	4, 7	K
Hemiergis millewae	2, (3), 4, 5, 6, 7, 8	K
Hemiergis peronii	1, 2, 3, 4, 7	K
Lampropholis delicata	1, 2, 3, 4	K

NAME	DISTRIBUTION	STATUS
Lampropholis guichenoti	1, 2, 3, 4, 5	K
Leiolopisma entrecastequxii	1, 2, 3, 4	K
Leiolopisma trilineatum	1, 2, 3	K
Lerista bipes	8	K
Lerista bougainvillii	1, 2, 3, 4, (5), 6, 8	K
Lerista desertorum	7, 8	K
Lerista frosti	2, 3, 4, (5), 6, 7, (8)	K
Lerista labialis	5, 6, 7, 8	K
Lerista microtis	4, 7	K
Lerista muelleri	2, 3, (4), 5, 6, 7, 8	K
Lerista picturata	3, 4, 7	K
Lerista punctatovittata	1, 2, 3, 4, 5, 6, (7), 8	K
Lerista terdigitata	4, 7, 8	K
Lerista xanthura	5, 6, 7	K
Menetia greyii	1, 2, 3, 4, 5, 6, 7, 8	K
Morethia adelaidensis	2, 3, 4, 5, 6, 7, 8	K
Morethia boulengeri	(1), 2, 3, 4, 5, 6, 7, 8	K
Morethia butleri	(4), 7, (8)	K
Morethia obscura	1, 2, 3, 4, 5, 7	K
Morethia ruficauda	8	K
Notoscincus ornatus	8	K
Proablepharus reginae	8	K
Sphenomorphus quoyii - Eastern Water Skink	2, 3, 4	K
Sphenomorphus tympanus	1, 2, 3, 4?	K

NAME	DISTRIBUTION	STATUS
Tiliqua adelaidensis	3, 4	K
Tiliqua branchialis	3, 4, 5, 6, 7, 8	K
Tiliqua multifasciata - Centralian Blue-tongued Lizard	8	K
Tiliqua nigrolutea - Blotched Blue-tongued Lizard	1	K
Tiliqua occipitalis - Western Blue-tongued Lizard	1, 2, 3, 4, (5), (6), 7, 8	K
Tiliqua scincoides - Eastern Blue-tongued Lizard	1, 2, 3, 4, (5), 6, 7	K
Trachydosaurus rugosus - Shingle-back	1, 2, 3, 4, (5), 6, 7, 8	K
SERPENTES - SNAKES		
TYPHLOPIDAE - BLIND SNAKES		
Ramphotyphlops australis	(1), 2, 3, 4, 5, 6, 7, 8	K
Ramphotyphlops bituberculatus	2, 3, 4, 5, 6, 7, 8	K
Ramphotyphlops broomi	(8)	K
Ramphotyphlops endoterus	4, 5, (6), 7, 8	K
Ramphotyphlops ligatus	(8)	K
Ramphotyphlops pinguis	(2), 4	K
Ramphotyphlops proximus	(1), (2)	K
Ramphotyphlops unguirostris	(2), (3), (4), (5)	K
BOIDAE - BOAS AND PYTHONS		
Aspidites ramsayi - Woma	8	K
Liasis childreni - Children's Python	4, (5), 6, 7, 8	K
Morelia spilota - Carpet (Diamond) Python	2, 3, 4, (5), 6, (7), 8	K

NAME	DISTRIBUTION	STATUS
ELAPIDAE - ELAPID SNAKES		
Acanthophis antarcticus - Common Death Adder	3, 4, (7)	K
Acanthophis pyrrhus - Desert Death Adder	7, 8	K
Austrelaps superbus - Copperhead	1	K
Austrelaps sp. (Undescribed species)	1, 3	K
Demansia psammophis - Yellow-faced Whip Snake	2, 3, 4, 5, 6, 7, 8	K
Drysdalia coronoides - Crowned Snake	1	K
Drysdalia mastersii - Master's Snake	1, 2, 4, 7	K
Echiopsis curta - Bardick	2, 4, 5	K
Furina diadema - Red-naped Snake	3, 4, (5), 6, 7, 8	K
Neelaps bimaculatus - Western Black-naped Snake	7, (8)	K
Notechis ater - Black Tiger Snake	3, 4, 6	K
Notechis scutatus - Eastern (Mainland) Tiger Snake	1, 2, 3, 4	K
Parademansia microlepidota - Fierce Snake (Inland Taipan)	8	K
Pseudechis australis - Mulga (King Brown) Snake	2, 3, 4, 5, 6, 7, 8	K
Pseudechis porphyriacus - Red-bellied Black Snake	(1), 2, 3, (5)	K
Pseudonaja affinis - Dugite	4, (7)	K
Pseudonaja guttata	8	K
Pseudonaja modesta - Ringed Brown Snake	(4), 5, 6, 7, 8	K
Pseudonaja nuchalis - Western Brown Snake (Gwardar)	2, 4, 5, 6, 7, 8	K
Pseudonaja textilis - Eastern Brown Snake	1, 2, 3, 4, 5, (6), 7, 8	K
Simoselaps anomalus	8	K

NAME	DISTRIBUTION	STATUS
Simoselaps australis - Coral Snake	1, 2, 3, 5, 6	K
Simoselaps bertholdi - Desert Banded Snake	3, 4, (5), (6), 7, 8	K
Simoselaps fasciolatus - Narrow-banded Snake	4, (6), 7, 8	K
Simoselaps semifasciatus - Half-girdled Snake	4, 7, 8	K
Suta suta - Myall (Curl) Snake	2, 3, 4, 5, 6, 7, 8	K
Unechis flagellum - Little Whip Snake	1, 2, 3, 4	K
Unechis monachus - Hooded Snake	(5), (6), 7, 8	K
Unechis nigriceps	1, 2, (3), 4, 5, 6, 7	K
Unechis spectabilis	2, 3, 4, 5, 6, 7	K
Vermicella annulata - Bandy-bandy	2, 3, 4, 5, 6, 7, 8	K
AMPHIBIANS		
ANURA - FROGS		
HYLIDAE - TREE FROGS		
Cyclorana platycephalus - Water-holding Frog	8	C
Litoria caerulea - Green Tree Frog	8	C
Litoria ewingii - Brown Tree Frog	1, 2, 3, 4	C
Litoria latopalmata	8	C
Litoria peronii - Peron's Tree Frog	2, 3	C
Litoria raniformis - Golden Bell Frog	1, 2, 3	C
Litoria rubella - Red Tree Frog (Desert Tree Frog)	6, 8	C

