A Review of

Lake Frome and Strzelecki Regional Reserves



environment and heritage



1991 - 2001

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Strzelecki Regional Decervec







This review has been prepared and adopted in pursuance to section 34A of the *National Parks and Wildlife Act 1972*.

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LIST OF ACRONYMS and ABBREVIATIONS

AND Aust	ralian Height Datum
DEH Depa	artment for Environment and Heritage
DOSAA Divis	sion of State Aboriginal Affairs
DPP Dese	ert Parks Pass
EL Expl	oration Licence (mineral)
EMS Envi	ronmental Management System
EPA Envi	ronment Protection Agency
GAS Goal	Attainment Scaling (PIRSA rehabilitation measure)
IBRA Inter	im Biogeographic Regionalisation of Australia
ILUA Indig	genous Land Use Agreement
IUCN Inter	national Union for the Conservation of Nature
Lake Frome RR Lake	e Frome Regional Reserve
NPWSA Natio	onal Parks & Wildlife SA
PAMS Prote	ected Area Management Systems (NPWSA database)
PEL Petro	oleum Exploration Licence
PELA Petro	oleum Exploration Licence Application
PIRSA Prim	nary Industries and Resources South Australia
PPL Petro	oleum Production Licence
RCD Rabb	bit Calicivirus Disease
SABU Sout	h Australian Business Unit, Santos
Strzelecki RR Strze	elecki Regional Reserve
TSA Tran	isport SA

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- PIRSA, Minerals and Petroleum Groups' staff mineral and petroleum exploration information;
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- DEH staff Jenny Bourne, Brenton Arnold, John Watkins, Christine Crafter, Grant Ortlepp, Alex McDonald, Sue Smalldon, Brian Moore;
- Aboriginal Representatives for the Native Title Claimant groups, Aboriginal Legal Rights Movement;
- Dog Fence Board Michael Balharry;
- Pastoral lessees on adjoining Stations.

FOREWORD

The proclamation of Lake Frome and Strzelecki Regional Reserves ten years ago was an important step in conservation becoming a legitimate and accepted framework for natural resource utilisation over a significant area of the arid zone in South Australia. Without the Regional Reserve concept this might not have been the case.

The Strzelecki Regional Reserve is a true multiple use area with management demands for petroleum exploration and production, cattle pastoralism, cultural and natural heritage conservation, tourism and recreation. Significant cultural heritage sites exist in the area and it is home to the endangered dusky hopping mouse. The Strzelecki Track, which passes through the reserve, is a major transport route in South Australia's outback.

Lake Frome Regional Reserve is an excellent example of an arid salt lake, is very important to Aboriginal people, and contains several mound springs. The area has had minimal petroleum exploration interest and is used to calibrate remote sensing equipment and data.

The challenge of managing both nature conservation and the ecologically sustainable use of natural resources has been addressed by the International Union for the Conservation of Nature. The IUCN recognises a multiple use category of reserve as an "area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time sustainable flow of natural products and services to meet community needs".

The objectives of management for this IUCN reserve category are:

- To protect and maintain the biological diversity, heritage and other values of the area in the long-term;
- To promote sound management practices for sustainable production purposes;
- To protect the natural resource base from being alienated for other land-use purposes that would be detrimental to the area's biological diversity; and
- To contribute to regional and national development.

Regional Reserves meet these objectives.

The *National Parks and Wildlife Act, 1972* requires a report to be prepared on each regional reserve at intervals of not more than ten years and prescribes assessment criteria. This report assesses impacts as required under the Act and provides a useful reflection on the management of these reserves.

I look forward to the community's support in the future management of these reserves. In accordance with the provisions of Section 34A (5) of the *National Parks and Wildlife Act, 1972*, I have much pleasure in presenting to Parliament this report on the use and management of Lake Frome and Strzelecki Regional Reserves.



Tohn Hice

HON JOHN HILL MP MINISTER FOR ENVIRONMENT AND CONSERVATION

EXECUTIVE SUMMARY

The *National Parks and Wildlife Act 1972* was amended in 1987, creating a regional reserve category that linked the concept of multiple use with a conservation function. This category of reserve provided a mechanism to develop cooperative partnerships between key stakeholders.

This report assesses the outcomes of ten years of multiple land use in Lake Frome and Strzelecki Regional Reserves. It includes as required by the legislation:

- Assessments of the impact of the utilisation of the natural resources on the conservation of the wildlife, natural and historic features of the reserves;
- Assessments of the impact or potential impact on the utilisation of the natural resources of the reserves on the economy of the State; and
- Recommendations as to the future status, under the *National Parks and Wildlife Act, 1972*, of the land constituting the reserves.

