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# A BIOLOGICAL SURVEY OF LAKE HAWDON SOUTH AUSTRALIA

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By  
H.J. Stewart, T.J. Hudspith, K.L. Graham,  
S.J. Milne and G.A. Carpenter



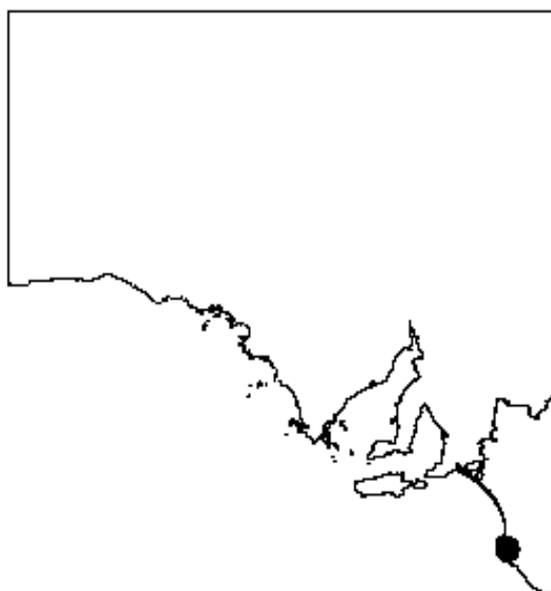
DEPARTMENT FOR  
**environment**  
and heritage



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# A BIOLOGICAL SURVEY OF LAKE HAWDON SOUTH AUSTRALIA IN JANUARY 2000

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By  
**By H. J. Stewart, T. J. Hudspith, K. L. Graham, S. J. Milne and G. A. Carpenter.**

Biodiversity Survey and Monitoring  
National Parks and Wildlife, South Australia  
Department for Environment and Heritage, South Australia

2001

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#### **CARTOGRAPHY AND MAP DESIGN**

**Geographical Analysis and Research Unit  
Department for Transport, Urban Planning and the Arts  
All geographical data came from the Statewide Map Library,  
Environmental Data Base of South Australia**

**Cover Photograph:  
Sedgeland is one of the typical vegetation communities found at Lake Hawdon.  
Photo. Hafiz Stewart.**

# PREFACE

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*A Biological Survey of Lake Hawdon, South Australia* is a further product of the Biological Survey of South Australia.

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

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

It is anticipated that the Biological Survey will achieve complete statewide coverage by 2015 and will be an achievement for which we can be very proud. Biologists in the future will be able to measure the direction of long-term ecological change, and we will have substantially improved our knowledge of the biodiversity of South Australia and our ability to adequately manage nature conservation into the future.



IAIN EVANS  
**Minister for Environment and Heritage**  
**Minister for Recreation, Sport and Racing**



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## Lake Hawdon Biological Survey

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# ABSTRACT

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A five-day survey of the vegetation and vertebrate fauna of Lake Hawdon was undertaken in January 2000 and two short reconnaissance trips occurred a few months prior to the survey. This resulted in the recognition of:

- 91 plant species (27 introduced),
- 7 mammal species (4 introduced),
- 88 bird species (4 introduced),
- 8 species of reptile and 5 species of frog.

In addition, a further 22 plant, 1 mammal and 17 bird species have been recorded from the study area previously. If all plant and animal records are considered then, Lake Hawdon supports 7 species of plant, 8 (possibly 9) species of bird and one species of reptile of conservation significance. Lake Hawdon also supports three vegetation communities of conservation significance. Rare and unusual formations known as stromatolites can also be found at Lake Hawdon.

The majority of Lake Hawdon is currently managed as unallotted Crown Land subject to occupational licences issued for sheep grazing purposes. Apart from grazing, Lake Hawdon has also been subjected to periodic burning. The practice of grazing and burning is likely to be detrimental to the long-term viability of some of the plants and animals of conservation significance. Grazing and burning is also likely to be detrimental to the long-term viability of some of the vegetation communities of conservation significance. Grazing by stock may adversely affect the long-term viability of the stromatolites. Any major change in the water regime or quality or a rise in salinity may be detrimental to the long-term viability of several plant and animal species and plant communities of conservation significance.

Based on this information, Lake Hawdon can be regarded as an area of high conservation value, which may be under threat from current land use practices. This report recommends that further biological research be conducted, current land use practices and water regime be reviewed, water quality and salinity be monitored and that all, or part of Lake Hawdon would be a worthy inclusion in the National Parks and Wildlife Reserve System as a Conservation Park under the National Parks and Wildlife Act, 1972.



# **ACKNOWLEDGMENTS**

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Unlike previous Biological Surveys in this series, the data contained in this report was collected over a one week period of field work undertaken in response to the need by the Department for Environment and Heritage, to acquire specific biological information for the Lake Hawdon area. This information was needed to assist in determining an appropriate management plan for Lake Hawdon. Consequently, a small team of biologists were developed and supervised by the survey coordinator, Hafiz Stewart. All members made a notable contribution to the effectiveness of this survey.

## **Field work**

### Vegetation survey

Kate Graham and Christine Arnold collected plant specimens during the survey.

### Vertebrate survey

The vertebrate survey entailed obtaining records for all mammals (m), reptiles (r) and birds (b) present at all survey sites during the survey. These records were obtained by Hafiz Stewart (m), Steve Milne (r) and by Graham Carpenter (b).

### General

Jane Burke also participated in the survey and provided general assistance to the survey team.

## **Specimen identification**

**Plants:** Kate Graham identified all plant species in the field. Collected specimens were verified by Rosemary Taplin and lodged in the collections of the State Herbarium.

**Mammals:** Hafiz Stewart identified all mammal species in the field. Collected specimens were verified by Cath Kemper and lodged in the collections of the SA Museum.

**Reptiles:** Steve Milne identified all reptile species in the field. Collected specimens were verified by Adrienne Edwards and lodged in the collections of the SA Museum.

**Birds:** Graham Carpenter identified all bird species in the field. No specimens were collected. Lynn Pedler, Jack Bourne and Brian Heywood also contributed to the bird data.

## **Vegetation mapping**

Jason Phillips from the Geographical Analysis and Research Branch (GAR), Department for Transport, Urban Planning and the Arts (DTUPA) produced the vegetation map contained in the pocket attached to the inside back cover of this report.

## **Editing**

Tim Hudspith edited this report.

## **Proof reading**

Tim Hudspith, Hafiz Stewart, Tony Robinson, Robert Brandle, Brenton Gear and Tim Croft all proof read either chapters or the entire report.

## **Other**

Thanks to Kathleen Grey from the Geological Survey of Western Australia for information in relation to stromatolites. Thanks to Brenton Gear for providing advice, direction, support and back ground information used to write part of the introduction. Thanks to Tim Croft for generously providing expert advice in relation to plant species and communities and other advice. Thanks also to all land managers for their assistance.

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**Lake Hawdon Biological Survey**

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# INTRODUCTION

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Since 1971 the South Australian Department for Environment and Heritage (DEH) has been conducting systematic biological surveys of the vegetation and vertebrate fauna of large regions of the state as part of the Biological Survey of South Australia. The aim of these surveys is to document the range of biological variation across the state to improve long-term natural resource management.

Up to mid 2001, 13 major regions have been studied by what is now the Biodiversity Survey and Monitoring Section, Biodiversity and Heritage Branch, National Parks and Wildlife, South Australia of DEH. These regions are: the Offshore Islands (excluding Kangaroo Island) (1971 - 1982), South-East Coast (1982 - 1983), Nullarbor Plain (1984), Gawler Ranges (1985), Yellabinna (1987), Kangaroo Island (1989 - 1990), Murray Mallee (1990 - 1991), South Olary Plains (1991 - 1992), South East (1991 & 1997), Stony Deserts (1994 - 1997), North Olary Plains (1995 - 1996), Coastal Dunes and Clifftops (1996 - 1998) and Flinders Ranges (1997 - 2000). Other comparable surveys conducted by consultants or NGO's under the auspices of the Biological Survey of South Australia include: Cooper Creek (1983 & 1991), Breakaways Reserve (1986), Chowilla (1988), Strzelecki Dunefields (1988 - 1992), Tallaringa Area (1988 & 1993), Kulliparu Conservation Park (1990), Lake Newland Conservation Park (1991), Gammon Ranges National Park (1993), Diamantina River Area (1994), Mt Brown (1994 & 1997), Gum Lagoon Conservation Park (1995 - 1996) and Lake Eyre South (1996 - 1997). Generally the boundaries of these surveys have been based on the Environmental Regions and the Environmental Associations described and mapped for South Australia by Laut *et al.* (1977).

Surveys involving vegetation sampling analysis and mapping only have been completed, or are in progress, in conjunction with the Department for Transport, Urban Planning and the Arts (DTUPA) for the Mid-North (1991 - 1998), Western Murray Flats (1992 & 1999), Burra Hills (1994 - 1995), Yorke Peninsula (1994 - 2000), Upper Mid-North and Northern Spencer Gulf (1996) and the Northern Adelaide Plains (1996).

Ongoing vegetation and vertebrate surveys are being conducted in the Anangu Pitjantjatjara Lands (1991 -), Sandy Deserts (1997 -), Mt Lofty Ranges (2000 -) and Eyre Peninsula (2001 -).

More recently, a number of specific surveys have been undertaken in response to the need for detailed biological

information for particular areas. These include: the Biological Survey of Yumberra Conservation Park (Owens *et al.*, 1995b), which assessed the potential impact of the proposed mineral explorations for the Park, the Box and Buloke Grassy Woodlands (Stokes, 1996), which collected biological information required to develop management recommendations for the conservation of these remnant woodlands, the Grasslands and Grassy Woodlands of the Lofty Block Bioregion (Robertson, 1998), which focused on vegetation associations of conservation significance and the Biological Surveys of Messent Conservation Park (Owens *et al.*, 1995a), Deep Swamp (Stewart, 1996), Tilley Swamp (Stewart *et al.*, 1998a) and Bunbury Conservation Reserve and Stoneleigh Park Heritage Agreement (Stewart *et al.*, 1998b) which assessed the likely biological impacts of proposed drains through these areas as part of the Upper South East Dryland Salinity and Flood Management Plan (1993).

The Biological Survey of Lake Hawdon was also undertaken in response to the need for detailed biological information for a specific area. The survey was coordinated by Hafiz Stewart and was carried out from January 17<sup>th</sup> to the 21<sup>st</sup> 2000.

### The location and characteristics of Lake Hawdon

Lake Hawdon is an ephemeral wetland located approximately 15km due east of Robe in the South East of South Australia (Figure 1). Lake Hawdon covers an area of 5,530 hectares and falls within the Lake Hawdon Environmental Association (1.2.3). The area is described by Laut *et al.* (1977) as being typified by "seasonal brackish swamps" surrounded by a cultural landscape of cleared grazing land. The region has a cool, moist climate with long mild summers. Evaporation in the summer months greatly exceeds precipitation. Mean annual rainfall is between 650mm to 850mm and mean annual evaporation is estimated to be 1600mm (Laut *et al.*, 1977).

Lake Hawdon is divided into two distinct basins, Lake Hawdon North and Lake Hawdon South. The Old Naracoorte Road passes in between these two basins.

Lake Hawdon North encompasses 2,340 hectares. Jones (1978) describes Lake Hawdon North as being "mostly open saltpan although there are several large areas of sedgeland in the northern half". The South Eastern Wetlands Committee (1985) suggests the body of the lake is "mainly bare saline shell grit". The edge of the lake is fringed with *Melaleuca halmaturorum* over *Gahnia filum* and *Juncus maritimus* (Jones, 1978). This narrow strip of vegetation grades into mainly cleared grazing land.

Lake Hawdon South comprises 3,190 hectares and is characterised by large expanses of sedgelands, including species such as *Gahnia filum*, *Juncus kraussii* and *Isolepis nodosa* (Jones, 1978). These sedgelands are thought to be of high conservation value as “there are no comparable areas of sedgeland remaining in the South-East” (Jones, 1978).

### **The water regime of Lake Hawdon**

It is thought that although Lake Hawdon was “probably never a permanent lake” its water regime has been “considerably affected by the construction of drainage works” (South Eastern Wetlands Committee, 1985).

In the past, floodwaters flowed in a north west direction along Biscuit Flat toward the south east of Lake Hawdon. These floodwaters then diverged with some flowing into Lake Hawdon, while the remainder either accumulated on the surrounding tea-tree flats, or by-passed the Dairy Range to the east before finally reaching Maria Creek near Kingston and flowing out to sea. Most of the swamps and floodwaters of the Biscuit Flat have now been drained by a complex system of drains, the first of which was constructed in the 1880’s (South Eastern Wetlands Committee, 1985).

Drain L a relatively major drain, constructed by the South Eastern Water Conservation and Drainage Board, runs through the middle of Lake Hawdon North in an east north east to west south west direction. The drain has a catchment as far east as the Bakers Range Watercourse, and also receives flows from Lake Hawdon South through the Lake Hawdon Connecting Drain. Jones (1978) suggests the drain “has probably reduced the amount of water” found in the Lake. Nevertheless, Lake Hawdon North is still inundated in periods of higher volume surface flows which flood out from Drain L. Private drains also direct water from low-lying clay pans to the east and north-east into Lake Hawdon North.

Biscuit Flat is the catchment for the Bray Drain which terminates in the south-eastern section of Lake Hawdon South. Consequently this part of the lake is often inundated with fresh water (Figure 2). Jones (1978) suggests this feature may have “created good habitat for some species of waterbirds”. Indeed, Lake Hawdon South supports high densities of the Australasian Bittern *Botaurus poiciloptilus* (South Eastern Wetlands Committee, 1985) which is listed as ‘vulnerable’ under Schedule 8, NPW Act, 1972.

In periods of extreme inundation, both lakes have a water depth of less than a metre with the southern basin retaining water until late summer and the northern basin drying-out approximately 6 weeks earlier.

The area functions as an important part of the local drainage and flood mitigation scheme. Lake Hawdon is utilised as a flood equalisation basin during winter and close cooperation between all land managers is required

to ensure achievement of flood mitigation and conservation objectives.

### **The biological and ecological significance of Lake Hawdon**

#### The regional perspective

Lake Hawdon is located in the South East Region of South Australia, which has high biological diversity, due to its variety of habitats. These include grasslands, shrublands, woodlands and forest as well as saline, brackish and freshwater wetlands. The flora and fauna of the region is generally typical of south-eastern Australia, with many species at their western limit, while its northern boundary is the southern limit of the mallee scrubs. This creates, in a number of cases, a unique mix of species. The region provides habitat for 77% of the State’s bird, 53% of the State’s mammal and 42% of the State’s plant species, although comprising only around 2% of the State’s land area (Croft *et al.*, 1999).

Since European settlement 82.5% of the region has been developed for agriculture or commercial forestry, the most extensively cleared of any of the State’s region’s, except for the Mount Lofty Ranges. Only 13% of the native vegetation remains. However, some authors argue even less native vegetation remains. Indeed, Jensen (1993) suggested as little as 7% remains.

The remaining areas of native vegetation play a crucial role in maintaining the region’s high biodiversity. Only 25% of the remaining native vegetation is conserved in State Government reserves, with a further 15% privately conserved under Heritage Agreements. The majority of the regions remaining native vegetation (60%) occurs on private land, much in degraded condition due to disturbance, such as domestic stock grazing, preventing regeneration of new plants.

Less than 2% of pre-European settlement wetlands remain in the South East and little of this area is in original condition (State of the Environment Report for South Australia, 1998). Most of these wetlands have been drained and modified, with the remaining areas now considered of high conservation significance. Two areas, the Coorong and Bool and Hacks Lagoons, are listed as Wetlands of International Importance under the Ramsar Convention. It is significant to note that Australia played a key role in developing the Ramsar convention and “was one of the first signatories” (Australian Nature Conservation Agency) and that the Ramsar convention now recognises the concept of ecologically sustainable development (ESD).

The region’s wetlands provide important habitat for waterbird species, including breeding areas, or overwintering feeding areas for migratory wader species subject to International Migratory Bird Agreements between Australia and Japan and the People’s Republic of China (JAMBA and CAMBA).