NAME	DISTRIBUTION	STATUS
LEPTODACTYLIDAE - SOUTHERN FROGS		
Geocrinia laevis	1	C
Limnodynastes dumerilii - Bull Frog (Eastern Banjo Frog)	1, 2, 3, 4, 5	C
Limnodynastes fletcheri - Long-thumbed Frog	2 (R. Murray), 3	C
Limnodynastes peronii - Brown-striped Frog	1	C
Limnodynastes spenceri	8	C
Limnodynastes tasmaniensis - Marbled Frog (Spotted Grass Frog)	1, 2, 3, 4, 5, 6, 7, 8	C
Neobatrachus centralis - Trilling Frog	5, 6, 7, 8	C
Neobatrachus pictus	1, 2, 3, 4	C
Neobatrachus sudelli	1	C
Neobatrachus sutor	8	C
Pseudophryne bibronii - Brown Toadlet	1, 2, 3, 4, 6, 7	C
Pseudophryne occidentalis - Orange-crowned Toadlet	8	C
Pseudophryne semimarmorata - Marbled Toadlet (Southern Toadlet)	1, 2	C
Ranidella deserticola	8	C
Ranidella parinsignifera	2 (R. Murray)	C
Ranidella riparia	3, 4, 6	C
Ranidella signifera - Brown Froglet (Common Eastern Froglet)	1, 2, 3, 4	C

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APPENDIX 15: FRESHWATER FISHES

NAME	DISTRIBUTION	STATUS
AGNATHA - JAWLESS CARTILAGINOUS FISHES		
PETROMYZONTIFORMES		
GEOTRIIDAE - POUCHED LAMPREY		
Geotria australis - Wide-mouthed Lamprey	1, 2, 3, 4b	V **
MORDACIIDAE - SHORT-HEADED LAMPREYS		
Mordacia mordax - Short-headed Lamprey	1, 2, 3, 4b	V **
OSTEICHTHYES - BONY FISHES		
ANGUILLIFORMES		
ANGUILLIDAE - FRESHWATER EELS		
Anguilla australis - Short-finned Eel	1, 2	V **
ATHERINIFORMES		
ATHERINIDAE - HARDYHEADS OR SILVERSIDES		
Atherinasoma microstoma	1, 3, 4	C
Craterocephalus dalhousiensis - Dalhousie Hardyhead	8	R *
Craterocephalus eyresii - Lake Eyre Hardyhead	2, 3, 5, 6, 7, 8	C
Craterocephalus stercusmuscarum - Mitchellian Hardyhead	1, 2, 3, 4b, 8	C
MELANOTAENIIDAE - RAINBOW FISHES		
Melanotaenia splendida - Crimson Spotted Rainbow Fish	2, 8	C
PERCICHTHYIDAE - AUSTRALIAN FRESHWATER BASSES, CODS AND PERCHES		
Maccullochella macquariensis - Trout Cod	2	X
Maccullochella peeli - Murray Cod	2	V **

NAME	DISTRIBUTION	STATUS
Macquaria ambigua - Callop (Yellowbelly, Golden Perch)	2, 4a(?), 8	C
Macquaria australiasica - Macquarie Perch	2(?)	R **
Macquaria colonorum - Estuary Perch	2	R **
CLUPEIFORMES		
CLUPEIDAE - HERRINGS		
Nematolosa erebi - Bony Bream (Pyberry)	2, 6, 8	C
PERCIFORMES		
AMBASSIDAE - CHANDA PERCHES AND ALLIES		
Ambassis castelnaui - Western Chanda Perch	2	E *
ELEOTRIDAE - GUDGEONS		
Hypseleotris klunzingeri - Western Carp Gudgeon	2, 8	K
Hypseleotris sp. 1 (Undescribed species) - Midgley's Carp Gudgeon	2, 8	K
Hypseleotris sp. 2 (Undescribed species) - Lake Carp Gudgeon	2, 8	K
Mogurnda adspersa - Southern Purple-Spotted (Chequered or Trout) Gudgeon	2, 3, 4b	E **
Mogurnda mogurnda - Northern Purple-Spotted (Chequered or Trout) Gudgeon	6, 8	R *
Philypnodon grandiceps - Bighead Gudgeon	2, 3, 4b	C
Philypnodon sp. (Undescribed species) - Dwarf Flathead Gudgeon	2	R **
GADOPSIDAE - RIVER BLACKFISH		
Gadopsis marmoratus - River Blackfish (Slippery)	1, 2, 3, 4b	V **
GOBIIDAE - GOBIES		
Chlamydogobius eremius - Desert Goby	8	R *

NAME	DISTRIBUTION	STATUS
Favonigobius tamarensis - Tamar River Goby	3, 4	C
Pseudogobius olorum - Swan River Goby (Southern Goby)	3, 4a, 4b	C
KUHLIIDAE - PIGMY PERCHES		
Nannoperca australis - Southern Pigmy Perch	1, 2	E **
Nannoperca obscura - Yarra Pigmy Perch	1	V **
TERAPONIDAE - FRESHWATER GRUNTERS OR TERAPON PERCHES		
Bidyanus bidyanus - Silver Perch (Tcheri)	2	C
Bidyanus welchi - Welch's Grunter (Welch's Perch)	8	K
Leiopotherapon unicolor - Spangled Perch	6, 8	C
Scortum barcoo - Barcoo Grunter (Barcoo Perch)	8	K
SALMONIFORMES		
CALAXIIDAE - GALAXIIDS (JOLLYTAILS, MINNOWS, NATIVE TROUTS)		
Galaxias brevipinnis - Climbing Galaxias	3, 4b	R **
Galaxias maculatus - Common Galaxias	1, 2, 3, 4a, 4b	C
Galaxias olidus - Mountain Galaxias	1, 2, 3, 4b	R **
Galaxias rostratus - Flathead Galaxias	2	R **
Galaxiella pusilla - Dwarf Galaxias	1	V **
PROTOTROCTIDAE - GRAYLING		
Prototroctes maraena - Australian Grayling	1	E **
RETROPINNIDAE - SMELT		
Retropinna semoni - Australian Smelt	2, 8	C

NAME	DISTRIBUTION	STATUS
SILURIFORMES		
PLOTOSIDAE - EEL-TAILED CATFISHES		
Neosilurus argenteus - Central Australian Catfish (Silver Tandan)	8	R *
Neosilurus hyrtlii - Hyrtl's Catfish (Hyrtl's Tandan)	8	K
Neosilurus sp. 1 (Undescribed species) - Glover's Catfish	8	E *
Neosilurus sp. 2 (Undescribed species)	8	K
Tandanus tandanus Mitchell - Freshwater Catfish	2, 3, 4b	V **
INTRODUCED SPECIES		
PERCIDAE - TRUE PERCHES		
Perca fluviatalis - Redfin Perch	1, 2, 3, 4b, 5, 8(?)	
POECILIIDAE - LIVE BEARERS		
Gambusia affinis - Mosquitofish	1, 2, 3, 6, 7++, 8	
CYPRINIDAE - CARPS AND ALLIES		
Carassius auratus - Goldfish	1, 2, 3, 4a++(?) 4b, 7++	
Cyprinus carpio - European Carp	2, 3, 4b	
Tinca tinca - Tench	1(?), 2, 3, 4b	
SALMONIDAE - SALMONS AND TROUTS		
Salmo gairdnerii - Rainbow Trout	1++, 2, 3++, 4++, (6?) 7++, 8++	
Salmo trutta - Brown Trout	1, 2, 3, 4b	
Salvelinus fontinalis - Brook Trout	3	

N.B. ++ indicates an occurrence only in artificial habitat such as dams or tanks.