LAKE FROME REGIONAL RESERVE

Lake Frome Regional Reserve, covering 259,239 hectares, lies between the southern Strzelecki Desert to the east and the Gammon Ranges National Park to the west. The boundary of Lake Frome Regional Reserve follows the margin of Lake Frome. It consists of a large saline lake in relatively pristine condition, in which there are isolated groups of mound springs and islands. Little is known of the ecology of the Lake. It is an extensive saline system providing occasional habitat for waterbirds. The Gammon Ranges catchment that feeds into Lake Frome via Balcanoona Creek is entirely within the Gammon Ranges National Park.

Lake Frome is important to Aboriginal people.

The primary reason for inclusion in the National Parks and Wildlife SA reserve system is to conserve a large arid salt lake system.

Impacts on natural and cultural heritage

The dominant land use of the reserve is biological and cultural conservation. There have been no significant impacts to the natural or cultural heritage of Lake Frome Regional Reserve over the review period.

Impacts on the economy of the State

Since Proclamation, Lake Frome Regional Reserve has not generated any quantifiable economic benefit to the State's economy.

Reserve Status under the Act

It is recommended that the classification of Lake Frome as a Regional Reserve be reconsidered as part of any future review of *National Parks and Wildlife Act 1972* reserve classifications taking into account the findings of this report.

STRZELECKI REGIONAL RESERVE

Strzelecki Regional Reserve, covering 1,165,350 hectares (including the Tinga Tingana pastoral lease) is in the northeast of South Australia within the Strzelecki Desert.

Strzelecki Creek, in the centre of the Regional Reserve, is an overflow of the Cooper Creek and a major feeder stream of Lake Blanche, a shallow freshwater ephemeral lake. The system is entirely unregulated. It is an extensive and important distributary and floodout system providing occasional habitat for waterbirds.

The dusky hopping-mouse (*Notomys fuscus*), rated as nationally "Endangered", has been recorded from sand dunes along the Strzelecki Creek.

The primary reason for inclusion in the National Parks and Wildlife SA reserve system is to conserve environments of the Strzelecki Desert, including the Strzelecki Creek.

There are sites of both Aboriginal and non-Aboriginal cultural importance in Strzelecki Regional Reserve.

The dominant land uses of the reserve are biological conservation, recreational tourism, petroleum exploration and production and cattle pastoralism.

Impacts on natural and cultural heritage

The Strzelecki Track passes through the Strzelecki Regional Reserve and is a well-travelled tourist route. Impacts to the natural and cultural heritage of the reserve from tourism are both positive, in increased awareness of arid ecology, and negative through accumulation of waste and off road vehicle use.

Unintentional impacts to Aboriginal cultural heritage by seismic operations, and illicit collection by souvenir hunters, are likely to have occurred though no impacts have been recorded. A survey of non-Aboriginal heritage is in progress and will be completed in late 2002.

Feral pigs are resident in the upper reaches of the Strzelecki Creek and camels reside in small groups around waterholes and range across the reserve. The rabbit population has declined since the release of Rabbit Calicivirus Disease (RCD) leading to increased vegetation cover and recruitment, but the population continues to fluctuate with seasons and RCD cycles. These feral animals each contribute to a negative impact on the ecology of the reserve.

Petroleum Exploration and Production

In the period since proclamation, extensive petroleum exploration has been undertaken in the northern part of the reserve. Short-term impacts, particularly of seismic surveys, are mainly visual and are severe. Disused seismic lines, tracks and wells have recovered or been rehabilitated. The most lasting impacts on the environment are the clay-capped access tracks and borrow pits created for track and well construction and maintenance. With increasing pressure on Strzelecki Regional Reserve for petroleum exploration and production comes a need for NPWSA to be increasingly vigilant and to work closely with the petroleum industry and regulators to ensure that conservation objectives in the reserve area are met.

It is recommended that PIRSA and NPWSA work together to ensure that at least the current level of regulation is applied to future petroleum exploration and production licence holders to maintain the current level of protection of natural and cultural features.

Pastoralism

The Tinga Tingana Pastoral Lease area was included in the original proclamation of the reserve. Delays have occurred in the transfer of the area to the reserve. Administrative processes have now been clarified and the transfer of Tinga Tingana to the Strzelecki Regional Reserve can now proceed.

It is recommended that NPWSA facilitate the surrender of Tinga Tingana Pastoral Lease and issue a lease for pastoral purposes under section 35 of the *National Parks and Wildlife Act 1972* that adequately protects and maintains the natural and cultural features of Strzelecki Regional Reserve. Monitoring of pastoral use will be a provision of the plan of management for Strzelecki Regional Reserve.

Impacts on the economy of the State

Since proclamation Strzelecki Regional Reserve has generated significant economic benefits to the State economy, principally through petroleum exploration and production and also through the upgrading and ongoing maintenance of the Strzelecki Track. Pastoralism, tourism and recreation within the reserve have made relatively smaller economic contributions to the State's economy.