The freshwater wetlands of the region provide habitat for native freshwater fish species, three of which are listed as 'threatened' nationally (Endangered Species Protection Act, 1992).

The region is characterised by a relatively high number of invertebrate species including two rare species *Boekella nyoraensis* and *Boekella spinosa*. (Walsh and Croft, unpublished draft).

A number of threatened plant species, and regionally rare plant communities are also found in the South East.

#### The local perspective

Lake Hawdon itself provides habitat for 2 migratory bird species listed under the 'Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment' (CAMBA). These species are the Glossy Ibis and Latham's Snipe. Lake Hawdon also has a rich and diverse waterbird population in general, including the Australasian Bittern, which is considered 'vulnerable' in South Australia (Schedule 8, NPW Act, 1972).

Lake Hawdon supports a population of the Glossy Grass Skink, which is considered 'endangered' in South Australia (Schedule 7, NPW Act, 1972).

Several 'rare' plant species have been recorded for Lake Hawdon including *Agrostis billardieri v. filifolia*, *Zoysia matrella* and *Triglochin alcockiae* (Schedule 9, NPW Act, 1972). The lake also supports areas of Cutting Grass *Gahnia trifida* Sedgeland and Thatching Grass *Gahnia filum* Sedgeland (Figure 3). These *Gahnia* spp. plant communities are considered 'vulnerable' at the Regional level (Croft *et al.*, 1999)

The *Gahnia* spp. sedgeland at Lake Hawdon is currently subjected to grazing and periodic burning (Figure 4). Ganf (1998) suggests "evidence from the scientific community is that grazing by domestic stock has unacceptable environmental impacts upon wetlands". Some of these impacts include increasing water turbidity and nutrient levels, which can lead to an increase in phytoplankton communities. If conditions are right these phytoplankton communities can cause cyanobacterial bloom which results in the water becoming toxic (Ganf, 1998). Other impacts include a decline in biomass, a decline in productivity, a loss of endemic species and an invasion by exotic species (Ganf, 1998). Indeed, exclosures set up at Lake Hawdon in the 1980's (Gould, pers. comm., 2001) demonstrate species regeneration and diversity are greater if stock are prevented from grazing (Ganf, 1998).

Unique, unusual and rare calcified formations known as stromatolites are present at Lake Hawdon South (Figure 5). Kathleen Grey from the Geological Survey of Western Australia describes stromatolites as living organisms, which resemble rock like structures, built by microorganisms, mainly cyanobacteria. These features are related to geologically ancient life forms dating back

3500 million years and were one of the earliest forms of life on earth. The discovery of modern examples of these formations assisted scientists in unravelling the history of life on earth and as such they are invaluable. Stromatolites are fragile and can be degraded due to drainage or trampling by stock. They can also be detrimentally affected by an increase in the level of available nutrients as this can change the ecology of the cyanobacteria communities (Grey, pers. comm., 2001).

The lake was registered on the Register of the National Estate in 1982. It is one of the few remaining areas of relatively natural habitat in the poorly conserved Interim Biogeographical Regionalisation of Australia (IBRA) Naracoorte Coastal Plains region. Only an estimated 5 – 10% of the total Naracoorte Coastal Plains region is considered conserved (Thackway and Cresswell, 1995).

#### **The cultural, tourism and recreational values of Lake Hawdon**

This report is mainly concerned with the biological aspects of Lake Hawdon. A separate report focusing on the cultural, recreational and tourism values may be required in formulating a management plan for Lake Hawdon. Only a brief discussion of these values is produced below.

Public use of Lake Hawdon is thought to be low with most interest being from visitors with an awareness of natural history. Lake Hawdon is readily accessible from both the Old Naracoorte and Robe-Penola Roads and provides recreational opportunities for bushwalking and birdwatching amongst heathland and wetland habitats.

Duck hunting occurs along the banks of Drain L and the Bray Drain. Seasonal grazing of sheep, subject to occupational licences also takes place.

In the relatively recent past, land use has predominantly been pondage for the drainage system. Indeed, the lake is still a significant component of the regional drainage network developed over the last century.

In the more distant past, the Bunganditj clan of the Boandik inhabited the area for thousands of years and the lake may still be important for the local indigenous people. However, it is not within the scope of this report to analyse in any detail past or current indigenous land use.

#### **The land tenure of Lake Hawdon**

The majority of Lake Hawdon is currently managed as unallotted Crown Land subject to occupational licences issued for sheep grazing purposes. The balance of the land is held as drainage reserve.

An area of unallotted Crown land is land not alienated from Crown responsibility through leasehold or licence

transaction, and which is not formerly placed under the care, control and management of a specific statutory authority. Unallotted Crown land is administered through the Department for Environment and Heritage.

Four occupation licences for sheep grazing purpose have been issued at Lake Hawdon. Three are for Lake Hawdon North and one for Lake Hawdon South.

The South Eastern Water Conservation and Drainage Board manage Section 386, Hundred of Waterhouse; Section 97, Hundred of Ross and Sections 199 and 200, Hundred of Bray as drainage reserves.

As such, for all, or part of Lake Hawdon to be declared as a Conservation Park and included in the National Parks and Wildlife Reserve System, the current nature of the land tenure would need to be changed.

### **The background to the Biological Survey of Lake Hawdon**

The biological potential of Lake Hawdon has long been recognised. In 1978 the Nature Conservation Society of South Australia published a report by Warren Jones titled 'The Wetlands of the South-East of South Australia'. The report aimed to "assess the current extent of wetlands in the South-East, their conservation status, and delineate any areas which may be worthy of acquisition as conservation reserves" (Jones, 1978). He described and assessed Lake Hawdon and recommended grazing be excluded from Lake Hawdon South and that the area be declared a Conservation Reserve. Jones (1978) also suggested Lake Hawdon North be flooded as it may be useful to waterbirds and "as such may supplement Lake Hawdon South as a Conservation Reserve or be managed for the production of game species".

Lake Hawdon was again assessed as part of the South Eastern Wetlands Committee (1985) report titled 'Wetland Resources of the South East of South Australia'. Lake Hawdon was also one of several large wetlands considered in the South East Coastal Lakes Strategy (1991) prepared by the Department of Lands. The South Eastern Wetlands Committee recommended a hydrological and ecological study be undertaken to determine the potential wetland habitat value of the lake. The Coastal Lakes Strategy recommended that, under the direction of a steering committee, a management plan with suggestions on the future allocation and management of the land be prepared for consideration of the Minister.

In 1998, an application was submitted to the Natural Heritage Trust entitled 'South East Coastal Lakes' with the aim of progressing the recommendations of the 'South East Coastal Lakes Strategy' and ensuring principles of wise wetland use were applied to the management of Lake Hawdon. This application was approved and part-funding granted from the Natural Heritage Trust to investigate the biological values of the lake and assist with the preparation and implementation of a management plan.

The Minister for Environment and Heritage approved the establishment of the Lake Hawdon Management Planning Steering Committee on 9<sup>th</sup> August 1999 to investigate future management options for Lake Hawdon and prepare a management plan for the site. The Lake Hawdon Management Planning Steering Committee is chaired by the District Council of Robe with members representing the Upper South East Consultative Committee, South Eastern Water Conservation and Drainage Board, South Australian Field and Game Association Inc, local landholders and the Department for Environment and Heritage.

The Lake Hawdon Management Planning Steering Committee was given the task of preparing a draft management plan. Once the plan is adopted, the provisions will be carried out and no activities, in conflict with the management plan, will be undertaken.

The Lake Hawdon management plan study area includes Sections 386, 398 and 399, Hundred of Waterhouse, Section 89, 97 and 173, Hundred of Ross, and Sections 177, 178, 199 and 200, Hundred of Bray.

A Biological Survey of Lake Hawdon was conducted in January 2000 in order to gather biological information to assist in the production of the draft management plan. The results of the survey are contained in this report.

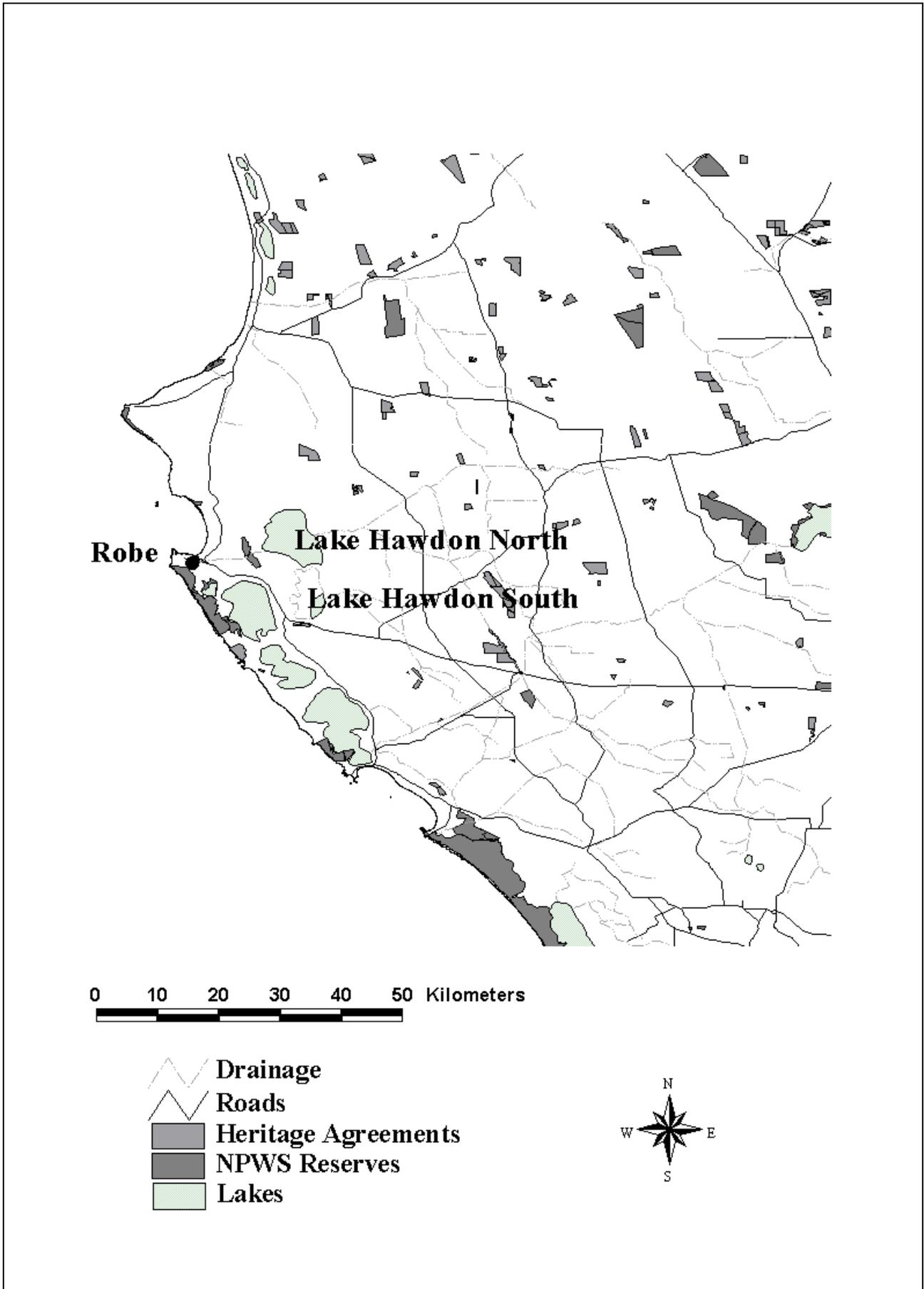


Figure 1. The location of Lake Hawdon in relation to NPWS reserves and Heritage Agreement areas. Map by Robert Brandle.



**Figure 2. Lake Hawdon South inundated with water in November 1999.  
Photo. Hafiz Stewart.**



**Figure 3. *Gahnia* spp. Sedgeland, a characteristic vegetation community of Lake Hawdon, is considered ‘vulnerable’ at the Regional level.  
Photo. Hafiz Stewart.**



**Figure 4. An area of burnt *Gahnia* spp. Sedgeland at Lake Hawdon South in November 1999.  
Photo. Hafiz Stewart.**



**Figure 5. An example of a stromatolite found at Lake Hawdon South.  
Photo. Hafiz Stewart.**



# METHODS

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Copley and Kemper (1992) explain the rationale behind regional Biological Surveys in detail and so only a brief explanation will be reproduced here.

The Lake Hawdon Biological Survey was conducted in patches of remnant vegetation in the agricultural district of South Australia, where much of the natural vegetation and its associated vertebrate fauna has been fragmented by clearance and undergone substantial habitat modification for agriculture. For this reason a number of alterations to the methods adopted in the previous regional surveys for extensive areas of natural vegetation were required. More recently, a number of specific Biological Surveys (Owens *et al.* 1995a,b, Stokes, 1996, Stewart, 1996, Stewart *et al.*, 1998a,b and Robertson, 1998) have been undertaken and these have provided a methodology which ensured data collected in this survey was comparable with data collected in previous broad-scale surveys.

The Biological Survey of Lake Hawdon was designed with the following aims:

- 1) To investigate and collate all previously existing information on the biota of Lake Hawdon.
- 2) To undertake a Biological Survey of Lake Hawdon in order to determine the presence of all flora and fauna, using standard and repeatable methodologies. This entailed providing both the SA Museum and State Herbarium with voucher specimens collected during the survey, and entering all the collected data onto the South Australian Survey Database.
- 3) To establish permanent sampling sites to collect baseline data, and monitor changes to the flora and fauna of Lake Hawdon over time.
- 4) To prepare a 1:70 000 scale vegetation map of the study area.
- 5) To make this information available to assist in determining an appropriate management plan for Lake Hawdon.

### Site selection and nomenclature

The fundamental concept behind all of the regional surveys conducted, as part of the Biological Survey of South Australia to date, has been that they are based on

intensive sampling at a series of 'quadrats' which are representative of the biological and geographical diversity of the study area.

Since the Lake Hawdon survey was designed to assist in determining an appropriate management plan for the area, some changes were made to the quadrat selection process. Due to the smaller size, and more intensive nature of the survey, only one group of eight quadrats was selected, all of which were sampled intensively over a one-week period from January 17<sup>th</sup> to the 21<sup>st</sup>, 2000. For the purposes of nomenclature, a group of quadrats is referred to as a 'camp'. Each camp is assigned a three-letter code, which usually relates to the mapsheet name or a significant feature found in the local area, such as a mountain. For this survey a camp name of 'ROBE' was chosen and so each quadrat was given a code starting with the letters 'ROB'. Each quadrat was then numbered from 10 to 17. The numbers 1 to 9 had already been used for previous surveys, which also utilised the camp name of 'ROBE'. Within each quadrat a representative area of habitat was surveyed and this area was referred to as a 'patch'. Thus patch 01 at quadrat 10, camp ROB was labelled ROB01001. For ease of interpretation 'ROB01001' was also referred to in lay terms as 'survey site 10'. This report uses this general terminology from time to time.

An attempt was made to locate at least one quadrat in each of the major habitat types. Some habitats were sampled more than once in relation to their abundance and relative conservation importance. Quadrat selection was also based on ease of access. Survey equipment is heavy, bulky and difficult to transport so in general most quadrats were located in close proximity to roads or tracks.

Where practical, quadrats were only placed in areas of habitat greater than four hectares (200m x 200m). This was done in an effort to minimise any 'edge' effect associated with neighbouring habitat types or cleared areas. Each patch was usually placed in the centre of the quadrat. Figure 6 (contained in a pocket attached to the inside back cover of this report) illustrates the distribution of survey sites.

### Data collection

At each survey site a 30m x 30m representative patch of vegetation was chosen for sampling. All vascular plants present within the patch were recorded and representative voucher specimens were collected and

labelled for later verification at the State Herbarium. All data on the plant species, including life stage, cover/abundance and vegetation association description were recorded on standard data sheets. Details on the overstorey height, canopy depth and diameter, and canopy cover were also recorded, as well as a description of the location and physical environment of each patch and quadrat. Table 1 lists the vegetation associations sampled at each of the eight quadrats.