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APPENDIX 16: MARINE FISHES

NOTE: Status for marine fish is based on information from the Department of Fisheries. Little quantitative data is available, and we have, therefore allotted a 'vulnerable' category to all species that are targets of commercial fishing operations as a preliminary measure only

The majority of species are typically southern Australian coastal inhabitants; some are more cosmopolitan or oceanic, whilst a few are normally regarded as tropical or sub-tropicl forms (Glover, 1982).

Many different English names are commonly used to describe the same species, so in order to avoid confusion, only the scientific names have been used.

NAME	DISTRIBUTION	STATUS
AGNATHA - JAWLESS CARTILAGENOUS FISHES		
CEPHALOCHORDATA - LANCELETS		
BRANCHIOSTOMIDAE		
Bathyamphioxus australis (Raff, 1912)		K
Paramphioxus bassanus (Günther, 1884)		K
PETROMYZONTIFORMES - LAMPREYS		
GEOTRIIDAE - POUCHED LAMPREYS		
Geotria australis (Gray, 1851)		K
MORDACIIDAE - SHORT-HEADED LAMPREYS		
Mordacia mordax (Richardson, 1846)		K
MYXINI - HAGFISHES		
EPTATRETIDAE		
Eptatretus longipinnis (Strahan, 1975)		K
CHONDRICHTHYES - SHARKS, SKATES AND RAYS		
ALOPIIDAE - THRESHER SHARKS		
Alopias vulpinus (Bonnaterre, 1788)		K

NAME	DISTRIBUTION	STATUS
CARCHARHINIDAE - WHALER SHARKS		
Carcharhinus brachyurus (Günther, 1870)		K
Carcharhinus greyi (Owen, 1853)		V
Furgaleus ventralis (Whitley, 1943)		V
Galeocerda cuvieri (Peron & Le Sueur, 1822)		K
Galeorhinus australis (Macleay, 1881)		V
Mustelus antarcticus (Günther, 1870)		V
Prionace glauca (Linnaeus, 1758)		K
Pterolamiops longimanus (Poey, 1861)		K
CETORHINIDAE - BASKING SHARKS		
Cetorhinus maximus (Gunner, 1765)		K
DASYATIDAE - STINGRAYS		
Dasyatis brevicaudata (Hutton, 1875)		K
Dasyatis thetidis (Waite, 1899)		V
HETERODONTIDAE - PORT JACKSON SHARKS		
Heterodontus portusjacksoni (Meyer, 1793)		K
HEXANCHIDAE - SEVEN-GILLED SHARKS		
Heptranchias perlo (Bonnaterre, 1788)		K
Notorhynchus cepedianus (Peron, 1807)		K
LAMNIDAE - MACKEREL SHARKS		
Carcharodon carcharius (Linnaeus, 1758)		K
Isurus oxyrinchus (Rafinesque, 1810)		K
MYLIOBATIDAE - EAGLE RAYS		
Myliobatis australis (Macleay, 1881)		V

NAME	DISTRIBUTION	STATUS
ODONTASPIDAE - SAND SHARKS		
Odontaspis taurus (Rafinesque, 1810)		K
ORECTOLOBIDAE - CARPET SHARKS		
Orectolobus ornatus (De Vis, 1883)		K
Orectolobus maculatus (Bonnaterre, 1788)		V
Parascyllium ferrugineum (McCulloch, 1911)		K
Parascyllium variolatum (Dumeril, 1853)		K
Sutorectus tentaculatus (Peters, 1864)		K
PRISTIOPHORIDAE - SAW SHARKS		
Pristiophorus cirratus (Latham, 1794)		K
Pristiophorus nudipinnis (Günther, 1870)		V
RAJIDAE - SKATES		
Irolita waitei (McCulloch, 1911)		K
Pavoraja nitida (Günther, 1880)		K
Raja cerva (Whitley, 1939)		K
Raja gudgeri (Whitley, 1940)		K
Raja lemprieri (Richardson, 1845)		K
Raja nasuta (Muller & Henle, 1941)		K
Raja whitleyi (Iredale, 1938)		K
Raja sp. 1 (of Last, Scott & Talbot, 1983)		K
Raja sp. 2 (of Last, Scott & Talbot, 1983)		K
RHINOBATIDAE - GUITARFISHES		
Aptychotrema vincentiana (Haacke, 1885)		K
Trygonorhina fasciata (Müller & Henle, 1841)		K
Trygonorhina melaleuca (Scott, 1954)		K

NAME	DISTRIBUTION	STATUS
MITSUKURINIDAE - GOBLIN SHARKS		
Mitsukurina owstoni (Jordan, 1898)		K
SCYLIORHINIDAE - CATSHARKS		
Asymbolus analis (Ogilby, 1885)		K
Cephaloscyllium isabella (Bonnaterre, 1788)?		K
Cephaloscyllium laticeps (Dumeril, 1853)		K
Galeus boardmani (Whitley, 1928)		K
Juncrus vincenti (Zietz, 1908)		K
SPHYRNIDAE - HAMMERHEAD SHARKS		
Sphyna zygaena (Linnaeus, 1758)		K
SQUALIDAE - DOGFISHES		
Centrophorus scalpratus (McCulloch, 1915)		K
Dalatias licha (Bonnaterre, 1788)		K
Deania calcea (Lowe, 1839)		K
Deania quadrispinosa (McCulloch, 1915)		K
Echinorhinus brucus (Bonnaterre, 1788)		K
Etmopterus lucifer (Jordan & Snyder, 1902)		K
Oxynotus bruniensis		K
Squalus acanthias (Linnaeus, 1758)		K
Squalus blainvillii		K
Squalus megalops (Macleay, 1881)		V
SQUATINIDAE - ANGEL SHARKS		
Squatina australis (Regan, 1906)		K
Squatina tergocellata (McCulloch, 1914)		K
TORPEDINIDAE - ELECTRIC RAYS		
Torpedo macneilli (Whitley, 1932)		K