All eight quadrats were also sampled for the presence of vertebrates and invertebrates. At each quadrat, a 60m line of six pitfall traps, linked together by a 30cm high mesh fence, were established. Each pitfall trap consisted of a 455mm x 380mm sheet of white, high impact polystyrene joined into a cylinder using a slotted H section plastic strip (HM12). Consequently, the pitfall traps had a diameter of 125mm and a depth of 380mm. Pitfall traps were used to capture small animals. Any captured animals were collected as soon as possible, usually in the early morning, to minimise any stress.

A line of 15 Elliott traps, also used to capture small animals, were set in association with each pitfall line and sampled the same habitat within the quadrat. A possum/cat size trap was placed at each end of the Elliott trap line. Any animals captured in these traps were also collected as soon as possible. A line of 6 micro-pitfalls, consisting of plastic vials measuring 80mm x 20mm, and filled with 70% alcohol, were placed parallel to the main pitfall line. These micro-pitfalls were used to trap invertebrates. Once trap-lines were established they were maintained for four nights.

Vertebrates were also sampled by manually searching each of the eight survey sites at least once during the survey period. A single harp trap, used to capture bats, was also set up within the survey area for three nights.

A small amount of vehicle spotlight searching was attempted but the demands of quadrat sampling and

specimen processing did not allow this to be undertaken in a systematic way.

Birds were recorded for each quadrat. An expert observer spent from one to several hours during the best bird observation times (early morning and evening) recording all birds within, or flying over, the quadrat during the search period. An attempt was made to put the same amount of search effort into each quadrat during the best observation times.

Observations of some plants and vertebrates encountered outside quadrats were recorded on a separate 'opportunistic' data sheet.

At least one specimen of each small mammal and reptile species recorded for the survey area was preserved as a museum specimen. Larger species, which had been collected from the general region in the past and did not present any identification problems, were not collected.

Samples of liver tissue were taken from all vertebrate specimens collected and these were temporarily stored in liquid nitrogen. These tissue samples are now permanently stored at the South Australian Museum (SAM).

Invertebrates were collected from the micro-pitfall and larger vertebrate pitfall traps or opportunistically around each quadrat. These samples were also lodged with SAM.

A permanent photographic monitoring point was established at each of the eight survey sites using two 1.4m long steel posts placed 10m apart (Figures 7 - 14).

A summary of the sampling effort over the whole survey is given in Table 2. The number of individual observations during the survey is shown in Table 3.

**Table 1.**  
**Flora and fauna sampling quadrats established in the Lake Hawdon study area, January 2000.**

Survey site code	Vegetation association
ROB01001	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> Tall open shrubland
ROB01101	<i>Juncus kraussii</i> , <i>Rumex crispus</i> Closed sedgeland
ROB01201	<i>Danthonia semiannularis</i> Tussock grassland
ROB01301	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> Open shrubland
ROB01401	<i>Gahnia filum</i> Sedgeland
ROB01501	<i>Baumea arthropphylla</i> Sedgeland
ROB01601	<i>Baumea arthropphylla</i> , <i>Baumea juncea</i> Closed sedgeland
ROB01701	<i>Gahnia trifida</i> Sedgeland

**Table 2.**  
**Trapping and spotlighting effort during the Lake Hawdon Biological Survey, January 2000.**

Survey site code	Pit trap nights	Elliott trap nights	Vehicle spotlight hours	Harp trap nights
ROB01001	24	60		
ROB01101	24	60		
ROB01201	24	60		
ROB01301	24	60		
ROB01401	24	60		
ROB01501	24	60		
ROB01601	24	60		
ROB01701	24	60		
Opportunistic			3.3	3
<b>Totals</b>	192	480	3.3	3

**Table 3.**  
**Total number of individual plant and vertebrate species recorded during the Lake Hawdon Biological Survey, January 2000.**

	Quadrats	Opportunistic	Totals
<b>Plants</b>	70 (8 sites)	12	82
<b>Mammals</b>	7 (8 sites)	0	7
<b>Birds</b>	40 (8 sites)	48	88
<b>Reptiles</b>	7 (8 sites)	0	7
<b>Amphibians</b>	5 (8 sites)	0	5

### Data management

All collected specimens were lodged with the appropriate institutions for verification and were added to their collections if required. The State Herbarium received all collected plant specimens and the vertebrate and invertebrate specimens were lodged with SAM. Any corrections to specimen identification were transferred to the original data sheets and the data was entered on the Opportunistic and Survey databases administered by the Biodiversity Survey and Monitoring Section of DEH.

### Vegetation mapping

Due to the relatively small number of vegetation quadrats sampled in this survey a PATN analysis, used to define floristic groups for most other surveys, was not attempted.

Instead, a 1:70 000 scale floristic vegetation map of the Lake Hawdon area was generated using previous regional floristic vegetation mapping undertaken by the Geographic Analysis and Research Unit (GAR) of the Department for Transport, Urban Planning and Arts (DTUPA). Jason Phillips, using ESRI ARC/INFO GIS software produced the final map (Figure 6). This map is contained in a pocket attached to the inside back cover of this report.



# RESULTS

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## VEGETATION

### Regional floristic vegetation mapping

Regional floristic vegetation mapping at 1:40 000 scale existed for the South East prior to this survey (Heard, 1999). This regional mapping was completed following the regional native vegetation survey in 1991, and subsequent data analysis and research. A report detailing the South East regional survey and mapping is currently in preparation (Foulkes and Heard, in prep).

Due to access difficulties and time constraints, floristic vegetation mapping at a finer scale was not undertaken as part of this project. Rather, the floristic classes displayed on the map contained in the pocket attached to the inside back cover of this report (Figure 6), were derived from the existing regional floristic vegetation mapping.

At the time of the regional survey, no vegetation survey sites existed at Lake Hawdon South, and only three sites were recorded for Lake Hawdon North (LE00701, LE00702 and WO00101). Prior to the regional survey the Department of Lands had also undertaken some vegetation monitoring for Lake Hawdon. The Department had erected exclosures to monitor the impact of grazing on vegetation regeneration. Ganf (1998) provides an anecdotal account of the effectiveness of these exclosures in relation to increasing regeneration and species richness.

### Local floristic vegetation mapping

The major plant communities mapped by Heard (1999) for Lake Hawdon North were *Gahnia filum*, *Samolus repens* Sedgeland with much smaller areas of *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland. In the mapping, these Tall shrublands occur occasionally as a mosaic with the *Gahnia filum* Sedgeland but more often as pure stands on the eastern side of the lake.

Lake Hawdon South is mapped as a mosaic of *Gahnia filum*, *Samolus repens* Sedgeland / *Juncus* sp., *Isolepis* sp., *Poa* sp. complex Sedgeland with much smaller amounts of *Melaleuca halmaturorum* ssp. *halmaturorum* Tall shrubland. The mapping suggests the Tall shrubland usually occurs as the second community in a mosaic with the *Gahnia filum* Sedgeland.

In total, eight vegetation quadrats were surveyed (Table 1). From these quadrats six vegetation communities were identified (Table 4). Two of the communities described are not recognised as regional vegetation communities. The reasons for this are discussed below. The other four plant communities fit within the regional vegetation communities identified by Heard and Goodwins (in prep). Three of the identified communities are considered to be regionally 'vulnerable' (Croft *et al.*, 1999, Croft and Carpenter, 2001).

### Lake Hawdon vegetation communities

**Table 4. Vegetation communities - Lake Hawdon.**

<b><i>Melaleuca halimifolia</i> ssp. <i>halimifolia</i> (Swamp Paper-bark) Tall open shrubland / Open shrubland</b> OVER mid-dense <i>Danthonia semiannularis</i> (Wetland Wallaby-grass), sparse <i>Gahnia filum</i> (Smooth Cutting-grass) and sparse <i>Schoenus nitens</i> (Shiny Bog-rush).
<b><i>Gahnia trifida</i> (Cutting Grass) Sedgeland</b> OVER sparse low sedges of <i>Baumea juncea</i> (Bare Twig-rush) and <i>Schoenus nitens</i> (Shiny Bog-rush) and the introduced grass * <i>Criticism marimum</i> (Sea Barley-grass).
<b><i>Gahnia filum</i> (Smooth Cutting-grass) Sedgeland</b> OVER a very sparse herb layer dominated by <i>Angianthus preissianus</i> (Salt Angianthus), <i>Schoenus nitens</i> (Shiny Bog-rush) and <i>Selliera radicans</i> (Shiny Swamp-mat).
<b><i>Juncus kraussii</i> (Sea Rush),*<i>Rumex crispus</i> (Curled Dock) Closed sedgeland</b> OVER very sparse <i>Sporobolus virginicus</i> (Salt Couch).
<b><i>Baumea arthrophylla</i> (Swamp Twig-rush) + / - <i>Baumea juncea</i> (Bare Twig-rush) Sedgeland</b> OVER very sparse <i>Selliera radicans</i> (Shiny Swamp-mat).
<b><i>Danthonia semiannularis</i> (Wetland Wallaby-grass) (Tussock) grassland</b> OVER a mid-dense understorey of <i>Schoenus nitens</i> (Shiny Bog-rush) and sparse <i>Agrostis billardieri</i> var. <i>filifolia</i> (Narrow-Leaf Blown-grass) and <i>Selliera radicans</i> (Shiny Swamp-mat).

**Swamp Paper-bark (*Melaleuca halimifolia* ssp. *halimifolia*) Tall open shrubland / Open shrubland**

This community was recorded twice during this survey, both times on the fringes of areas subjected to winter flooding. This type of vegetation community is generally associated with lower lying saline soils and requires regular seasonal flooding to flush the salts from the soils around the root system, especially in highly saline situations. While seasonal flooding is necessary, extended flooding is detrimental to this community. It is sensitive to changes in water regime (eg: increased soil drying, extended flooding or changes in salinity) and may respond either positively and negatively depending on the type of change (Croft pers. comm., 2001). The conservation status of this community at the State level is ‘reasonable’ according to Neagle (1995).

**Cutting Grass (*Gahnia trifida*) Sedgeland**

This community was recorded once on the survey on the eastern side of Lake Hawdon South. It is a vegetation community typical of treeless areas subjected to inundation in winter and spring. At the time of European settlement in the South East *Gahnia trifida* formed extensive sedgelands along watercourses between the region’s ranges. In areas such as Lake Hawdon it forms a mosaic with other vegetation communities. In the north *Gahnia trifida* Sedgeland is usually replaced by the similar and related *Gahnia filum* Sedgeland which occurs on more saline soils (Croft pers. comm., 2001).

This vegetation community has been dramatically degraded due to extensive, systematic drainage, and subsequent pasture improvement, stock grazing, cropping and burning. Little is formally conserved in Government reserves or Heritage Agreements. Repeated burning over time is likely to be detrimental to this vegetation community (Croft pers. comm., 2001). This plant community is susceptible to changes

in water regime and quality, and is not considered tolerant of high salinity levels for extended periods. It is considered to be regionally ‘vulnerable’ (Croft *et al.*, 1999, Croft and Carpenter, 2001).

**Smooth Cutting-grass (*Gahnia filum*) Sedgeland**

This sedgeland community was sampled once on the survey at the northern end of Lake Hawdon South. This is also a vegetation community of treeless, winter and spring inundated areas of the South East’s inter-range watercourses. In areas such as Lake Hawdon it forms a mosaic with other vegetation communities. In the south in the region, *Gahnia filum* Sedgeland is often replaced by the similar and related *Gahnia trifida* Sedgeland which occurs on less saline soils. This is a plant community which has been severely degraded through extensive, systematic drainage and subsequent pasture improvement, stock grazing, cropping and burning in the South East of South Australia. Little is formally conserved in Government reserves or Heritage Agreements. Repeated burning over time is likely to be detrimental to this vegetation community (Croft pers. comm., 2001).

Smooth Cutting-grass communities are susceptible to changes in water regime and quality, and are not considered tolerant of high salinity levels for extended periods. Once forming extensive areas at the time of European settlement it is now considered regionally ‘vulnerable’ (Croft *et al.*, 1999, Croft and Carpenter, 2001).

**Swamp Twig-rush (*Baumea arthrophylla*) + / - Bare Twig-rush (*Baumea juncea*) Sedgeland**

This community was sampled twice on the survey, on the western side of Lake Hawdon South. It is usually associated with fresher wetland systems with long-standing, but not permanent water. Regionally, this Sedgeland is considered as part of a complex of plant communities. The complex is dominated by various sedges found in seasonally inundated freshwater

swamps that are distributed through most of the South East, but predominantly in the Lower South East. All the plant communities of this complex occur on soils which are waterlogged for a good part of the year (Eardley, 1943). The complex includes:

- *Baumea arthropophylla* +/- *Baumea juncea* Sedgeland
- *Baumea juncea* Sedgeland
- *Baumea rubiginosa* Sedgeland
- *Chorizandra enodis* - *Baumea juncea* Sedgeland
- *Schoenoplectus pungens* Sedgeland

Some of the communities listed in the Sedgeland complex above may not occur in Lake Hawdon.

This *Baumea arthropophylla* +/- *Baumea juncea* Sedgeland community is subject to degradation through pasture improvement, grazing by domestic stock, and nutrient inputs (both directly and indirectly through run-off), and changes in water regime (eg: drying out through drainage or changes in salinity). *Baumea arthropophylla* +/- *Baumea juncea* Sedgeland is not well conserved in Government reserves or Heritage Agreements in the region and is considered regionally 'vulnerable' (Croft *et al.*, 1999, Croft and Carpenter, 2001).

#### **Sea Rush (*Juncus kraussii*),\* Curled Dock (*Rumex crispus*) Closed sedgeland**

This community was sampled once on the survey at Lake Hawdon North just south of drain K/L and abutting a smaller waterway, flowing into the drain. Croft (pers. comm., 2001) suggests this is a localised vegetation community, probably resulting from ongoing disturbance. Both of the species dominating the overstorey here, as well the associated understorey species, are responsive to disturbed, fairly wet, brackish situations.

#### **Wetland Wallaby-grass (*Danthonia semiannularis*) (Tussock) grassland**

This community was sampled only once on the survey at Lake Hawdon North in an area that was just slightly raised above the surrounding saltlake. It is considered to be a localised vegetation type only and is not recognised on a regional vegetation community level. This small tussock grassland is probably the result of past disturbance as *Danthonia semiannularis* is a species normally associated with the understorey of sedgelands or shrublands (Croft pers. comm., 2001). Evidence of both sheep and kangaroo presence was noted at the site and according to Jessop and Toelken (1986) *Danthonia semiannularis* is a palatable species. As its common name implies, the species is usually found in damp, occasionally semi-aquatic situations. It is also considered capable of persisting after fire (Croft pers. comm., 2001).

#### **Plant species at Lake Hawdon**

A total of 144 plant records were collected at the eight survey sites and from these, 70 different species were identified. Of the 144 plant records, 104 were indigenous species. Of the 70 species recorded, 43 were indigenous. (Note: two of these indigenous species were Mosses and Lichens, not usually collected in line with the Biological Survey of South Australia). A further 12 indigenous species were recorded as opportunistic collections and 9 other indigenous species, not collected at sites, had been recorded on reconnaissance trips prior to the survey. Another 22 species had been collected from Lake Hawdon from previous survey sites (LE00701, LE00702, and WO00101). While none of the species were rated under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999, there were a number with conservation significance at the State level (Schedules of the National Parks and Wildlife Act 1972 (SA) 2000) or Regional level (Lang and Kraehenbuehl, 2001). Refer to Appendix I for a list of the recorded species and an explanation of conservation codes.

It is important to note that the Biological Survey of Lake Hawdon focused on collecting terrestrial plants. Some aquatic plants were collected however, further survey work is required during periods of inundation, to better determine the diversity of aquatic plants found at Lake Hawdon.

#### **Species of State and Regional conservation significance**

##### **Purple eyebright (*Euphrasia collina* ssp. *collina*)**

Purple eyebright is a semi-parasitic perennial herb growing 20 to 80cm high, with white, to pink or violet flowers clustered at the end of the main flowering stalk, which is held erect. It flowers from November to December. The species is recorded only from the South East in South Australia, but elsewhere from New South Wales, Victoria and Tasmania. This species has scattered populations in a variety of habitat types, mainly sclerophyll forests and woodlands, heathy shrublands near the coast, and the edges of lakes and near swamps. This plant will grow in well and moderately drained habitats, but does not tolerate poorly drained sites such as wetlands that may be submerged for long periods (Croft pers. comm., 2001). In South Australia *Euphrasia collina* ssp. *collina* is usually associated with swampy sites (Jessop and Toelken, 1986). This species was recorded during a reconnaissance trip on the western side of Lake Hawdon South in a submerged *Baumea* sp. Sedgeland, growing on small hummocks of soil that were slightly raised above the surrounding wetland.

The palatability of this plant is unknown but, as it is a low growing herb, it would be adversely affected by stock trampling. Its response to fire is unknown but it is thought to be capable of surviving fire (Croft pers. comm., 2001). Due to the plants intolerance to submersion in water and association with swampy

sites, it would be affected by changed water regimes. This species has a State conservation rating of 'vulnerable' (NPW Act, 1972).

#### **Alcock's Water-ribbons (*Triglochin alcockiae*)**

Alcock's Water-ribbons is an emergent aquatic perennial herb with rhizome bearing roots, which end in tubers. It was recorded on a reconnaissance trip in shallow water at the edge of Lake Hawdon South. In South Australia it is recorded from the Southern Lofty, Kangaroo Island and South East botanical regions. It is also recorded from south-western Victoria and Tasmania. It flowers from September to January and is usually found in fresh, still, clear water up to 30cm deep, such as that present in ephemeral swamps. The species can also be found in stagnant water and small streams. Increased flooding would be expected to favour the species, provided the water is not too deep or permanent. Disturbance of wetlands through stock trampling can be detrimental. Its response to fire is unknown, however it does not grow in some areas of apparently suitable habitat which are subject to fire (Croft pers. comm., 2001). This species has a State conservation rating of 'rare' (NPW Act, 1972).

#### **Manila Grass (*Zoysia matrella*)**

Manila Grass is a small, creeping grass with rigid leaf blades and short erect stems that sprout from underground rhizomes. Flowers develop on a short, dense terminal spike in November to February. This plant was collected at three of the survey sites. Of the 10 species from the Genus *Zoysia* only *Z. matrella* is found in South Australia. The species is recorded from Kangaroo Island and the South East in South Australia and also from Queensland, Victoria and Tasmania as well as parts of Asia (Jessop and Toelken, 1986). The species is rated as 'rare' at the State level (NPW Act, 1972).

#### **Narrow-leaf Blown-grass (*Agrostis billardieri* var. *filifolia*)**

Narrow-leaf Blown-grass was recorded from six of the eight sites surveyed in Lake Hawdon. This species is a low annual grass growing 0.15m and occasionally up to 0.6m high, its leaves are almost threadlike and it flowers from September to December. This plant's South Australian distribution is limited to the South East and Southern Lofty botanical regions. Elsewhere *Agrostis billardieri* var. *filifolia* is recorded from Victoria and Tasmania (Jessop and Toelken, 1986).

The species is associated with areas of saline soils, such as interdunal watercourses in the region. The plant's susceptibility to fire is unknown as it grows in areas not usually subjected to fire. This species does not grow in areas subjected to long periods of flooding, but can tolerate some short-term inundation. The plant's palatability is unknown (Croft pers. comm., 2001). Narrow-leaf Blown-grass has a State

conservation rating of 'rare' under Schedule 9, National Parks and Wildlife Act, 1972.

#### **Shrubby Groundsel (*Senecio cunninghamii* var. *cunninghamii*)**

Recorded from four of the eight survey sites, Shrubby Groundsel is an erect or spreading shrub growing 0.5 to 1.2 metres high, flowering September to April. In South Australia the plant is recorded from the Murray Mallee (associated with the River Murray and Lower Lakes), Yorke Peninsula, Southern Lofty and South East botanical regions. Elsewhere the species is recorded from Western Australia, New South Wales and Victoria. Shrubby Groundsel occasionally spreads through suckering (Jessop and Toelken, 1986).

*Senecio cunninghamii* var. *cunninghamii* is usually found in heavier, winter-wet soils, as well as rocky sites. According to Cuningham *et.al.* (1992) in NSW the plant is grazed only sparingly in the absence of more palatable species. This plant is known to contain moderately high levels of alkaloids, which cause liver damage or even death in animals. The species is capable of growing on quite saline soils. An increase in flooding may cause the loss of this species in some areas, but may provide suitable habitat elsewhere in the area. Fire response is unknown (Croft pers. comm., 2001). This species does not have a State rating although it is likely to be classified as either 'threatened' or 'rare' at the Regional level but presently there is insufficient data available for a more precise assessment.

#### **Australian Lilaepsis (*Lilaepsis polyantha*)**

Australian Lilaepsis was recorded at two survey sites, one on Lake Hawdon South and one on Lake Hawdon North. The species was also recorded on a reconnaissance trip prior to the survey in water on the western edge of Lake Hawdon South. *Lilaepsis polyantha* is a perennial herb with creeping rhizomes, flowering in October to May. The plant's preferred habitat is wet areas, mostly in fresh-water, around swamps and the margins of lakes but it sometimes also grows in brackish locations, occasionally submerged. In South Australia, this species is recorded from the Eyre Peninsula, Murray Mallee, Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from Victoria, Queensland, New South Wales and Tasmania (Jessop and Toelken, 1986). This species response to fire is unknown but due to its habitat preference is unlikely to be subjected to fire. Palatability is unknown. Australian Lilaepsis has a Regional rating of 'rare'.

#### **Tall Saw-sedge (*Gahnia clarkei*)**

Tall Saw-sedge was not collected during the Lake Hawdon survey but was collected previously as part of the South East Coast Survey at survey site LE00701. This species forms a tall, perennial tussock with stems growing up to 2m high and inrolled, very rough leaves.

It can flower throughout the year, but primarily during spring and summer. This plant's South Australian distribution is limited to the South East botanical regions. Elsewhere *Gahnia clarkei* is recorded from Victoria, New South Wales and Queensland (Jessop and Toelken, 1986).

It is usually associated with the edges of freshwater wetlands and watercourses in the region, although it can tolerate moderately saline conditions. The plant's susceptibility to fire is unknown, although like other *Gahnia* species, it would likely regrow from rootstock following fire. As it prefers the edges of mainly freshwater wetlands, it is thought it would not tolerate permanent flooding or increasing salinity. Its palatability to stock is unknown, but young growth may be palatable (Croft pers. comm., 2001). The species has a State conservation rating of 'rare' under Schedule 9, National Parks and Wildlife Act, 1972.

### Other plant species of interest

#### Wetland Wallaby-grass (*Danthonia semiannularis*)

Wetland Wallaby-grass was recorded at three sites on the survey, being the dominant overstorey species at one site at Lake Hawdon North. *Danthonia semiannularis* is an erect, tufted, slender perennial grass growing up to 60cm high and flowering from October to December. In South Australia, the species is recorded from the Murray Mallee, Southern Lofty and South East botanical regions. Elsewhere it is recorded from Victoria, New South Wales and Tasmania (Jessop and Toelken, 1986).

This species is usually found in damp habitats and occasionally semi-aquatic situations. The plant is highly palatable to stock. Wetland Wallaby-grass is also considered capable of persisting after fire (Croft pers. comm., 2001). This species is listed as regionally 'uncommon'.

#### Salt Pratia (*Pratia platycalyx*)

Salt Pratia was collected at two survey sites, both at Lake Hawdon South in *Gahnia* spp. sedgeland. *Pratia platycalyx* is a low growing perennial herb that spreads along the ground often rooting at the nodes. The species flowers from December to March. In South Australia this plant is recorded from the Murray (associated with the River Murray and Lower Lakes), Kangaroo Island and the South East botanical regions. Elsewhere it is recorded from Victoria and Tasmania (Jessop and Toelken, 1986).

Salt Pratia is mainly found growing in coastal areas and frequently in salt marshes, but also on sandy soil often associated with limestone. In the South East the species is usually found on heavier, seasonally damp soils, such as the interdunal watercourses and salt marshes. *Pratia platycalyx* is a species tolerant of a range of salinity levels (Croft pers. comm., 2001). The

plant's palatability and response to fire is unknown. The species is considered regionally 'uncommon'.

#### White Sebaea (*Sebaea albidiflora*)

This species was recorded on both Lake Hawdon North and South during the survey and was also picked up on a reconnaissance trip prior to the survey. White Sebaea is a stiffly erect annual herb, rarely growing up to 20cm high, which flowers from October to December. In South Australia, the species is recorded from the Eyre Peninsula, Yorke Peninsula and South East botanical regions. Elsewhere it is recorded from Victoria and Tasmania (Jessop and Toelken, 1986).

White Sebaea is usually found in saline soils, prone to flooding, or near the coast in saltmarsh habitats. The plant is not considered highly palatable to stock and its response to fire is unknown (Croft pers. comm., 2001). The species is listed as regionally 'uncommon'.

#### Tiny Selaginella (*Selaginella gracillima*)

Tiny Selaginella was collected from two sites at Lake Hawdon South. The species is a small, annual sporophyte herb growing 2 to 6cm high. It grows with spirally arranged leaves along erect, sometimes forked stems. In South Australia, the plant is recorded from the Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from the temperate areas of all Australian States. The species grows in moist shaded situations near creeks and swamps and is often overlooked because of its size (Jessop and Toelken, 1986). Due to the small size of *Selaginella gracillima*, the plant would be vulnerable to trampling by stock. This species is listed as regionally 'uncommon'.

#### Scrub Nettle (*Urtica incisa*)

Scrub nettle was recorded on one site at Lake Hawdon South. The plant is a perennial herb growing up to 1m high, initially spreading horizontally and becoming erect. *Urtica incisa*'s leaves are covered in rigid stinging hairs, which contain an irritating fluid. The plant may be found flowering at any time of the year. In South Australia, the species is recorded from the Murray (associated with the River Murray and Lower Lakes), Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere in Australia Scrub Nettle is recorded from all States except the Northern Territory, it is also found in New Zealand and New Caledonia.

*Urtica incisa* is not considered tolerant of high salinity levels as it is typically associated with freshwater wetlands (Croft pers. comm., 2001). This species is listed as regionally 'uncommon'.

#### Purple Bladderwort (*Utricularia dichotoma*)

Purple Bladderwort was collected on a reconnaissance trip prior to the survey. The recorded habitat was a

herbfield in a Cutting Grass Sedgeland on the eastern side of Lake Hawdon South. The area was still moist but unlikely to have been fully submerged. This is a perennial herb, growing 10 to 50cm high, mainly flowering from August to December. In South Australia, Purple Bladderwort is recorded from the Flinders Ranges (now thought to be extinct in this region), Southern Lofty, Kangaroo Island and South East botanical regions. Elsewhere it is recorded from Western Australia, Victoria, Queensland, New South Wales, Australian Capital Territory, and Tasmania (Jessop and Toelken, 1986, Croft. pers. comm., 2001).

*Utricularia dichotoma* can be locally common in suitable sites in damp or wet, usually heathy habitats. The Genus *Utricularia* is taken from the Latin word *Utriculus*, which means ‘a small bottle’ and alludes to the plant’s bladder like traps. The plant has no true root system but contains minute traps on its stolons, each with a door that opens and closes to capture small organisms in the soil (Jessop and Toelken, 1986). Disturbance of the soil by stock is expected to be detrimental to this small herbaceous plant through trampling and loss of covering vegetation. The species is expected to be palatable to stock, its response to fire is not known (Croft pers. comm., 2001). The species is considered regionally ‘uncommon’.

**Tree Everlasting (*Ozothamnus ferrugineus*)**

Tree everlasting was collected at site LE00701 as part of the South East Coast Biological Survey. It is typically a tall perennial shrub growing 1 to 2m high, but occasionally occurs as a small tree up to 5m high. It flowers December to March. In South Australia this plant is only recorded from the South East botanical region. Elsewhere it is recorded from New South Wales, Victoria, and Tasmania (Jessop and Toelken, 1986).

*Ozothamnus ferrugineus* can be locally common in moist soils, including freshwater wetlands (eg:

*Letospermum lanigerum* Tall shrubland) south of Robe. The species is not considered highly palatable to stock, however its branches are brittle and susceptible to damage by cattle pushing through vegetation. It is not noted to grow in highly saline areas or associated with permanent water. It can regenerate prolifically from seed following fire and other disturbance (Croft. pers. comm., 2001). The plant is considered regionally ‘uncommon’.

**(*Hydrocotyle plebeya*)**

*Hydrocotyle plebeya* was collected as part of the South East Coast Biological Survey at site WO00101. The species is a low perennial herb growing 8 - 20cm high with a creeping stem rooting at the lower nodes. It flowers December to April. In South Australia it is recorded for the Southern Lofty and South East botanical regions, but elsewhere only from Western Australia (Jessop and Toelken, 1986, Jessop, 1993).

It typically grows in moist soils where it can be locally common, including as groundcover in freshwater wetlands (eg: *Letospermum lanigerum* Tall shrubland). Its palatability to stock and susceptibility to fire are unknown. As it is commonly associated with freshwater areas, it is not considered tolerant of saline situations. It is not recorded where there is permanent water (Croft pers. comm., 2001). The species is considered regionally ‘uncommon’.

**Number of species of conservation significance in relation to vegetation communities**

Table 5 demonstrates that *Gahnia* spp. Sedgeland supported the highest number of species of conservation significance for Lake Hawdon. All of the vegetation communities sampled during the Biological Survey of Lake Hawdon supported at least one species of conservation significance.

**Table 5. Number of species of conservation significance in relation to vegetation communities.\***

Vegetation communities	Number of species of conservation significance
<i>Gahnia filum</i> and <i>G. trifida</i> – Sedgeland	9
<i>Danthonia</i> sp. Tussock grassland	5
<i>M. halmaturorum</i> Open Shrubland	3
<i>Baumea</i> sp. Sedgeland	2
<i>Juncus</i> sp. Sedgeland	1

\*This Table does not include species recorded opportunistically.

**Species of conservation significance in relation to Lake Hawdon North and South**

Table 6 illustrates how plants of conservation significance were distributed relatively evenly between

both lakes. Lake Hawdon North supported 9, while Lake Hawdon South supported 11 species of conservation significance.

**Table 6. Species of conservation significance in relation to Lake Hawdon North and South.**

Plant species of conservation significance	Lake Hawdon North	Lake Hawdon South
<i>Danthonia semiannularis</i>	+	
<i>Agrostis billardieri</i> var. <i>filifolia</i>	+	+
<i>Sebea albiflora</i>	+	+
<i>Senecio cunninghami</i> var. <i>cunninghami</i>	+	+
<i>Lileopsis polyantha</i>	+	+
<i>Zoysia matrella</i>	+	+
<i>Selaginella gracillima</i>		+
<i>Pratia platycalyx</i>		+
<i>Urtica incisa</i>		+
<i>Utricularia dichotoma</i>		+
<i>Euphrasia collina</i> ssp. <i>collina</i>		+
<i>Triglochin alcockiae</i>		+
<i>Ozothamnus ferrugineus</i> *	+	
<i>Hydrocotyle plebeya</i> *	+	
<i>Gahnia clarkei</i> *	+	

\*Species collected during previous survey work.

**Table 7. Number of indigenous and introduced plant species recorded at each survey site.**

Survey site code	Vegetation association	No. of indigenous species	No. of introduced species	Total no. of species
ROB01001	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> Tall open shrubland	15	9	24
ROB01101	<i>Juncus kraussii</i> , <i>Rumex crispus</i> Closed sedgeland	7	8	15
ROB01201	<i>Danthonia semiannularis</i> Tussock grassland	16	6	22
ROB01301	<i>Melaleuca halmaturorum</i> ssp. <i>halmaturorum</i> Open shrubland	11	0	11
ROB01401	<i>Gahnia filum</i> Sedgeland	14	3	17
ROB01501	<i>Baumea arthropphylla</i> Sedgeland	10	0	10
ROB01601	<i>Baumea arthropphylla</i> , <i>Baumea juncea</i> Closed sedgeland	3	0	3
ROB01701	<i>Gahnia trifida</i> Sedgeland	27	15	42

### Introduced species

Of the 70 plant species recorded from the survey sites, 27 (38%) or more than one in three were introduced. This represents a relatively high percentage of introduced species (Croft, pers. comm., 2001).