NAME	DISTRIBUTION	STATUS
HYPNIDAE - NUMBFISH		
Hypnos monopterygium (Shaw & Nodder, 1795)		K
UROLOPHIDAE - STINGAREES		
Urolophus cruciatus (Lacépède, 1804)		K
Urolophus expansus (McCulloch, 1916)		K
Urolophus gigas (Scott, 1954)		V
Urolophus mucosus (Whitley, 1939)		K
Urolophus paucimaculatus (Dixon, 1969)		K
Urolophus sp. 2 (of Hutchins & Thompson, 1983)		K
HOLOCEPHALI		
CALLORHYNCHIDAE - ELEPHANT FISHES		
Callorhynchus milii (Bory de St. Vincent, 1823)		V
CHIMAERIDAE - GHOST SHARKS		
Hydrolagus ogilbyi (Waite, 1898)		V
OSTEICHTHYES - BONY FISHES		
ACANTHOCLINIDAE		
Acanthoclinus sp.		
ALEPISAURIDAE - LANCET FISHES		
Alepisaurus brevirostris (Gibbs, 1960)		K
ALEPOCEPHALIDAE - SLICKHEADS		
Aleposomus squamilaterus (Alcock, 1898)		K
ANGUILLIDAE - FRESHWATER EELS		
Anguilla australis (Richardson, 1841)		K

NAME	DISTRIBUTION	STATUS
ANTENNARIIDAE - ANGLER FISHES		
Allenichthys glauerti (Whitley, 1944)		K
Echinophryne crassispina (McCulloch & Waite, 1918)		K
Echinophryne sp. (of Pietsch (MS))		K
Histiophryne bougainvilli (Cuvier & Valenciennes, 1837)		K
Histiophryne cryptacanthus (Weber, 1913)		K
Phyllophryne scortea (McCulloch & Waite, 1918)		K
Rhycherus filamentosus (Castelnau, 1872)		K
Rhycherus gloveri (Pietsch, 1984)		K
Trichophryne mitchelli (Morton, 1897)		K
APLOACTINIDAE - MARBLEFISHES		
Aploactisoma milesii (Richardson, 1850)		K
Paraploactis trachyderma (Bleeker, 1865)		K
APLODACTYLIDAE - SEA CARP		
Dactylosargus arctidens (Richardson, 1839)		K
APOGONIDAE - CARDINAL FISHES OR GOBBLEGUTS		
Apogonops anomalus (Ogilby, 1896)		K
Epigonus lenimen (Whitley, 1935)		K
Siphamia cephalotes (Castelanu, 1875)		K
Vincentiana novaehollandiae (Cuvier & Valenciennes, 1832) (=Vincentiana conspersus (Klunzinger, 1872?))		K
ARACANIDAE - BOXFISHES		
Anoplocapros lenticularis (Richardson, 1841)		K
Aracana aurita (Shaw, 1798)		K

NAME	DISTRIBUTION	STATUS
Aracana ornata (Gray, 1838)		K
Capropygia unistriata (Kaup, 1855)		K
ARGENTINIDAE - HERRING SMELTS		
Argentina australiae (Cohen, 1958)		K
Argentina elongata (Hutton, 1879)		K
ARRIPIDAE - AUSTRALIAN SALMONS		
Arripis georgianus (Cuvier & Valenciennes, 1831)		V
Arripis trutta (Block & Schneider, 1801)		V
ATHERINIDAE - HARDYHEADS		
Atherinasoma lincolnensis (Whitley, 1941)		V
Atherinasoma microstoma (Günther, 1861)		V
Atherinasoma presbyteroides (Richardson, 1843)		V
Atherinason esox (Klunzinger, 1872)		V
Atherinason hepsetoides (Richardson, 1843)		V
Atherinason sp. (of Last et al., 1983)		V
AULOPIDAE - SERGEANT BAKERS		
Aulopus purpurissatus (Richardson, 1843)		K
BERYCIDAE - RED SNAPPERS		
Beryx splendens (Lowe, 1833)		K
Trachichthodes affinis (Günther, 1859)		K
Trachichthodes gerrardi (Günther, 1887)		V
Trachichthodes lineatus (Cuvier & Valenciennes, 1829)		K

NAME	DISTRIBUTION	STATUS
BLENNIDAE - BLENNIES		
Cyneichthys anolius (Cuvier & Valenciennes, 1836)		K
Pictiblennius tasmanianus (Richardson, 1849)		K
BOTHIDAE - LEFT-HAND FLOUNDERS		
Arnoglossus bassensis (Norman, 1926)		V
Arnoglossus muelleri (Klunzinger, 1872)		V
Lophonectes gallus (Günther, 1880)		V
BOVICHTHYIDAE - TEMPERATE ICEFISHES; 'CONGOLLI		
Bovichtus variegatus (Richardson, 1846)		K
Pseudaphritis urvilli (Cuvier & Valenciennes, 1831)		V
BRACHIONICHTHYIDAE - HANDFISHES		
Sympterichthys verrucosus (McCulloch & Waite, 1918)		K
BRAMIDAE - POMFRETS		
Brama brama (Bonnaterre, 1788)		K
CALLIONYMIDAE - STINKFISHES; DRAGONETS		
Callionymus calcaratus (Macleay, 1881)		K
Synchiropus calauropomus (Richardson, 1844)		K
Synchiropus papilio (Günther, 1864)		K
Synchiropus phasis (Günther, 1880)		K
CARANGIDAE - TREVALLIES		
Caranx georgianus (Cuvier & Valenciennes, 1833)		V
Decapterus russellii (Ruppell, 1831)		K
Naucrates ductor (Linnaeus, 1758)		K

NAME	DISTRIBUTION	STATUS
Seriola hippos (Günther, 1876)		V
Seriola lalandi (Cuvier & Valenciennes, 1833)		V
Trachurus declivis (Jenyns, 1841)		V
Trachurus novaezelandiae (Richardson, 1843)		K
CENTROLOPHIDAE - TREVALLAS; WAREHOU'S		
Hyperoglyphe porosa (Richardson, 1845)		V
Seriolella brama (Günther, 1860)		V
Seriolella maculata (Forster, 1794)		K
CEPOLIDAE - BANDFISHES		
Cepola australis (Ogilby, 1899)		K
CHAETODONTIDAE - CORAL FISHES		
Chelmonops truncatus (Kner, 1859)		K
CHEILODACTYLIDAE - MORWONGS		
Cheilodactylus nigripes (Richardson, 1850)		K
Cheilodactylus rubrolabiatus (Allen & Heemstra, 1976)		K
Dactylophora nigricans (Richardson, 1850)		V
Nemadactylus macropterus (Bloch & Schneider, 1801)		V
Nemadactylus valenciennesi (Whitley, 1937)		V
CHIRONEMIDAE - KELPFISHES		
Chironemus georgianus (Cuvier & Valennciennes, 1829)		K
Threpterius maculosus (Richardson, 1850)		K
CHLOROPHTHALMIDAE - GREEN EYES		
Chlorophthalmus nigripinnis (Günther, 1878)		K