As can be seen from Table 7, no introduced species were recorded at three of the survey sites. The most frequently recorded non-native species were: Lesser Hawkbit (*Leontodon taraxacoides* ssp. *taraxacoides*), Spear Thistle (*Cirsium vulgare*) (4 sites) Sea Barley-grass (*Critesion marinum*), Coast Beard-grass (*Polypogon maritimus*), Branched Centaury (*Centaureum tenuiflorum*) (3 sites) Pimpernel (*Anagallis arvensis*), Common Onion-grass (*Romulea rosea* var. *australis*) (2 sites).

The remaining introduced species were collected only once. In most cases the introduced species had very small cover/abundance.

### Exclosures

Of some interest were a group of exclosures located approximately 100m north of site ROB01701 at Lake Hawdon South. Although a thorough search was not conducted, ten species were collected in this area that had not been recorded in other sites on the survey. These are listed in Appendix 1. The understorey appeared more intact inside the exclosures, with a much higher density of grasses and herbs covering the ground. There were also shrubs present that were not found outside the exclosures. Ganf (1998) tends to support this anecdotal observation.

It was also of note that a large number of spiny black spiders (unknown species) were present in webs both inside the exclosure and along the surrounding fences.

This area may give some indication of species favoured by the removal of stock and would be an interesting comparison for monitoring purposes, were stock to be removed from the surrounding vegetation.

### The affect of livestock on wetland vegetation

The physiology of indigenous wetland plants makes them more prone to damage by grazing than introduced weeds. Ganf (1998) describes how repeated grazing of native wetland plants over time can prevent some species from successfully reproducing by damaging meristems and eventually exhausting rhizomes. However, non-native species are more tolerant of repeated grazing and so can begin to colonise areas inhabited by native plants, which may be suffering stress.

Ganf (1998) also describes how the boundary between the terrestrial and aquatic environments is often in a state of flux due to changing water levels. This dynamic aquatic herbland, or littoral zone, is often typified by the highest diversity of species, including many palatable plants. Not surprisingly, sheep grazing tends to concentrate on this area. Thus, even if some plant species, which occupy the margins of wetlands, are not particularly palatable, they can still be detrimentally affected by trampling associated with livestock.



**Figure 7. ROB1001 *Melaleuca halmaturorum* ssp. *halmaturorum* Tall open shrubland.  
Photo. Kate Graham.**



**Figure 8. ROB1101 *Juncus kraussii*, *Rumex crispus* Closed sedgeland.  
Photo. Kate Graham.**



**Figure 9. ROB01201 *Danthonia semiannularis* Tussock grassland.**

**Photo. Kate Graham.**



**Figure 10. ROB01301 *Melaleuca halmaturorum* ssp. *halmaturorum* Open shrubland.**

**Photo. Kate Graham.**



**Figure 11. ROB01401 *Gahnia filum* Sedgeland.**

**Photo. Kate Graham.**



**Figure 12. ROB01501 *Baumea arthropylla* Sedgeland.**

**Photo. Kate Graham.**



**Figure 13. ROB01601 *Baumea arthropylla*, *Baumea juncea* Closed sedgeland.**

**Photo. Kate Graham.**



**Figure 14. ROB01701 *Gahnia trifida* Sedgeland.**

**Photo. Kate Graham.**

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## Lake Hawdon Biological Survey

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### MAMMALS

Historically, little biological research has been conducted at Lake Hawdon North or South. Three survey sites (LE00701, LE00702 and WO00101) were installed at Lake Hawdon North in September 1982 as part of the South East Coast Biological Survey. However, of these, only the first two sites sampled vertebrates. Consequently, this survey represents the first systematic mammal trapping of both Lake Hawdon North and South.

A total of eight (possibly nine\*) mammal species have been recorded from Lake Hawdon North and South. Of these, seven species (three native and four introduced) were recorded during this survey (Appendix II). None of these species are currently of conservation significance. However, the Toolache Wallaby (*Macropus greyi*), which once inhabited the area, is now thought to be extinct. The Red-necked Wallaby (*M. rufogriseus*) and Swamp Antechinus (*Antechinus minimus*) were probably resident in the area within the past 50 – 100 years (Robinson and Young, 1983, van Weenen, 2001) but may have become locally extinct due to habitat disturbance.

#### Native species known from Lake Hawdon

##### Western Grey Kangaroo (*Macropus fuliginosus*)

The Western Grey Kangaroo is a common species with a widespread distribution from the coast of Western Australia to western Victoria and central New South Wales. In South Australia it is found on the Eyre Peninsula, Kangaroo Island, the Flinders Ranges and in the South East. This species grazes in open areas, spending much of the time resting under shade during the day. The local population exists sympatrically with the Eastern Grey Kangaroo (*Macropus giganteus*) which occurs on the northern edge of Lake Hawdon North.

This species was observed at five sites across both Lake Hawdon North and South, in a range of habitat types including *Melaleuca halmaturorum* Tall open shrubland, *Juncus kraussii* Sedgeland, *Danthonia* sp. Grassland and *Gahnia filum* Sedgeland. The Western Grey Kangaroo may benefit from the repeated burning of the *Gahnia* spp. sedgelands because burning tends to open up sedgelands and leads to the development of herb fields, which is preferred by this species.

##### Bush Rat (*Rattus fuscipes*)

The Bush Rat is a common ground dwelling rodent inhabiting the forested coasts and ranges of southern Western Australia, South Australia and the east coast of Victoria, New South Wales and some parts of Queensland (Lunney, 1995). In South Australia it has been recorded from Eyre and Yorke Peninsula, the Mount Lofty Ranges, Kangaroo Island and the South East.

The Bush Rat was only recorded at site LE00701 as part of the South East Coast Survey in September 1982, and may represent one of the most northerly records for this species in the South East. It is of interest that this species was not recorded during this survey even though similar habitats were trapped and searched.

##### Swamp Rat (*Rattus lutreolus*)

The Swamp Rat is an inhabitant of wet swampy areas and low-lying heaths from coastal South Australia east along the eastern seaboard to southern Queensland (Lunney, 1995). It feeds mainly on grasses and sedges and relies on dense low cover. In South Australia, this species has a disjunct population having been recorded from western Kangaroo Island, the Mount Lofty Ranges and the South East.

Swamp Rats were only captured in *Baumea arthrophylla* Sedgeland at ROB01501, however, this species probably occurs over much of this habitat type.

#### Other species of interest

##### Toolache Wallaby (*Macropus greyi*)

The Toolache Wallaby was once an abundant species inhabiting Cutting Grass swamps and the ecotonal zone sandwiched between the edge of swamps and terrestrial shrublands. This species was once found across the Wimmera district of Western Victoria, north to Bordertown and west along the Younghusband Peninsula, and Salt Creek in the Upper South East (Robinson and Young, 1983).

The last living specimen of the Toolache Wallaby was held captive in Robe in 1939. However, locals reported several unofficial observations of this species from Lake Hawdon North in 1953 (Sect 68, Hd of Ross). A dead Toolache Wallaby was reported observed at "Bog Lane" near Lake St Clair (Sect 5, Hd Bray) and three Toolache Wallabies were reported from Wood Soak between Lake St Clair and Bray Junction (Sect 14, Hd Lake George) (Robinson and Young, 1983). It would seem that the vast expanses of Thatching and Cutting

Grass at Lake Hawdon might have supported some of the last Toolache Wallabies in the South East. This species is now thought to be extinct.

#### **Swamp Antechinus (*Antechinus minimus*)**

The Swamp Antechinus is a small, marsupial, insectivore, typically inhabiting wet closed heath, wet tussock grassland and sedgeland (Figure 15). This species is found in Tasmania and in southern coastal Victoria and the lower South East of South Australia. Recent study has shown this species to have a limited and disjunct distribution in Silky Tea-tree (*Leptospermum lanigerum*) Tall shrubland swamps along the coast of the South East from Piccaninnie Ponds to just north of Robe (van Weenen, 1997). This species is currently rated as 'endangered' in South Australia due to degradation of its preferred habitat type through grazing and the affect of fire (van Weenen, 1997).

In 2000 a small population of Swamp Antechinus were trapped approximately 5 kilometres west of Lake Hawdon South, on the north east edge of Lake Eliza, in Silky Tea-tree habitat (pers comm. M. Bachmann, 2001). Given the close distribution of this species, and the existence of Silky Tea-tree at site LE00701 at Lake Hawdon North, and a patch to the north east of Lake Hawdon North, it is reasonable to conclude that the Swamp Antechinus once occurred at Lake Hawdon. Jones (1978) supports this view.

(\*Several locals commented on the existence of a population of the Eastern Grey Kangaroo *Macropus giganteus* at Lake Hawdon North).



**Figure 15. The Swamp Antechinus may have occurred at Lake Hawdon in the past.**

**Photo. Hafiz Stewart.**

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## Lake Hawdon Biological Survey

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### BIRDS

Despite its size, Lake Hawdon has received relatively little attention from ornithologists. Sutton (1929) visited the lake during an expedition to the South East in November 1928 (Appendix III). Waders were counted as part of a state-wide survey in 1981 (Australasian Wader Studies Group, 1981). Of particular interest is the report of two Plains-wanderers, a nationally listed 'threatened' species, at Lake Hawdon North, in 1988 (Bonnin and Angove, 1989).

In spite of the relative lack of ornithological studies, a total of 105 bird species have been recorded from Lake Hawdon (Appendix III). This survey recorded 88 species, including 40 from survey sites and four introduced species. Of these, nine species are of conservation significance in South Australia (Table 7). These include four species considered 'vulnerable', and five considered 'rare' (NPW Schedules, May 2000).

Opportunistic counts of waterbirds on Lake Hawdon South in 1999 and 2000 (both relatively dry years) found almost 9,000 individuals of 43 species (Appendix IV). This included over 5000 individuals of 7 shorebird species, which migrate to breed in the Northern Hemisphere during our winter.

It is significant to note that the numbers of some species can vary depending on when a count takes place. As the seasons change, and the water level of the lake rises and falls, environmental conditions become more suitable to some species and less suitable to others. Some species prefer drier conditions and so tend to be summer visitors while others prefer wetter conditions and so are more likely to be present in winter. Figure 16 graphically illustrates this point. For example, the graph shows a decline in the numbers of Black-winged Stilts but an increase in the numbers of Sharp-tailed Sandpipers over a three-month period from late spring to mid -summer.

A comparison with previous shorebird counts (Australasian Wader Studies Group 1981, 1982) indicates that Lake Hawdon South can support the highest concentration of Black-winged Stilts, Sharp-tailed Sandpipers and Marsh Sandpipers of any site in the South East. The counts of Black-winged Stilts are among the highest for any site in South Australia.

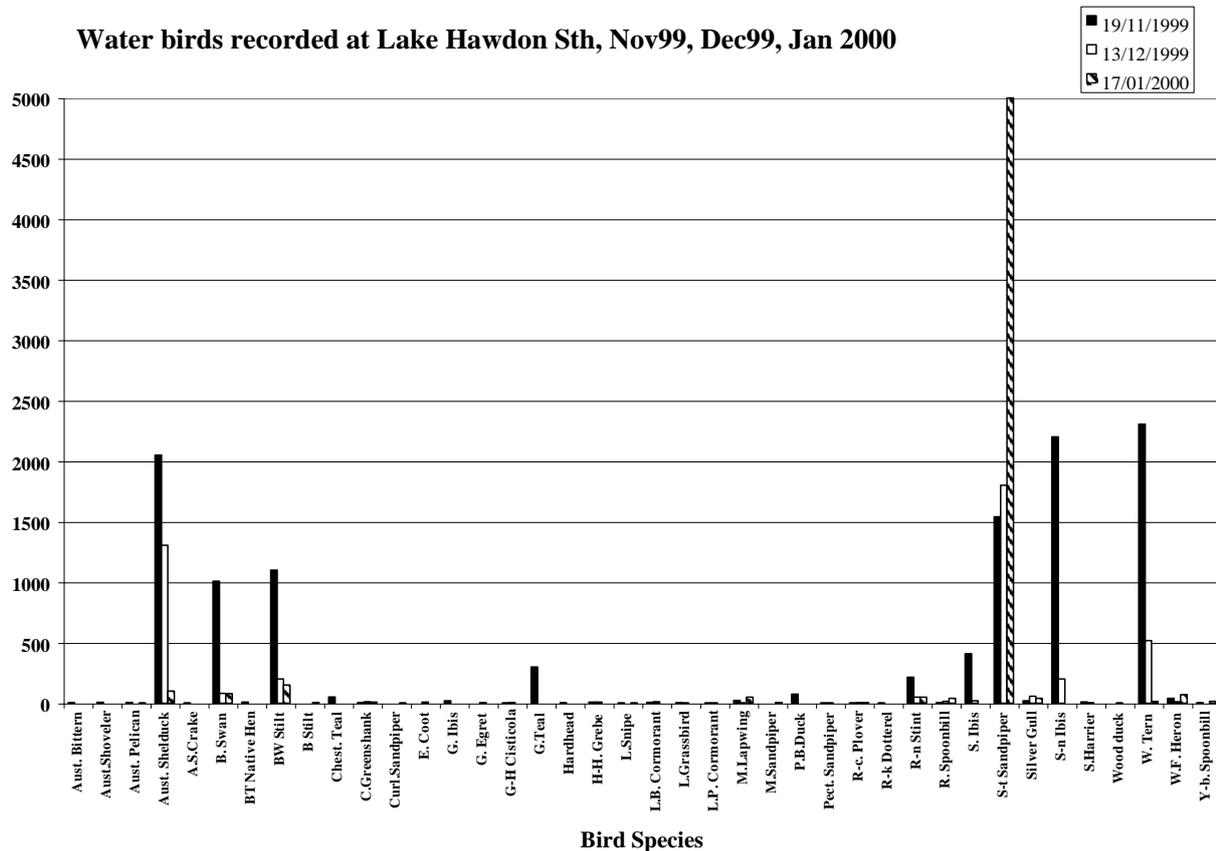
Ongoing surveys are required because of the variation in numbers of waterbirds from year to year. These surveys should be undertaken at a time when birds are concentrated on Lake Hawdon South while it dries out. Further surveys (probably by boat) also need to be conducted in September-October in wet years to determine

the importance of both Lake Hawdon North and South as a breeding area for waterbirds. While Lake Hawdon South has been the subject of water bird counts in the past, Lake Hawdon North also provides habitat for waterbirds and is worthy of investigation. The extensive areas of Cutting Grass *Gahnia* spp. and Tea-tree *Melaleuca halmaturorum* at Lake Hawdon North and South would provide suitable nesting sites for a variety of waterfowl.

**Table 7. Birds of conservation significance recorded during the Lake Hawdon Biological Survey, January 2000.**

Common name	Scientific name	#SA
Australasian Shoveler	<i>Anas rhynchos</i>	R
Australasian Bittern	<i>Botaurus poiciloptilus</i>	V
Glossy Ibis	<i>Plegadis falcinellus</i>	R
Latham's Snipe	<i>Gallinago hardwickii</i>	V
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	V
Blue-winged parrot	<i>Neophema chrysostoma</i>	V
Southern Emu-wren	<i>Stipiturus malachurus</i>	R
Beautiful Firetail	<i>Stagonopleura bella</i>	R
Golden-headed Cisticola	<i>Cisticola exilis</i>	R

# Conservation significance according to the Schedules of the SA National Parks and Wildlife Act, 1972.



**Figure 16. Results from three water bird counts for Lake Hawdon South.**

## Species of particular interest

### Vulnerable species

#### **Australasian Bittern (*Botaurus poiciloptilus*)**

Currently listed as 'vulnerable' in South Australia and 'vulnerable' nationally in the Action Plan for Australian Birds (Garnet and Crowley, 2000), the Australasian Bittern has narrow habitat preferences, preferring larger, shallow, vegetated freshwater swamps where frogs are abundant. These swamps have been extensively drained and cleared in the South East.

Several Australasian Bitterns were heard calling from extensive, flooded *Baumea arthropphylla* habitats at Lake Hawdon South during the survey. The large extent of this habitat suggests that at least several pairs occur and breed in this area, making it probably the second most important site (after the Bool Lagoon complex) for this species in South Australia. Further survey work is required to determine whether Australasian Bitterns reside in the area throughout the year.