NAME	DISTRIBUTION	STATUS
CLINIDAE - WEEDFISHES; SNAKE BLENNIES		
Cristiceps aurantiacus (Castelnau, 1879)		K
Cristiceps australis (Cuvier & Valenciennes, 1836)		K
Heteroclinus adelaidae (Castelnau, 1873)		K
Heteroclinus eckloniae (McKay, 1970)		K
Heteroclinus forsteri (Castelnau, 1872)		K
Heteroclinus heptaeolus (Ogilby, 1885)		K
Heteroclinus johnstoni (Saville-Kent, 1886)		K
Heteroclinus macrophthalmus (Hoese, 1976)		K
Heteroclinus perspicillatus (Cuvier & Valenciennes, 1836)		K
Heteroclinus puellarúm (Scott, 1955)		K
Heteroclinus roseus (Günther, 1861)		K
Heteroclinus wilsoni (Lucas, 1890)		K
Heteroclinus species 5, 8, 9, 20 of Hoese (MS, 1984)		K
Ophioclinops pardalis (McCulloch & Waite, 1918)		K
Ophioclinops varius (McCulloch & Waite, 1918)		K
Ophioclinops aethiops (McCulloch & Waite, 1918)		K
Ophioclinops antarcticus (Castelnau, 1872)		K
Ophioclinops gabriedi (Waite, 1906)		K
Ophioclinops gracilis (Waite, 1906)		K
Ophioclinops ningulus (George & Springer, 1980)		K
Peronedeys anguillaris (Steindachner, 1884)		K
Sticharium dorsale (Günther, 1867)		K

NAME	DISTRIBUTION	STATUS
CLUPEIDAE - HERRINGS, SPRATS, BONY BREAM		
Etumeus jacksoniensis (Macleay, 1878)		K
Hyperlophus vittatus (Castelnau, 1875)		K
Nematolosa erebi (Günther, 1868)		K
Sardinops sagax (Jenyns, 1842)		V
Spratelloides robustus (Ogilby, 1897)		K
Spratus bassensis (McCulloch, 1911)		V
CONGIOPODIDAE - PIGFISHES		
Congiopodus leucopaecilus (Richardson, 1846)		K
Perryena leucometopon (Waite, 1922)		K
CONGRIDAE - CONGER EELS		
Conger wilsoni (Bloch & Schneider, 1801)		V
Myrophis sp.		K
Scalanago lateralis (Whitley, 1935)		K
CORYPHAENIDAE - DOLPHINFISHES		
Coryphaena hippurus (Linnaeus, 1758)		K
CREEDIIDAE - TOMMY FISHES		
Creedia haswelli (Ramsay, 1881)		K
CYNOGLOSSIADE - TONGUE SOLES		
Cynoglossus broadhursti (Waite, 1905)		V
DINOLESTIDAE - LONG-FINNED PIKE		
Dinolestes lewini (Griffith, 1834)		V
GERRIDAE - SILVER BIDDIES		
Parequula melbournensis (Castelnau, 1872)		K

NAME	DISTRIBUTION	STATUS
GNATHANACANTHIDAE - RED VELVETFISH		
Gnathanacanthus goetzeei (Bleeker, 1855)		K
GOBIESOCIDAE - CLINGFISHES		
Alabes dorsalis (Richardson, 1845)		K
Alabes hoesi (Springer & Fraser, 1976)		K
Alabes parvulus (McCulloch, 1909)		K
Alabes sp.?		K
Aspasmogaster tasmaniensis (Günther, 1861)		K
Cochleoceps spatula (Günther, 1861)		K
Creocele cardinalis (Ramsay, 1882)		K
Gobiesocidae spp. (4)		K
Parvicrepis parvipinnis (Waite, 1906)		K
Parvicrepis sp.		K
GOBIIDAE - GOBIES		
Arenigobius bifrenatus (Kner, 1865)		K
Callogobius depressus (Ramsay & Ogilby, 1886)		K
Callogobius mucosus (Günther, 1872)		K
Eviota bimaculata (Lachner & Karnella, 1980)		K
Favonigobius lateralis (Macleay, 1881)		K
Favonigobius tamarensis (Johnston, 1883)		K
Gobiopterus semivestitus (Munro, 1949)		K
Gobius haackei (Steindachner, 1884)		K
Mugilogobius paludis (Whitley, 1930)		K
Nesogobius pulchellus (Castelnau, 1872)		K
Nesogobius sp. 1 (of Last et al., 1983) (=Nesogobius sp. 2 (of Hoese (MS, 1984)))		K
Nesogobius species 5, 6, 7 (of Hoese (MS, 1984))		K

NAME	DISTRIBUTION	STATUS
Pseudogobius olorum (Sauvage, 1880)		K
Tasmanogobius sp. 1 (of Last et al., 1983)		K
Tasmanogobius sp. 2 (of Last et al., 1983)		K
GONORHYNCHIDAE - BEAKED SALMON		
Gonorhynchus greyi (Richardson, 1845)		K
HALOSAURIDAE - HALOSAURS		
Halosaurus pectoralis (McCulloch, 1926)		K
HARPODONTIDAE - LIZARDFISHES		
Saurida undosquamis (Richardson, 1848)		K
HEMIRAMPHIDAE - GARFISHES		
Hyporhamphus melanochir (Cuvier & Valenciennes, 1846)		V
HOPLICHTHYIDAE - GHOST FLATHEADS		
Hoplichthys haswelli (McCulloch, 1907)		K
IDIACANTHIDAE - SEA DRAGONS		
Idiacanthus niger (Peters, 1876)		K
ISTIOPHORIDAE - SPEARFISHES; MARLIN		
Makaira indica (Cuvier & Valenciennes, 1831)		K
Tetrapturus angustirostris (Tanaka, 1914)		K
Tetrapturus audax (Philippi, 1887)		K
KYPHOSIDAE - DRUMMERS; BLACKFISHES		
Girella tricuspidata (Quoy & Gaimard, 1824)		K
Girella zebra (Richardson, 1846)		K
Kyphosus sydneyanus (Günther, 1886)		V

NAME	DISTRIBUTION	STATUS
LABRIDAE - WRASSES OR PARROT FISHES		
Achoerodus gouldii (Richardson, 1843) (Fishery extensively regulated)		V
Austrolabrus maculatus (Macleay, 1881)		K
Bodianus frenchii (Klunzinger, 1879)		K
Dotalabrus aurantiacus (Castelnau, 1872)		K
Eupetrichthys angustipes (Ramsay & Ogilby, 1888)		K
Ophthalmolepis lineolatus (Cuvier & Valenciennes, 1838)		K
Pictilabrus laticlavius (Richardson, 1839)		K
Pseudolabrus fucicola (Richardson, 1840)		V
Pseudolabrus parilus (Richardson, 1850)		
Pseudolabrus psittaculus (Richardson, 1840)		V
Pseudolabrus tetricus (Richardson, 1840)		V
LAMPRIDIDAE - OPAHS		
Lampris guttatus (Brunnich, 1788)		K
Lampris regius (Bonnaterre, 1788)		K
LATRIDAE - TRUMPETERS		
Latridopsis forsteri (Castelnau, 1872)		V
Latris lineata (Bloch & Schneider, 1801)		K
LEPTOSCOPIDAE - SANDFISHES		
Crapatalus arenarius (McCulloch, 1915)		K
Crapatalus sp. (of Last et al., 1983)		K
MACRORHAMPHOSIDAE - BELLOWS FISHES		
Centriscops humerosus (Richardson, 1846)		K
Notopogon lilliei (Regan, 1914)		K

NAME	DISTRIBUTION	STATUS
MACROURIDAE - WHIPTAILS		
Coelorhynchus fasciatus (Günther, 1878)		K
Coelorhychus innotabilis (McCulloch, 1907)		K
Coelorhychus mirus (McCulloch, 1926)		K
Lepidorhynchus denticulatus (Richardson, 1846)		K
Macruronus novaezelandiae (Hector, 1871)		K
Nematonurus armatus (Hector, 1875)		K
Ventrifossa nigromaculatus (McCulloch, 1907)		K
MERLUCCIIDAE - HAKE		
Macruronus novaezelandiae (Hector, 1891)		V
MELANATOAENIIDAE - RAINBOW FISHES		
Melanotaenia splendida (Peters, 1867)		K
MELANOSTOMIIDAE - SCALELESS DRAGONFISHES		
Echiostoma barbatum (Lowe, 1843)		K
MOLIDAE - SUNFISHES		
Masturus lanceolatus (Liénard, 1840)		K
Mola ramsayi (Giglioli, 1883)		K
Ranzania laevis (Pennant, 1776)		
MONACANTHIDAE - LEATHERJACKETS		
Acanthaluteres spilomelanurus (Quoy & Gaimard, 1824)		V
Bigener brownii (Richardson, 1846)		V
Brachaluteres jacksonianus (Quoy & Gaimard, 1824)		V
Eubalichthys bucephalus (Whitley, 1931)		V
Eubalichthys gunnii (Günther, 1870)		V

NAME	DISTRIBUTION	STATUS
Eubalichthys mosaicus (Ramsay & Ogilby, 1886)		V
Eubalichthys quadrispinis (Hutchins, 1977)		V
Eubalichthys sp. (of Hutchins & Thompson, 1983)		V
Meuschenia australis (Donovan, 1824)		V
Meuschenia flavolineata (Hutchins, 1977)		V
Meuschenia freycineti (Quoy & Gaimard, 1824)		V
Meuschenia galii (Waite, 1905)		V
Meuschenia hippocrepis (Quoy & Gaimard, 1824)		V
Meuschenia venusta (Hutchins, 1977)		V
Nelusetta ayraudi (Quoy & Gaimard, 1824)		V
Parika scaber (Bloch & Schneider, 1801)		V
Penicipelta vittiger (Castelnau, 1873)		V
Scobinichthys granulatus (Shaw, 1790)		V
Thamnaconus degeni (Regan, 1903)		V
MONODACTYLIDAE - POMFRETS		
Schuettea woodwardi (Waite, 1905)		K
MORIDAE - MORID CODS		
Euclichthys polynemus (McCulloch, 1926)		K
Lotella callarias (Günther, 1863)		K
Mora dannevigi (Whitley, 1948)		K
Physiculus bachus (Bloch & Schneider, 1801)		K
Physiculus barbatus (Günther, 1863)		V
Tripterophycis intermedius (Whitley, 1948)		K

NAME	DISTRIBUTION	STATUS
MUGILIDAE - MULLETS		
Aldrichetta forsteri (Cuvier & Valenciennes, 1836)		V
Liza argentea (Quoy & Gaimard, 1825)		V
Mugil cephalus (Linnaeus, 1758)		V
Myxus elongatus (Günther, 1861)		V
MUGILOIDIDAE - GRUBFISHES		
Parapercis allporti (Günther, 1876)		K
Parapercis haackei (Steindachner, 1884)		K
Parapercis ramsayi (Steindachner, 1884)		K
MULLIDAE - GOATFISHES		
Upeneichthys porosus (Cuvier & Valenciennes, 1829)		V
Upeneichthys lineatus (Bloch & Schneider, 1801)		K
MURAENIDAE - MORAY EELS		
Gymnothorax prasinus (Richardson, 1848)		K
MYCTOPHIDAE - LANTERN FISHES		
Diaphus coeruleus (Klunzinger, 1871)		K
NEOSCOPELIDAE - LONG-SNOUTED LANTERN FISHES		
Neoscopelus macrolepidotus (Johnson, 1863)		K
Myctophidae sp.		K
NOTACANTHIDAE - SPINY EELS		
Notacanthus sexspinis (Richardson, 1846)		K
ODACIDAE - ROCK WHITINGS		
Haletta semifasciata (Cuvier & Valenciennes, 1840)		V

NAME	DISTRIBUTION	STATUS
Neoodax balteatus (Cuvier & Valenciennes, 1840)		K
Odax acroptilus (Richardson, 1846)		K
Odax cyanomelas (Richardson, 1850)		K
Siphonognathus argyrophanes (Richardson, 1858)		K
Siphonognathus attenuatus (Ogilby, 1897)		K
Siphonognathus beddomei (Johnston, 1885)		K
Siphonognathus caninis (Scott, 1976)		K
Siphonognathus radiatus (Quoy & Gaimard, 1835)		K
OPHICHTHIDAE - SNAKE EELS		
Muraenichthys australis (Macleay, 1881)		K
Muraenichthys breviceps (Günther, 1876)		K
Myrophis sp. (of Glover, 1979)		K
Ophisurus serpens (Linnaeus, 1758)		K
OPHICLINIDAE - SNAKE BLENNIES		
Ophiclinus aethicops (McCulloch & Waite, 1918)		K
Ophiclinus antarcticus (Castelnau, 1872)		K
Ophiclinus gabrieli (Waite, 1906)		K
Ophiclinus gracilis (Waite, 1906)		K
Ophiclinus pardalis (McCulloch & Waite, 1918)		K
Ophiclinus varius (McCulloch & Waite, 1918)		K
Peronedys anguillaris (Steindachner, 1884)		K
Sticharium dorsale (Günther, 1867)		K