#### **Blue-winged Parrot (*Neophema chrysostoma*)**

The Blue-winged Parrot is a mobile and poorly known species breeding in a limited area of south-eastern Australia and dispersing widely into the inland during autumn-winter (Blakers *et al.*, 1984). In South Australia, it breeds in Stringybark forests and adjacent Red gum woodlands, including scattered trees, occurring in the south-east of the State, extending only as far north as Naracoorte. In winter it disperses widely as far as the north-east of the State, with concentrations in the saltmarshes and dunes along the South East and Coorong coast.

The species probably does not breed in the study area, occurring only as a post-breeding visitor in small numbers. During the survey most birds were seen flying over only. One bird, either *N. chrysostoma* or the Elegant Parrot *N. elegans*, was flushed from *Danthonia* sp. grassland at site ROB01201, and a flock of 10 from weeds along the drain bank through Lake Hawdon North. Both species were also observed at Lake Hawdon North during a reconnaissance trip prior to the survey (Stewart, pers. comm., 2001).

#### **Latham's Snipe (*Gallinago hardwickii*)**

Latham's Snipe is a non-breeding summer (October - February) visitor to Australia mostly from Japan. This species frequents ephemeral and permanent freshwater swamps with dense sedges and adjacent shelter, especially Red gum and tea-tree swamps in the South East, River Murray and Murray Lakes. Areas of flooded grasses and samphire adjacent the Murray Lakes occasionally support large numbers. In South Australia numbers have declined, probably due to clearance and drainage of wetlands (Naardang, 1983), and historically because of hunting. During the survey a pair was flushed from damp ground among *Juncus kraussii* and introduced grasses at site

ROB01101, and a pair opportunistically from grass among *Gahnia trifida* at the south eastern edge of Lake Hawdon South.

#### **Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*)**

This large distinctive cockatoo is threatened in many areas due to the lack of suitable breeding habitat of large, hollow bearing eucalypts with feeding areas nearby. The habitat within the study area is unsuitable, although a single bird was seen flying over during the survey.

### Rare species

#### **Southern Emu-wren (*Stipiturus malachurus*)**

The Southern Emu-wren, a small secretive species, has declined in many areas due to drainage and clearance of habitat and introduced predators (Figure 17). It is widely distributed, although in low numbers, in less disturbed wet heaths throughout southern Australia (Milne, pers. comm., 2001).

During the survey it was recorded at half of the survey sites, either in *Gahnia* spp. or several hundred metres out into Lake Hawdon South in *Baumea arthropphylla*.

Extensive burning and grazing of habitat is likely to be detrimental to this species.

#### **Glossy Ibis (*Plegadis falcinellus*)**

The Glossy Ibis (Figure 18) occurs in small numbers in freshwater wetlands in the South East and has few reported nesting colonies.

A flock of 20 birds were observed feeding in flooded *Baumea juncea* at Lake Hawdon South in November 1999.

#### **Beautiful Firetail (*Emblema bellum*)**

This finch inhabits coastal and sub-coastal scrubs and low open forests throughout south-eastern Australia and has declined due to clearance and introduced predators. It feeds mostly on the seeds of a variety of native sedges (Read, 1994).

During the survey Beautiful Firetails (Figure 19) were observed feeding on *Gahnia* spp. inflorescences among *M. halmaturorum* at site ROB01001 at Lake Hawdon North.

Grazing of habitat by stock is likely to be detrimental to Beautiful Firetails.

#### **Australasian Shoveler (*Anas rhynchotis*)**

This duck occurs throughout wetlands in south-eastern Australia and has declined generally with the drainage of

swamps and lack of suitable flooding events to trigger breeding. Although only a few birds were counted in the study area in November 1999, large numbers may occur in the study area during floods, with areas of flooded *Melaleuca halmaturorum* and *Gahnia* spp. providing suitable breeding habitat.

Follow up surveys, during periods of flooding, are necessary to better determine the number of individuals relying on the study area.

#### **Golden-headed Cisticola (*Cisticola exilis*)**

This species occurs in grasslands associated with freshwater swamps. It was recorded in *Gahnia trifida* at three sites during the survey at Lake Hawdon South.

The survey area is likely to be a stronghold for this species in the South East.

#### **Species of high conservation significance previously recorded in the study area**

##### **Plains-wanderer (*Pedionomus torquatus*)**

This nationally listed 'vulnerable' species was reported in low grass on the dry bed of Lake Hawdon North on 18 February 1988 (Bonnin and Angove, 1989).

The relatively large areas of little disturbed *Danthonia* sp. Grasslands and semi-saline Herblands at Lake Hawdon North should provide ideal habitat for this species. Further surveys (preferably by spotlight) during the late spring and summer months are needed to establish the status of this cryptic species within the study area.

A limited amount of spotlighting was conducted during this survey but no Plains-wanderers were observed.

##### Other species of significance

##### **Straw-necked Ibis (*Threskiornis spinicollis*)**

During the survey a total of about 70 recently used nests were found at Lake Hawdon South. The nests comprised mounds of flattened *Baumea arthropphylla*. The skull of a dead chick was collected and identified by the South Australian Museum.

A nesting colony has not previously been reported from this site, and Parker *et al.* (1979) list only six other nesting sites in the South East.



**Figure 17.** The ‘rare’ and secretive Southern Emu-wren *Stipiturus malachurus* has declined in many areas due to the affects of introduced predators, drainage and habitat clearance.  
**Photo.** Deb Hopton.



**Figure 18.** The Glossy Ibis *Plegadis falcinellus* has a ‘rare’ rating in South Australia.  
**Photo.** M. Harper.



**Figure 19. Beautiful Firetails were observed feeding on *Gahnia* spp. inflorescences among *M. halmaturorum* at site ROB01001.  
Photo. South Australian Ornithological Association (SAOA).**

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## Lake Hawdon Biological Survey

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### REPTILES AND AMPHIBIANS

A total of 12 species of reptile and amphibian were recorded from the survey sites (Appendix V). These included two snake species, one legless lizard, four skinks and five species of frog. One species of conservation significance was recorded - *Pseudemoia rawlinsoni*, (Figure 20) which is regarded as 'endangered' in South Australia (Robinson *et al.*, 2000). One species of tortoise *Chelodina longicollis* was also observed during a reconnaissance trip in November 1999 (Figure 21).

At least one species of reptile was recorded from all sites, with the exception of ROB01201 on Lake Hawdon North (Appendix V). The number of reptile species recorded at sites on Lake Hawdon North was generally low. This probably reflects the lack of cover at ground level, especially at those sites dominated by *Melaleuca halmaturorum*. The *Gahnia* spp. sites on Lake Hawdon South had the highest numbers of reptile species with five species recorded at ROB01701. The most widely encountered reptile was the Tiger Snake (*Notechis scutatus*), which was recorded at three sites and may be present at all sites.

The total number of reptiles captured was relatively low. This can be partially attributed to the mild, overcast conditions experienced for most of the survey, but it may also be a reflection of relatively low reptile abundance in these habitats.

Frogs were recorded at five sites. The Common Froglet (*Crinia signifera*) was the most abundant species, and was the only frog recorded on Lake Hawdon North. Frog diversity was higher on Lake Hawdon South, and frogs were recorded at three of the four sites (Figure 22). Five frog species were recorded at the two wetter sites dominated by *Baumea* spp. and *Gahnia* spp.

It is unlikely that all species present in the area were detected during the survey period. There are very few survey or museum records from Lake Hawdon or the immediate vicinity for comparison, however other species found in the general region that may occur at Lake Hawdon include: the Lowland Copperhead (*Austrelaps superbus*), Eastern Brown Snake (*Pseudonaja textilis*), Eastern Bearded Dragon (*Pogona barbata*), Blotched Bluetongue (*Tiliqua nigrolutea*) and Eastern Bluetongue (*Tiliqua scincoides*).

The presence of the 'endangered' Glossy Grass Skink (*Pseudemoia rawlinsoni*) in *Gahnia* spp. and *Baumea* spp. habitats at Lake Hawdon South is quite significant (Figure 20). This species is known from very few localities, and appears to be tied into wetland-edge

habitats, which are declining and poorly conserved, in the South East. It is important for the conservation of this species in South Australia that habitats such as those at Lake Hawdon South are protected from grazing and other disturbances.



**Figure 20. The ‘endangered’ Glossy Grass Skink *Pseudemoia rawlinsoni* was found in *Gahnia* spp. and *Baumea* spp. habitats at Lake Hawdon South.  
Photo. Hafiz Stewart.**



**Figure 21. The Common Long Neck Tortoise *Chelodina longicollis* was found at Lake Hawdon South in November 1999.  
Photo. Hafiz Stewart.**



**Figure 22.** This beautifully marked frog *Litoria ewingii* was photographed at Lake Hawdon South in November 1999. Photo. Hafiz Stewart.

# CONCLUSIONS AND RECOMMENDATIONS

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## CONCLUSIONS

### Plants

Lake Hawdon supports 7 plant species of State conservation significance including 'vulnerable' species such as Purple eyebright (*Euphrasia collina* ssp. *collina*) and 'rare' species such as Alcock's Water-ribbon (*Triglochin alcockiae*), Manila Grass (*Zoysia matrella*), Narrow-leaf Blown-grass (*Agrostis billardieri* var. *filifolia*) and Tall Saw-sedge (*Gahnia clarkei*).

Lake Hawdon also supports three 'vulnerable' plant communities being Cutting Grass (*Gahnia trifida*), Smooth Cutting-grass (*Gahnia filum*) and Swamp Twig-rush (*Baumea arthropphylla*) / Bare Twig-rush (*Baumea juncea*) Sedgeland.

The plants species and communities of conservation significance were distributed relatively evenly between Lake Hawdon South and North. As such, both lakes are important in relation to the conservation of flora in the area.

The response of many of these plant species and communities to fire is unknown. However, most species prefer habitats not usually subjected to fire. Repeated burning over time would most likely adversely affect the *Gahnia* spp. Sedgeland communities, which support the highest number of plants of conservation significance of any of the plant communities found at Lake Hawdon.

The palatability to livestock of many of these plants and communities of conservation significance is also unknown, but young growth of *Gahnia* sp. is likely to be palatable.

Indigenous wetland vegetation is more prone to damage through grazing and trampling by livestock than introduced species. Thus, in all probability the actions of livestock are adversely affecting native species at Lake Hawdon.

Alcock's Water-ribbon may benefit from an increase in the frequency and length of periods of inundation however it is thought all other plant species of conservation significance would be adversely affected. Most of the plant communities are also likely to be detrimentally affected by a change in the water regime. Some communities are likely to be intolerant of increased inundation, while others may suffer from a decrease in the frequency and length of inundation.

Any changes to salinity levels may also negatively influence both plant species and communities at Lake Hawdon. Some of the plant species of conservation significance prefer fresh to brackish wetland habitats and may be unable to survive more saline environments. Many of the plant communities, including the *Gahnia* spp. Sedgeland, would most likely become stressed should there be a significant increase in salinity levels.

There was a high percentage of non-indigenous plants recorded from survey sites at Lake Hawdon (38%). The unusually high proportion of non-indigenous plants may be a consequence of disturbance associated with grazing and burning because weeds tend to colonise disturbed areas. However, the cover / abundance of non-introduced species still remains relatively low

The information gained from the exclosures tends to demonstrate the effectiveness of plant species recovery following the removal of stock. Apart from a notable increase in species diversity, the understorey also seemed more intact inside the exclosures. It is likely, given the relatively low cover / abundance of non-introduced species at survey sites, that other sections of Lake Hawdon would also experience an increase in species diversity and an improvement in the health of the understorey if livestock were prevented from grazing.

### Mammals

No mammals of conservation significance were recorded during the Biological Survey of Lake Hawdon. However, the 'endangered' Swamp Antechinus may have occurred there in the past and is still found in close proximity to Lake Hawdon and so the study area may be of importance to this species.

### Birds

Lake Hawdon supports 8 (possibly 9) species of birds of conservation significance including the Australasian Bittern (*Botaurus poiciliptilus*) and potentially the Plains-wanderer (*Pedionmus torquatus*), which are nationally listed 'vulnerable' birds. The lake also supports the 'rare' Southern Emu-wren (*Stipiturus malachurus*) and Glossy Ibis (*Plegadis falcinellus*). Other bird species of conservation significance are listed in Table 7.

While most of the birds of conservation significance were recorded from Lake Hawdon South, several were also recorded from Lake Hawdon North, including one record

of the Plains-wanderer (*Pedionmus torquatus*). Each lake offers varied but complimentary water regimes and habitats, which cater to the specific requirements of different bird species. Thus, both lakes are important in relation to birds of conservation significance.

Apart from supporting individual species of conservation significance, the study area also provides habitat for thousands of waterbirds, which depend on the lake for breeding and as a winter feeding ground. The majority of wetlands in the South East have been subjected to extensive drainage, clearance, burning and grazing. Thus, the small percent of remaining wetlands, such as Lake Hawdon, are probably of considerable importance to waterbirds.

The Southern Emu-wren (*Stipiturus malachurus*) would in all probability be adversely affected by extensive burning and grazing. The 'rare' Beautiful Firetail (*Emblema bellum*) is also likely to be detrimentally affected by grazing.

Latham's Snipe (*Gallinago hardwickii*), which is subject to International Migratory Bird Agreements between Australia and Japan and the People's Republic of China (JAMBA and CAMBA), have declined in South Australia, probably in part as a consequence of clearance and drainage of wetlands. Thus, any further clearance or drainage of Lake Hawdon may impact detrimentally on the local population of this 'vulnerable' species.

### **Reptiles and Amphibians**

The one reptile of conservation significance recorded for Lake Hawdon was the Nationally 'endangered' Glossy Grass Skink (*Pseudemoia rawlinsoni*).

The Glossy Grass Skink is known from only a few locations in South Australia, so the Lake Hawdon records of this species are significant. The animal seems to prefer the edges of wetlands, a habitat which has both dramatically declined and is poorly conserved in the South East. The conservation of wetland habitats is likely to be important to ensure the ongoing viability of this species. Protection from disturbances such as grazing would probably be beneficial for this animal.

### **Stromatolites**

Stromatolites are reported from Lake Hawdon. These unusual formations are of great interest to scientists as they are modern day examples of one of the earliest forms of life on earth. The evidence seems to suggest that these rare formations are likely to be degraded by trampling by stock or changes in water quality.

### **Summary**

In summary, the study area supports a range of plant species, plant communities and bird species of conservation significance. Lake Hawdon also provides

habitat for one Nationally 'endangered' reptile and, if suitable habitat was restored, could be important to one 'endangered' mammal as well. The area is also characterised by rare stromatolites.

Many of these species of conservation significance are found at Lake Hawdon South and North. Most are likely to be adversely affected by burning, grazing, changes in water regime or quality or an increase in salinity. The stromatolites may also be detrimentally affected by similar factors.

The study area supports a high percentage of weed species, which may be a consequence of disturbance. However, these species have a relatively low cover / abundance rating.

The anecdotal evidence from the exclosures, tends to indicate that plant species diversity, and the health of the understory, is greater when stock are removed from the area. Other sections of Lake Hawdon may experience an increase in plant species diversity and an increase in the health of the understory following the removal of stock. However, a more detailed and objective analysis of the data gathered from the exclosures is required before this view can be confirmed.

As can be seen from the above, Lake Hawdon North and South support a variety of species and plant communities of conservation significance. Burning, grazing, changes in water regime or quality (turbidity, nutrient levels, pollution) or an increase in salinity may threaten the viability of many of these species and communities. Disturbances associated with grazing may be responsible for the high percentage of weed species. The removal of stock and prevention of other disturbances from the area may be of benefit to many species of conservation significance.

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## Lake Hawdon Biological Survey

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### RECOMMENDATIONS

The Biological Survey of Lake Hawdon was a single study conducted over a one-week period. Thus, it is unlikely that the data gathered from this one short survey could answer all of the biological questions raised in relation to Lake Hawdon. Rather, this survey should be seen as a useful guide and an important first step. Further work is required in order to build a more complete picture of the biology of Lake Hawdon. However, some recommendations can be inferred from the existing data and these are discussed below.