NAME	DISTRIBUTION	STATUS
OPHIDIIDAE - LINGS		
Dermatopsis multiradiatus (McCulloch & Waite, 1918)		K
Danneviga tusca (Whitley, 1941)		K
Genypterus blacodes (Bloch & Schneider, 1801)		V
Genypterus microstomus (Regan, 1903)		K
Monothrix polylepis (Ogilby, 1897)		K
OPLEGNATHIDAE - KNIFEJAWS		
Oplegnathus woodwırdi (Waite, 1900)		V
Ostorhinchus conwaii (Richardson, 1840)		K
OREOSOMATIDAE - OREO DORIES		
Allocyttus verrucosus (Gilchrist, 1906)		K
Neocyttus rhomboidalis (Gilchrist, 1906)		K
Oreosoma atlanticum (Cuvier & Valenciennes, 1829)		K
PARALEPIDIDAE - BARRACUDINAS		
Lestidiops pacifica (Parr, 1931)		K
Macroparalepis macrogeneion (Post, 1973)		K
PARALICHTHYIDAE - LEFT-HAND FLOUNDERS		
Pseudorhombus arsius (Hamilton - Buchanan, 1822)		V
Pseudorhombus jenynsii (Bleeker, 1855)		V
PATACEIDAE - PROWFISHES		
Aetapcus maculatus (Günther, 1861)		K
Aetapcus vincenti (Steindachner, 1883)		K
Neopataecus waterhousii (Castelnau, 1872)		K
Pataecus fronto (Richardson, 1844)		K

NAME	DISTRIBUTION	STATUS
PEGASIDAE - SEA-MOTHS		
Acanthopegasus lancifer (Kaup, 1861)		K
PEMPHERIDAE - BULLSEYES		
Parapriacanthus elongatus (McCulloch, 1911)		K
Pempheris klunzingeri (McCulloch, 1911)		K
Pempheris multiradiata (Klunzinger, 1879)		K
Pempheris sp. (of Hutchins & Thompson, 1983)		K
PENTACEROTIDAE - ARMOURHEADS (BOARFISHES)		
Paristiopterus gallipavo (Whitley, 1944)		V
Paristiopterus labiosus (Günther, 1871)		V
Pentaceropsis recurvirostris (Richardson, 1845)		V
Pentaceros decacanthus (Günther, 1859)		K
Parazanclistius hutchinsi (Hardy, 1983)		K
Zanclistius elevatus (Ramsay & Ogilby, 1889)		K
PERCICHTHYIDAE - BASSES		
Apogonops anomalus (Ogilby, 1896)		K
Polyprion oxygeneios (Bloch & Schneider, 1801)		V
PHOTOICHTHYIDAE - LIGHTFISHES		
Photichrhys argenteus (Hutton, 1872)		K
PLATCEPHALIDAE - FLATHEADS		
Platycephalus bassensis (Cuvier & Valenciennes, 1829)		V
Platycephalus conatus (McCulloch & Waite, 1915)		K

NAME	DISTRIBUTION	STATUS
Platycephalus haackei (Steindachner, 1884)		K
Platycephalus inops (Jenyns, 1940)		K
Platycephalus laevigatus (Cuvier & Valenciennes, 1829)		V
Platycephalus speculator (Klunzinger, 1872)		K
Thysanophrys cirronasus (Richardson, 1848)		K
PLESIOPIDAE - PRETTYFINS		
Paralesiops meleagris (Peters, 1870)		K
Paraplesips sp. (of Hutchins & Thompson, 1983)		K
Trachinops caudimaculatus (McCoy, 1890)		K
Trachinops noarlungae (Glover, 1974)		K
PLEURONECTIDAE - RIGHT-HAND FLOUNDERS		
Ammotretis brevipinnis (Norman, 1926)		V
Ammotretis elongatus (McCulloch, 1914)		V
Ammotrtis rostratus (Günther, 1862)		V
Ammotretis tudori (McCulloch, 1914)		V
Azygopus pinnifasciatus (Norman, 1926)		V
Rhombosolea tapirina (Günther, 1862)		V
PLOTOSIDAE - EEL-TAILED CATFISHES		
Cnidoglanis macrocephalus (Cuvier & Valenciennes, 1840)		V
Neosilurus argenteus (Zietz, 1896)		K
Neosilurus hyrtlii (Steindachner, 1867)		K
2 x Neosilurus spp. (of Feinberg (MS, 1979))		K
POMACENTRIDAE - DAMSELFISHES		
Parma victoriae (Günther, 1863)		K

NAME	DISTRIBUTION	STATUS
POMATOMIDAE - BLUEFISHES		
Pomatomus saltator (Linnaeus, 1766)		V
PSYCHROLUTIDAE - BLOBFISHES		
Neophrynichthys marcidus (McCulloch, 1926)		K
REGALECIDAE - OARFISHES		
Regalecus glesne (Ascanius, 1772)		K
SCIAENIDAE - MULLOWAY; JEWFISHES		
Argyrosomus lolepidotus (Lacépède, 1802)		V
SCOMBERESOCIDAE - BILLFISHES		
Scomberesox saurus (Walbaum, 1792)		K
SCOMBRIDAE - MACKERELS; TUNAS		
Allothunnus fallai (Serventy, 1948?)		V
Auxis thazard (Lacépède, 1801)		V
Katsuwonus pelamis (Linnaeus, 1758)		V
Sarda australis (Macleay, 1880)		V
Scomber australasicus (Cuvier & Valenciennes, 1832)		V
Thunnus albacares (Bonnaterre, 1788)		V
Thunnus alalunga (Bonnaterre, 1788)		V
Thunnus maccoyii (Castelnau, 1872) (Fishing pressure has reduced this species to 20% of its original population, CSIRO regard this as a 'critical' level).		V
SCORPAENIDAE - SCORPIONFISHES		
Centropogon australis (White, 1790)		K
Glyptauchen panduratus (Richardson, 1850)		K
Gymnapistes marmoratus (Cuvier & Valenciennes, 1829)		K

NAME	DISTRIBUTION	STATUS
Helicolenus papillosus (Bloch & Schneider, 1801)		V
Maxillicosta scabriceps (Whitley, 1935)		K
Maxillicosta whitleyi (Eschmeyer & Poss, 1976)		K
Neosebastes nigropunctatus McCulloch, 1915)		K
Neosebastes pandus (Richardson, 1842)		K
Neosebastes panticus (McCulloch & Waite, 1918)		K
Neosebastes thetidis (Waite, 1899)		K
Scorpaena ergastulorum (Richardson, 1842)		K
SCORPIDIDAE - SWEEPS		
Scorpis aequipinis (Richardson, 1848)		V
Scorpis geogianus (Waite, 1905)		V
Neatypus obliquus (Waite, 1905)		K
Vinculum sexfasciatum (Richardson, 1842)		K
SERRANIDAE - SEA BASSES		
Acanthistius serratus (Cuvier & Valenciennes, 1828)		K
Caesioperca lepidoptera (Bloch & Schneider, 1801)		K
Caesioperca rasor (Richardson, 1839)		K
Hypoplectrodes nigrorubrum (Cuvier & Valenciennes, 1828)		K
Lepidoperca occidentalis (Whitley, 1951)		K
Othos dentex (Cuvier, 1828)		K
Promicrops lanceolatus (Bloch, 1790)		K
INCERTAE SEDIS		
Callanthias australis (Ogilby, 1899)		K

NAME	DISTRIBUTION	STATUS
SILLAGINIDAE - AUSTRALIAN WHITINGS		
Sillaginodes punctatus (Cuvier & Valenciennes, 1829)		V
Sillago bassensis (Cuvier & Valenciennes, 1829)		V
Sillago schomburgkii (Peters, 1865)		V
SOLEIDAE - SOLES		
Aseraggodes haackeanus (Steindachner, 1883)(?)		V
SPARIDAE - BREAM		
Acanthopagrus butcheri (Munro, 1949)		V
Chrysophrys auratus (Bloch & Schneider, 1801)		V
SPHYRAENIDAE - BARRACUDAS; SNOOK		
Sphyraena novaehollandiae (Günther, 1860)		V
Sphyraena obtusata (Cuvier & Valenciennes, 1829)		K
STERNOPTYCHIDAE - HATCHETFISHES		
Agyropelecus gigas (Norman, 1930)		K
Polyipnus tridentifer (McCulloch, 1914)		K
STOMIIDAE - SCALY DRAGONFISHES		
Stomias boa (Risso, 1810)		K
SYNANCEJIDAE		
Glyptauchen panduratus (Richardson, 1850)		K
SYNGNATHIDAE - PIPEFISHES AND SEAHORSES		
Acentronura australe (Waite & Hale, 1921)		K
Campichthys tryoni (Ogilby, 1890)		K

NAME	DISTRIBUTION	STATUS
Filcampus tigris (Castelnau, 1879)		K
Heraldia nocturna (Paxton, 1975)		K
Hippocampus abdominalis (Lesson, 1827)		K
Hippocampus breviceps (Peters, 1870)		K
Hippocampus whitei (Bleeker, 1855)		K
Histiogamphelus gallinaceus (Hale, 1941)		K
Histiogamphelus maculatus (Hale, 1939)		K
Histiogamphelus robensis (Whitley, 1948)		K
Hypselognathus horridus (Dawson & Glover, 1982)		K
Hypselognathus rostratus (Waite & Hale, 1921)		K
Kaupus costatus (Waite & Hale, 1921)		K
Leptoichthys fistularius (Kaup, 1853)		K
Leptonotus semistriatus (Kaup, 1853)		K
Lissocampus affinis (Whitley, 1944)		K
Lissocampus caudalis (Waite & Hale, 1921)		K
Lissocampus runa (Whitley, 1931)		K
Macroubra perserrata (Whitley, 1948)		K
Notiocampus ruber (Ramsay & Ogilby, 1886)		K
Phycodurus eques (Günther, 1865) (Leafy Sea-dragon is completely protected)		V
Phyllopteryx taeniolatus (Lacépède, 1804)		K
Solegnathus robustus (McCulloch, 1911)		K
Solegnathus spinosissimus (Günther, 1870)		K
Stigmatopora argus (Richardson, 1840)		K
Stigmatopora nigra (Kaup, 1853)		K
Stipecampus cristatus (McCulloch & Waite, 1918)		K

NAME	DISTRIBUTION	STATUS
Syngnathus curtirostris (Castelnau, 1872)		K
Syngnathus flindersi (Scott, 1957)		K
Syngnathus phillipi (Lucas, 1891)		K
Syngnathus poecilolaemus (Peters, 1869)		K
Syngnathus vercoi (Waite & Hale, 1921)		K
Urocampus carinirostris (Castelnau, 1872)		K
TERAPONIDAE - GRUNTER PERCHES		
Pelates sexlineatus (Quoy & Gaimard, 1825)		V
Pelsartia humeralis (Ogilby, 1899)		K
TETRAODONTIDAE - PUFFERFISHES		
Contusus brevicaudus (Hardy, 1981)		K
Contusus richei (Freminville, 1873)		K
Lagocephalus sceleratus (Gmelin, 1788)		K
Omegophora armilla (McCulloch & Waite, 1915)		K
Omegophora cyanopunctata (Hardy & Hutchins, 1981)		K
Polyspina piosae (Whitley, 1955)		K
Tetractenos glaber (Freminville, 1813)		K
Tetraodon firmamentun (Temminck & Schlegel, 1850)		K
Torquigener pleurogramma (Regan, 1903)		K
TRACHICHTHYIDAE - SAWBELLIES		
Gephyroberyx darwini (Johnson, 1866)		K
Hoplostethus gigas (McCulloch, 1914)		K
Hoplostethus intermedius (Hector, 1875)		K
Hoplostethus mediterraneus (Cuvier & Valenciennes, 1829)		V

NAME	DISTRIBUTION	STATUS
Optivus elongatus (Günther, 1859)		K
Paratrachichthys trailli (Hutton, 1876)		K
Trachichthys australis (Shaw & Nodder, 1799)		V
TRACHIPTERIDAE - RIBBONFISHES		
Trachipterus arawatae (Clarke, 1881)		K
TRICHIURIDAE - HARITAILS		
Lepidopus lex (Phillips, 1932)		K
Trichiurus coxii (Ramsay & Ogilby, 1887)		K
TRIGLIDAE - GURNARDS		
Chelidonichthys kumu (Lesson & Garnot, 1826)		V
Lepidotrigla vanessa (Richardson, 1839)		K
Paratrigla papilio (Cuvier & Valenciennes, 1829)		K
Peristedion picturatum (McCulloch, 1926)		K
Pterygotrigla picta (Günther, 1880)		K
Pterygotrigla polyommata (Richardson, 1839)		V
TRIPTERYGIIDAE - THREEFIN BLENNIES		
Brachynectes fasciatus (Scott, 1957)		K
Helcogramma decurrens (McCulloch & Waite, 1918)		K
Lepidoblennius marmoratus (Macleay, 1878)		K
Norfolkia striaticeps (Ramsay & Ogilby, 1888)		K
Norfolkia spp. x 2 (of Kuiter & Glover (MS, 1984))		K
Trainectes bucephalus (McCulloch & Waite, 1918)		K

NAME	DISTRIBUTION	STATUS
URANOSCOPIDAE - STARGAZERS		
Ichthyscopus barbatus (Mees, 1960)		K
Kathetostoma laeve (Bloch & Schneider, 1801)		K
Kathetostoma nigrofasciatum (Waite & McCulloch, 1915)		K
Kathetostoma sp. (of Last et al., 1983)		K
Pleuroscopus sp. (of Last et al., 1983)		K
XIPHIIDAE - SWORDFISH		
Xiphias gladius (Linnaeus, 1758)		K
ZEIDAE - DORIES		
Cyttus australis (Richardson, 1843)		V
Cyttus traversi (Hutton, 1872)		K
Zenopsis nebulosus (Temminck & Schlegel, 1845)		V
Zeus faber (Linnaeus, 1758)		V

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