#### Plants

In all probability, grazing and burning are adversely affecting the flora of Lake Hawdon, including plant species and communities of conservation significance. These disturbances are probably responsible for the high percentage of weed species found in the study area. The flora of Lake Hawdon would most likely benefit if the practices of grazing and burning were reduced or stopped and consequently, it is recommended that these activities be reviewed and that the consequences of a decrease in grazing be investigated.

Most of the plant species and communities of conservation significance would perhaps vary or decline in distribution if there were a major change in the water regime or quality or a rise in salinity. Thus, it may be of benefit to the flora to maintain the current water regime, resist further drainage and monitor water quality and salinity. A water-sampling program is recommended to achieve this goal.

The high percentage of non-native plant species tends to indicate that a weed control program may be necessary. The cover / abundance values for weed species were low and so early intervention is recommended to ensure this remains the case. However, the utmost care should be exercised should herbicides be used to make certain they do not detrimentally affect the ecology of this important wetland. It may be advisable to seek expert advice in relation to the use of herbicides in wetland habitats before proceeding with this form of weed control.

It may be of benefit to analyse existing data relating to the exclosures. An analysis is suggested as it may better determine the affect of grazing on the local plant species. In addition, an analysis may provide data concerning the rate of species regeneration and recovery once grazing stops. Continuing to monitor the exclosures is advisable.

The Biological Survey of Lake Hawdon focused on collecting and recording terrestrial, vascular plants. Only

a few aquatic or non-vascular plants were collected. Further survey work is required to determine the diversity and extent of aquatic plants found in the study area. This work should be conducted during periods of inundation.

#### Birds

In all probability, grazing and burning are adversely affecting some of the bird species found at Lake Hawdon, including species of conservation significance. Several of the birds of Lake Hawdon would most likely benefit if the practices of grazing and burning were reduced or stopped and so it is recommended that these activities be reviewed.

Some of the bird species of conservation significance would perhaps suffer if there were a major change in the water regime or quality (turbidity, nutrient levels, pollution) or a rise in salinity. While some species require periods of inundation, others require drier conditions. A change to the water regime may benefit some species but at the expense of others. A decline in water quality or a rise in salinity may detrimentally affect the preferred food source of some species, which may cause a localised loss of these birds. Thus, it may be of benefit to the bird population to maintain the current water regime, quality and salinity levels. However, it may be wise to seek expert advice to determine if a change in water regime (for example an increase in the period of inundation) may in fact be desirable for some species.

Further counts of waterbirds are recommended, as these would better determine the diversity and number of individual bird species utilising the habitat found at Lake Hawdon. These studies should be conducted over time to better assess the temporal value of Lake Hawdon to waterbirds.

A search for the Plains-wanderer (*Pedionmus torquatus*) during summer in the native grasslands at Lake Hawdon North may better determine the status of this 'vulnerable' species within the study area.

#### Reptiles and Amphibians

Any activities likely to threaten the viability of the Lake Hawdon population of the Nationally 'endangered' Glossy Grass Skink (*Pseudemoia rawlinsoni*) should probably be minimised and preferably stopped. In all probability this includes the practices of burning and grazing. The importance of the Lake Hawdon records for this species can not be underestimated and so ongoing monitoring of this animal is recommended.

In spite of the fact that the Biological Survey of Lake Hawdon was conducted during summer, the weather was relatively cool. Reptiles are usually more visible during

warmer weather. Thus, the survey may not have recorded all reptile species inhabiting Lake Hawdon. Further survey work, during warmer weather and when water levels are low for ease of access, is recommended to better determine the full range of reptile species found in the study area.

### **Stromatolites**

The stromatolites of Lake Hawdon are likely to benefit from the cessation of grazing. The presence of these formations in Western Australia in part led to the dedication of a reserve to ensure their conservation. An investigation of the relative rarity and importance of the Lake Hawdon stromatolites in relation to the Region, State and Nation is recommended. If these stromatolites are deemed to be of Regional, State or National significance then an investigation of the Western Australian experience in conserving these formations is suggested.

### **Other**

Lake Hawdon may support several endemic species of invertebrates. An investigation of the aquatic and terrestrial invertebrates of Lake Hawdon may provide useful information in relation to the ecology of Lake Hawdon and wetlands in the South East in general. Invertebrates are an important source of food for a range of fauna and little is known about the invertebrates of the South East. Some of these invertebrates may prove to be useful as indicator species when assessing the overall ecological health of the area.

### **Summary**

Both Lake Hawdon North and South conserve several species of conservation significance.

Further biological research is required to better determine:

1. The diversity of aquatic plants found at Lake Hawdon.
2. The impact of grazing in relation to species diversity, recovery and regeneration by analysing data gathered from the exclosures.
3. The status of the Swamp Antechinus (*Antechinus minimus*) in the study area.
4. The diversity and numbers of waterbird species utilising Lake Hawdon and the status of the Plains-wanderer (*Pedionmus torquatus*) in particular.
5. The diversity and extent of the reptile fauna at Lake Hawdon, with a focus on the 'endangered' Glossy Grass Skink (*Pseudemoia rawlinsoni*).
6. The diversity and extent of the invertebrate fauna of Lake Hawdon.

The practices of grazing and burning are likely to be detrimental to the flora and fauna of Lake Hawdon. Consequently, it is recommended that these activities be reviewed.

Changes to the water regime, particularly increased drainage, or a decline in water quality (turbidity, nutrient levels, pollution), or an increase in salinity are also likely to be detrimental to the flora and fauna of Lake Hawdon and to the stromatolites. Thus, it is recommended that the current water regime be reviewed and that water quality and salinity levels be monitored.

Lake Hawdon supports a range of species and communities of conservation significance however, further research is required to better understand the biology of Lake Hawdon. The practice of grazing and burning is likely to be detrimental to the long-term viability of some of the plants and animals of conservation significance. Grazing and burning is also likely to be detrimental to the long-term viability of some of the vegetation communities of conservation significance. Grazing by stock may adversely affect the long-term viability of the stromatolites. Any major change in the water regime or quality or a rise in salinity may be detrimental to the long-term viability of several plant species and communities.

Based on this information, Lake Hawdon can be regarded as an area of high conservation value, which may be under threat from current land use practices. This report recommends that further biological research be conducted, current land use practices and water regime be reviewed, water quality and salinity be monitored and that Lake Hawdon is worthy of inclusion in the National Parks and Wildlife Reserve System as a Conservation Park under the National Parks and Wildlife Act, 1972.

If all or part of Lake Hawdon were to be dedicated as a Conservation Park, then certain visitor infrastructure could be installed. Raised board-walks could be installed to view stromatolites while protecting them from damage through trampling by visitors. These board-walks would simultaneously facilitate easy access to these interesting features. Interpretive signs could be erected providing information about stromatolites and the flora, fauna and general ecology of the region. A bird hide could also be constructed and this feature could facilitate public bird watching. These facilities may increase visitation to the local area and these visitors might in turn, provide the added bonus of contributing to the local economy.

# RESOURCE MATERIAL AND BIBLIOGRAPHY

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## MAPS

### 1:250 000 Topographic

Penola SJ 54-6 1983

### 1:50 000 Topographic

Robe 6823-I 1981

Beachport 6823-II 1985

### Floristic vegetation map

The Lake Hawdon floristic vegetation map (Figure 6) contained in the pocket attached to the inside back cover of this report is directly derived from the regional floristic vegetation map. The regional mapping was based on the interpretation of 1:40 000, 1987 colour aerial photography together with extensive field-work. Lee Heard from Planning SA (DTUPA) conducted and coordinated the regional mapping. Jason Phillips from Planning SA (DTUPA) produced the Lake Hawdon map.

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# APPENDICES

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## Appendix I

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### PLANT SPECIES RECORDED FROM LAKE HAWDON

Species are arranged in alphabetical order of Family and then Species. The following list includes all plants recorded within the quadrats. Survey site numbers have been shortened, for example 'ROB01001' is listed as '10'. A cross at a site number indicates the presence of a plant species at that survey site. Opportunistic records are listed under 'Opp'. Records obtained from the enclosure are listed under 'Ex'. Records from previous survey sites are listed under 'LE' (LE00701) and 'WO' (WO00101). South Australian conservation ratings are listed under 'SA'. Indigenous plants have a 'Y' listing under 'Ind'. Non-indigenous plants have a 'N' listing under 'Ind'.

#### SOUTH AUSTRALIAN CONSERVATION STATUS (SA)

The codes are based on Schedules of the National Parks and Wildlife Act 1972 (SA) as amended in 2000. Please note that these codes only provide a guide to status under this Act, and there may be discrepancies and omissions that result from differences in taxonomy and nomenclature. Where certainty is required, the schedules should be consulted directly to determine official designations under the NPWS Act.

**E Endangered** (Schedule 7, Part 2)

*Note that there is no category specifically for species that are presumed to be extinct. Instead these are included in the Endangered category.*

**V Vulnerable** (Schedule 8, Part 2)

**R Rare** (Schedule 9, Part 2)

#### REGIONAL CONSERVATION STATUS

The regions are as defined by the State Herbarium (Plant Biodiversity Centre). These are illustrated in the back covers of 'Flora of South Australia' (Ed. Jessop and Toelken, 1986) and 'A List of the Vascular Plants of South Australia (Edition IV)' (Ed. Jessop, 1993). Note: Care should be exercised when applying regional conservation status designations to records near region boundaries. In such cases, it is advisable to also make reference to the status codes that apply in adjoining regions.

(Listed in order of decreasing conservation significance:)

**X Extinct/Presumed extinct:** not located despite thorough searching of all known and likely habitats; known to have been eliminated by the loss of localised population(s); or not recorded for more than 50 years from an area where substantial habitat modification has occurred.

**E Endangered:** rare and in danger of becoming extinct in the wild.

**T Threatened:** likely to be either Endangered or Vulnerable but insufficient data available for more precise assessment.

**V Vulnerable:** rare and at risk from potential threats or long term threats that could cause the species to become endangered in the future.

**K Uncertain:** likely to be either Threatened or Rare but insufficient data available for a more precise assessment.

**R Rare:** has a low overall frequency of occurrence (may be locally common with a very restricted distribution or may be scattered sparsely over a wider area). Not currently exposed to significant or widespread threats, but warrants monitoring and protective measures to prevent reduction of population sizes.

- U** **Uncommon:** less common species of interest but not rare enough to warrant special protective measures.
- Q** Not yet assessed but flagged as being of possible significance.
- N** Not of particular significance / Common. (Also indicated by a blank entry).

Species	Common name	SA	Ind	10	11	12	13	14	15	16	17	LE	WO	Ex	Opp
<b>CAMPANULACEAE</b>															
<i>Lobelia alata</i>	angled lobelia		Y									+			
<i>Pratia platycalyx</i>	salt pratia		Y					+				+			
<b>CENTROLEPIDACEAE</b>															
<i>Centrolepis polygyna</i>	wiry centrolepis		Y									+			
<b>CHENOPODIACEAE</b>															
<i>Atriplex prostrata</i>	creeping saltbush		N		+										
<i>Sarcocornia quinqueflora</i>	beaded samphire		Y									+			
<b>COMPOSITAE</b>															
<i>Angianthus preissianus</i>	salt angianthus		Y	+		+	+	+	+			+			
<i>Hypochaeris radicata</i>	rough cat's-ear		N											+	
<i>Cirsium vulgare</i>	spear thistle		N	+	+	+						+			
<i>Cotula coronopifolia</i>	water buttons		N												+
<i>Leontodon taraxacoides</i> ssp. <i>taraxacoides</i>	lesser hawkbit		N	+		+		+				+			
<i>Ozothamnus ferrugineus</i>	tree everlasting		Y											+	
<i>Olearia ramulosa</i>	twiggy daisy-bush		Y											+	
<i>Pseudognaphalium luteoalbum</i>	Jersey cudweed		Y									+			
<i>Senecio cunninghamii</i> var. <i>cunninghamii</i>	shrubby groundsel		Y	+		+	+		+						
<i>Senecio</i> sp.	groundsel		Y						+			+	+		
<i>Sonchus asper</i> ssp. <i>glaucescens</i>	rough sow-thistle		N			+									
<i>Sonchus hydrophilus</i>	native sow-thistle		Y											+	
<i>Sonchus oleraceus</i>	common sow-thistle		N		+										
<i>Sonchus</i> sp.	sow-thistle		Y					+				+			
<b>CRASSULACEAE</b>															
<i>Crassula helmsii</i>	swamp crassula		Y												+
<b>CONVOLVULACEAE</b>															
<i>Cuscuta campestris</i>	golden dodder		N			+									
<i>Wilsonia backhousei</i>	narrow-leaf wilsonia		Y			+	+	+							
<i>Wilsonia rotundifolia</i>	round-leaf wilsonia		Y			+									
<b>CYPERACEAE</b>															
<i>Baumea arthropophylla</i>	swamp twig-rush		Y			+	+		+	+					
<i>Baumea juncea</i>	bare twig-rush		Y								+	+			
<i>Cyperaceae</i> sp.			Y											+	
<i>Gahnia clarkei</i>	tall saw-sedge	R	Y											+	
<i>Gahnia filum</i>	smooth cutting-grass		Y	+		+	+	+						+	
<i>Gahnia trifida</i>	cutting grass		Y								+	+			
<i>Isolepis nodosa</i>	knobby club-rush		Y											+	+
<i>Schoenoplectus pungens</i>	spiky club-rush		Y												+
<i>Schoenus nitens</i>	shiny bog-rush		Y	+		+	+	+				+			
<b>DENNSTAEDTIACEAE</b>															
<i>Pteridium esculentum</i>	bracken fern		Y											+	
<b>DILLENIAACEAE</b>															
<i>Hibbertia sericea</i> var. <i>sericea</i>	silky guinea-flower		Y											+	
<b>DROSERACEAE</b>															
<i>Drosera pygmaea</i>	tiny sundew		Y									+			
<b>EPACRIDACEAE</b>															
<i>Leucopogon parviflorus</i>	coast beard-heath		Y										+	+	+
<b>FAMILY NOT ASSIGNED</b>															
<i>Lichen</i> sp.			Y	+											
<i>Herb</i> sp.			Y										+		
<i>Moss</i> sp.			Y	+										+	
<b>GENTIANACEAE</b>															
<i>Blackstonia perfoliata</i>	yellow-wort		N	+											
<i>Centaurium</i> sp.	centaury		N									+			

<i>Centaurium tenuiflorum</i>	branched centaury	N	+		+					
<i>Sebaea albidiflora</i>	white sebaea	Y			+					+
<b>GERANIACEAE</b>										
<i>Geranium molle</i> var. <i>molle</i>	soft geranium	N								+
<b>GOODENIACEAE</b>										
<i>Scaevola albida</i>	pale fanflower	Y								+
<i>Selliera radicans</i>	shiny swamp-mat	Y	+		+	+	+	+		+
<b>GRAMINEAE</b>										
<i>Agrostis billardieri</i> var. <i>filifolia</i>	narrow-leaf blown-grass	R	Y		+	+	+	+	+	+
<i>Aira caryophyllea</i>	silvery hair-grass	N	+							
<i>Avena barbata</i>	bearded oat	N								+
<i>Briza minor</i>	lesser quaking-grass	N								+
<i>Bromus rigidus</i>	rigid brome	N								+
<i>Critesion marinum</i>	sea barley-grass	N			+	+				+
<i>Danthonia caespitosa</i>	common wallaby grass	Y								+
<i>Danthonia semiannularis</i>	wetland wallaby-grass	Y	+		+		+			
<i>Hainardia cylindrica</i>	common barb-grass	N								+
<i>Holcus lanatus</i>	Yorkshire fog	N								+
<i>Lagurus ovatus</i>	hare's tail grass	N								+
<i>Lolium rigidum</i>	Wimmera ryegrass	N								+
<i>Polypogon maritimus</i>	coast beard-grass	N	+		+					+
<i>Polypogon monspeliensis</i>	annual beard-grass	N			+					
<i>Sporobolus virginicus</i>	salt couch	Y	+		+	+		+		+
<i>Stipa flavescens</i>	coast speargrass	Y								+
<i>Tribolium acutiflorum</i>		N						+		
<i>Zoysia matrella</i>	manila grass	R	Y	+				+		+
<b>HALORAGACEAE</b>										
<i>Myriophyllum</i> sp.	milfoil	Y								+
<b>IRIDACEAE</b>										
<i>Romulea rosea</i> var. <i>australis</i>	common onion-grass	N	+							+
<b>JUNCACEAE</b>										
<i>Juncus kraussii</i>	sea rush	Y	+	+	+			+		+
<b>JUNCAGINACEAE</b>										
<i>Triglochin alcockiae</i>	alcock's water-ribbons	R	Y							+
<i>Triglochin striatum</i>	streaked arrowgrass	Y	+	+	+					+
<b>LEGUMINOSAE</b>										
<i>Acacia longifolia</i> var. <i>sophorae</i>	coastal wattle	Y								+
<i>Acacia leiophylla</i>	coast golden wattle	Y								+
<i>Trifolium tomentosum</i>	woolly clover	N	+							
<b>LAURACEAE</b>										
<i>Cassytha pubescens</i>	downy dodder-laurel	Y								+
<b>LENTIBULARIACEAE</b>										
<i>Utricularia dichotoma</i>	purple bladderwort	Y								+
<b>LILIACEAE</b>										
<i>Dianella brevicaulis</i>	short-stem flax-lily	Y								+
<i>Myrsiphyllum asparagoides</i>	bridal creeper	N								+
<i>Thysanotus junceifolius</i>	rush fringe-lily	Y								+
<b>LYTHRACEAE</b>										
<i>Lythrum hyssopifolia</i>	lesser loosestrife	Y								+
<b>MENYANTHACEAE</b>										
<i>Villarsia reniformis</i>	running marsh-flower	Y						+		
<b>MYOPORACEAE</b>										
<i>Myoporum insulare</i>	common boobialla	Y								+
<b>MYRTACEAE</b>										
<i>Leptospermum continentale</i>	prickly tea-tree	Y								+
<i>Leptospermum lanigerum</i>	silky tea-tree	Y								+



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## Lake Hawdon Biological Survey

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### Appendix II

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#### MAMMAL SPECIES RECORDED FROM LAKE HAWDON

Species are arranged in alphabetical order of Family and then Species. The following list includes all mammals recorded within the quadrats. Survey site numbers have been shortened, for example 'ROB01001' is listed as '10'. A cross at a site number indicates the presence of a mammal species at that survey site. Records from previous survey sites are listed under 'LE1' (LE00701) and 'LE2' (LE00702). South Australian conservation ratings are listed under 'SA'.

Mammal taxonomy follows Kemper and Queale (1990).

The State conservation ratings are shown in bold following the scientific name. These have been taken from Kemper and Queale (1990).

The definition for the status codes are as follows:

**E Endangered:** taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

**V Vulnerable:** taxa believed likely to move into endangered category in the near future if the causal factors continue operating.

**R Rare:** taxa with small populations in South Australia that are not presently endangered or vulnerable, but are at risk.

Family	Species	SA	10	11	12	13	14	15	16	17	LE1	LE2
CANIDAE	<i>Vulpes vulpes</i>		+				+					
LEPORIDAE	<i>Oryctolagus cuniculus</i>					+						
MACROPODIDAE	<i>Macropus fuliginosus</i>		+		+	+	+					+
MURIDAE Murinae	<i>Mus musculus</i>		+	+	+	+	+				+	+
	<i>Rattus fuscipes</i>										+	+
	<i>Rattus rattus</i>										+	+
PSEUDOCHEIRIDAE	<i>Pseudocheirus peregrinus</i>											
TACHYGLOSSIDAE	<i>Tachyglossus aculeatus</i>		+									

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## Lake Hawdon Biological Survey

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### Appendix III

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#### BIRD SPECIES RECORDED FROM LAKE HAWDON

Species are arranged in alphabetical order of Family and then Species. The following list includes all birds observed within the quadrats. Survey site numbers have been shortened, for example 'ROB01001' is listed as '10'. A cross at a site number indicates the presence of a bird species at that survey site. Opportunistic records are listed under 'Opp'. Records obtained from the three previous studies are listed under the year of publication. Thus, '1929' refers to Sutton, '1989' refers to Bond and Watson and '2000' refers to Bourne *et al.* South Australian conservation ratings are listed under 'SA'. Australian conservation rating are listed under 'AU'. State conservation ratings follow the NPWS Act (1972), Kemper and Queale (1990) and Carpenter and Reid (1994).

The status codes definitions are as follows (after Kemper and Queale (1990)):

**E Endangered:** taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

**V Vulnerable:** taxa believed likely to move into endangered category in the near future if the causal factors continue operating.

**R Rare:** taxa with small populations in South Australia that are not presently endangered or vulnerable, but are at risk.

In addition Watts (1990) also used the category **Uncommon** for species not considered at risk. The definition for this category follows:

**U Uncommon:** taxa occurring in relatively low numbers in South Australia, but not rare.

Species considered common, and therefore not at immediate risk, are not labelled.

Family	Common name	Species	SA	AU	10	11	12	13	14	15	16	17	Opp	1928	1989	2000
ACANTHIZIDAE	Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>				+								+		+
ACANTHIZIDAE	Brown Thornbill	<i>Acanthiza pusilla</i>				+		+						+		+
ACANTHIZIDAE	Southern Whiteface	<i>Aphelocephala leucopsis</i>												+		
ACANTHIZIDAE	Striated Fieldwren	<i>Calamanthus fuliginosus</i>				+	+	+		+			+	+		+
ACANTHIZIDAE	White-browed Scrub-wren	<i>Sericornis frontalis</i>				+		+					+	+		
ACCIPITRIDAE	Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>				+		+								
ACCIPITRIDAE	Wedge-tailed Eagle	<i>Aquila audax</i>											+			+
ACCIPITRIDAE	Swamp Harrier	<i>Circus approximans</i>				+	+		+	+	+	+	+	+	+	+
ACCIPITRIDAE	Black-shouldered Kite	<i>Elanus axillaris</i>					+									
ACCIPITRIDAE	Whistling Kite	<i>Haliastur spheonurus</i>												+		
ACCIPITRIDAE	Black Kite	<i>Milvus migrans</i>							+							
ALAUDIDAE	Skylark	<i>Alauda arvensis</i>				+	+		+	+	+	+				+
ALAUDIDAE	Singing Bushlark	<i>Mirafra javanica</i>					+						+			
ANATIDAE	Chestnut Teal	<i>Anas castanea</i>											+			25
ANATIDAE	Grey Teal	<i>Anas gracilis</i>											+	+		
ANATIDAE	Australasian Shoveler	<i>Anas rhynchotis</i>	R										+	+		
ANATIDAE	Pacific Black Duck	<i>Anas superciliosa</i>											+			10
ANATIDAE	Hardhead	<i>Aythya australis</i>											+	+		
ANATIDAE	Musk Duck	<i>Biziura lobata</i>												2	+	10
ANATIDAE	Australian Wood Duck	<i>Chenonetta jubata</i>											+			
ANATIDAE	Black Swan	<i>Cygnus atratus</i>											+		+B	30
ANATIDAE	Pink-eared Duck	<i>Malacorhynchus membranaceus</i>													+	4
ANATIDAE	Australian Shelduck	<i>Tadorna tadornoides</i>											+	+		300
ARDEIDAE	Great Egret	<i>Ardea alba</i>											+			10
ARDEIDAE	Australasian Bittern	<i>Botaurus poiciloptilus</i>	V									+	+	+		
ARDEIDAE	White-faced Heron	<i>Egretta novaehollandiae</i>											+			50
ARDEIDAE	White-necked Heron	<i>Egretta pacifica</i>														10
ARDEIDAE	Nankeen Night Heron	<i>Nycticorax caledonicus</i>													+	
ARTAMIDAE	Dusky Woodswallow	<i>Artamus cyanopterus</i>													+	
ARTAMIDAE	Grey Butcherbird	<i>Cracticus torquatus</i>						+						+		
ARTAMIDAE	Australian Magpie	<i>Gymnorhina tibicen</i>				+	+	+				+	+	+		+
CACATUIDAE	Galah	<i>Cacatua roseicapilla</i>											+			+
CACATUIDAE	Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>	V										+			
CASUARIIDAE	Emu	<i>Dromaius novaehollandiae</i>							+				+			
CHARADRIIDAE	Red-capped Plover	<i>Charadrius ruficapillus</i>											+			10
CHARADRIIDAE	Black-fronted Dotterel	<i>Elseya melanops</i>														1
CHARADRIIDAE	Red-kneed Dotterel	<i>Erythronyx cinctus</i>											+			20
CHARADRIIDAE	Masked Lapwing	<i>Vanellus miles</i>						+					+	1		10
COLUMBIDAE	Crested Pigeon	<i>Ocyphaps lophotes</i>				+										
CORVIDAE	Little Raven	<i>Corvus mellori</i>				+							+			+
CORVIDAE	Forest Raven	<i>Corvus tasmanicus</i>					+	+	+			+	+	?		
CUCULIDAE	Horsfield's Bronze-cuckoo	<i>Chrysococcyx basalis</i>														+
DICRURIDAE	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>														+
DICRURIDAE	Magpie-lark	<i>Grallina cyanoleuca</i>					+						+	+		+
DICRURIDAE	Grey Fantail	<i>Rhipidura albiscapa</i>							+							+
DICRURIDAE	Willie Wagtail	<i>Rhipidura leucophrys</i>												+		+
ESTRILIDAE	Red-browed Finch	<i>Neochima temporalis</i>											+			
ESTRILIDAE	Beautiful Firetail	<i>Stagonopleura bella</i>	R			+										
FALCONIDAE	Brown Falcon	<i>Falco berigora</i>										+	+			+
FALCONIDAE	Nankeen Kestrel	<i>Falco cenchroides</i>														
FALCONIDAE	Australian Hobby	<i>Falco longipennis</i>						+								
FALCONIDAE	Black Falcon	<i>Falco subniger</i>											+			
FRINGILLIDAE	European Goldfinch	<i>Carduelis carduelis</i>				+	+		+							+
HIRUNDINIDAE	Welcome Swallow	<i>Hirundo neoxena</i>					+			+	+	+	+			+
HIRUNDINIDAE	Fairy Martin	<i>Petrochelidon aerial</i>														+
HIRUNDINIDAE	Tree Martin	<i>Petrochelidon nigricans</i>						+					+			
LARIDAE	Whiskered Tern	<i>Chlidonias hybridus</i>											+		+	150
LARIDAE	Silver Gull	<i>Larus novaehollandiae</i>											+	4	+	100
LARIDAE	Caspian Tern	<i>Sterna caspia</i>											+			
MALURIDAE	Superb Fairy-wren	<i>Malurus cyaneus</i>				+	+		+	+		+	+	+		+
MALURIDAE	Southern Emu-wren	<i>Stipiturus malachurus</i>	R			+			+	+		+	+			
MELIPHAGIDAE	White-fronted Chat	<i>Epthianura albifrons</i>				+	+	+	+	+		+	+	+		+
MELIPHAGIDAE	Spiny-cheeked Honeyeater	<i>Acanthagenys rufogularis</i>				+		+						+		+
MELIPHAGIDAE	Red Wattlebird	<i>Anthochaera carunculata</i>												+		+
MELIPHAGIDAE	Little Wattlebird	<i>Anthochaera chrysoptera</i>												+		
MOTACILLIDAE	Richard's Pipit	<i>Anthus novaeseelandiae</i>						+				+	+	+		+



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## Lake Hawdon Biological Survey

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### Appendix IV

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#### COUNTS OF WATERBIRDS AT LAKE HAWDON IN 1999 AND 2000.

\*Surveys:

19 November 1999: G. Carpenter, H Stewart pers. obs. (Lake Hawdon South only)

13 December 1999: L. Pedler, H. Stewart pers. obs. (Lake Hawdon South only)

17 - 21 January 2000: This study (Lake Hawdon North and South)

5 December 2000: J. Bourne, B. Heywood pers obs. (Lake Hawdon North and South, incomplete count)

B = breeding record

Species	*Surveys				Maximum
	19/11/99	5/12/00	13/12/99	17/01/00	
Musk Duck	0	10	0	0	10
Chestnut Teal	52	25	0	0	52
Grey Teal	300	0	0	0	300
Australasian Shoveler	8	0	0	0	8
Pacific Black Duck	75	10	0	0	75
Pink-eared Duck	0	4	0	0	4
Hardhead	3	0	0	0	3
Australian Wood Duck	0	0	2	0	2
Black Swan	1008	30	82	103	1008
Australian Shelduck	2050	300	1305	170	2050
Hoary-headed Grebe	10	+	9	0	10
Little Pied Cormorant	2	0	1	1	2
Little Black Cormorant	8	+	12	0	12
Australian Pelican	6	0	0	2	6
Great Egret	0	10	4	3	10
Australasian Bittern	5	0	0	0	5
White-faced Heron	41	60	13	77	77
White-necked Heron	0	10	0	0	10
Yellow-billed Spoonbill	3	2	0	27	27
Royal Spoonbill	4	5	15	44	44
Glossy Ibis	20	0	0	0	20
Australian White Ibis	410	110	20	0	410
Straw-necked Ibis	2200	200	200	5	2200
Eurasian Coot	0	+	10	0	10
Dusky Moorhen	0	+	0	0	+
Black-tailed Native-hen	10	0	0	0	10
Australian Spotted Crake	1	0	0	0	1
Sharp-tailed Sandpiper	1540	0	1800	5100	5100
Pectoral Sandpiper	1	0	1	0	1
Curlew Sandpiper	0	1	0	1	1
Red-necked Stint	215	0	50	50	215
Latham's Snipe	2	0	0	2	2
Common Greenshank	5	0	12	9	12
Marsh Sandpiper	0	0	0	14	14
Banded Stilt	0	0	0	6	6
Black-winged Stilt	1100	1000	200	150	1100
Red-capped Plover	1	10	3	19	19

Red-kneed Dotterel	2	0	0	0	2
Black-fronted Dotterel	0	1	0	0	1
Masked Lapwing	24	10	1	54	54
Silver Gull	20	100	58	55	100
Whiskered Tern	2305	150	517	261	2305
Caspian Tern	0	0	0	1	1
<b>Totals</b>	<b>5226</b>	<b>1272</b>	<b>2642</b>	<b>5722</b>	<b>8944</b>

## Lake Hawdon Biological Survey

### Appendix V

#### REPTILE AND AMPHIBIAN SPECIES RECORDED FROM LAKE HAWDON

Species are arranged in alphabetical order of Class, Family and then Species. The following list includes all amphibians and reptiles recorded within the quadrats. Survey site numbers have been shortened, for example 'ROB01001' is listed as '10'. A cross at a site number indicates the presence of a species at that survey site. Opportunistic records are listed under 'Opp'. Records from previous survey sites are listed under 'LE' (LE00701). South Australian conservation ratings are listed under 'SA'.

Taxonomy follows Edwards and Tyler (1990).

Class	Family	Species	SA	10	11	12	13	14	15	16	17	LE	Opp
<b>AMPHIBIA</b>													
	HYLIDAE	<i>Litoria ewingi</i>							+				
	LEPTODACTYLIDAE	<i>Crinia signifera</i>			+		+		+	+	+	+	
	LEPTODACTYLIDAE	<i>Limnodynastes dumerili</i>							+	+			
	LEPTODACTYLIDAE	<i>Limnodynastes peroni</i>							+	+	+		
	LEPTODACTYLIDAE	<i>Limnodynastes tasmaniensis</i>							+				
<b>REPTILIA</b>													
	ELAPIDAE	<i>Drysdalia coronoides</i>							+				
	ELAPIDAE	<i>Notechis scutatus</i>					+				+	+	
	GEKKONIDAE Pygopodinae	<i>Aprasia striolata</i>										+	
	SCINCIDAE	<i>Hemiergus peronii</i>			+							+	
	SCINCIDAE	<i>Pseudemoia entrecasteauxii</i>		+					+			+	
	SCINCIDAE	<i>Pseudemoia rawlinsoni</i>	E					+	+	+			
	SCINCIDAE	<i>Tiliqua rugosa</i>					+					+	