Reserve Status under the Act

It is recommended that Strzelecki Regional Reserve remain a Regional Reserve under the *National Parks* and *Wildlife Act 1972*.

Plans of Management

Plans of management have not yet been developed for either Lake Frome or Strzelecki Regional Reserves. Future management of Tinga Tingana pastoral lease area will be reflected in the NPWSA lease and plan of management for Strzelecki Regional Reserve. With new companies entering into petroleum exploration in the area, it is imperative that PIRSA, DEH and exploration companies work together to ensure ongoing sound land management. The plan will assist NPWSA future management of the reserve.

It is recommended that plans of management for Lake Frome Regional Reserve and Strzelecki Regional Reserve

be formulated, which include clear objectives and clearly defined environmental and economic indicators that will enable adequate data collection for future assessments of management performance.

1 INTRODUCTION

1.1 Regional Reserves

The *National Parks and Wildlife Act 1972* provides for the establishment and management of reserves for public benefit and enjoyment, to provide for the conservation of wildlife in a natural environment, and for other purposes. Reserves are of five types; National Parks, Conservation Parks, Recreation Parks, Game Reserves and Regional Reserves. The provisions of the *National Parks and Wildlife Act 1972* apply to all types of reserve constituted under the Act or specified by the Act.

Regional Reserves, proclaimed under Section 34A of this Act and managed pursuant to Section 37 (Objectives of Management), provide for the conservation of wildlife or the natural or historic features of that land whilst at the same time, permitting the utilisation of the natural resources of that land.

This provides a multiple land use management regime within a conservation framework for defined areas that have conservation values but are subject to other legitimate land uses. The Regional Reserve mechanism provides for:

- a conservation focus;
- conservation management planning and implementation;
- security of tenure for lands reserved under the Act;
- managed utilisation of natural resources; and
- regulation for the management of human activity.

The major challenge for Regional Reserve management is to establish strategies that successfully integrate the different uses for which a reserve has been created.

The *National Parks and Wildlife Act 1972* also provides for agreements between the Minister responsible for National Parks and Wildlife reserves and the Minister administering the Mining Act and holders of mining tenements to prescribe the way in which natural resources will be utilised in Regional Reserves. No agreements of this type have been made in relation to either Lake Frome or Strzelecki Regional Reserves.

The Regional Reserve classification is not fixed, as it does not prevent all or part of such a reserve from being reconstituted as another class of reserve under the Act at some future date, subject to a resolution of both Houses of Parliament.

It was not intended that the Regional Reserve model would be used as a stepping-stone in restricting the land use to nature conservation to the exclusion of other uses. If decisions are to be taken subsequently that result in the discontinuation of other land uses, such decisions need to be based on relevant economic, environmental and social considerations.

Regional Reserves are classified as IUCN Category VI Protected Areas, '*areas containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs*' (IUCN 1994). The key words here are **sustainable** with respect to production objectives, and **protection and maintenance** with reference to biological diversity.

1.2 Purpose of this Review

This is a Ministerial Review required pursuant to National Parks and Wildlife Act, 1972 Section 34A (5).

The Minister must within ten years of the constitution of a Regional Reserve:

- (a) Prepare a report:
 - (i) Assessing the impact of the utilisation of natural resources on the conservation of the wildlife and the natural and historic features of the reserve
 - (ii) Assessing the impact or the potential impact of the utilisation of the natural resources of the reserve on the economy of the State, and
 - (iii) Making recommendations as to the future status under this Act of the land constituting the reserve, and
- (b) Cause a copy of the report to be laid before each House of Parliament.

1.3 Interpretation

In undertaking this review, it has been necessary to ensure that the requirements of the Act are adequately met. An interpretative analysis of Section 34A of the Act is in Appendix A. This analysis has been used to guide the conduct of the review. It is also useful in guiding readers of the report.

During the conduct of the review, issues emerged that will need to be addressed in the ongoing management of the reserve. Some of these relate to the scope and quality of baseline data upon which critical analysis of management should rely and which will be essential for the conduct of future Section 34A reviews.

Recommendations for management, while not a requirement in the context of the Section 34A review, are included in this report to identify some issues that will be need to be addressed in the preparation of plans of management for these reserves.

1.4 Review Process

Data has been drawn from existing reports and from the Environmental Database of South Australia maintained by the Department for Environment and Heritage. Primary Industries and Resources South Australia provided data on mineral exploration activity. Impacts of tourism were assessed with input from NPWSA staff, members of the regional community, tour operators and some members of the Aboriginal community. A strong reliance on qualitative information was necessary because little quantitative data are available.

The impact of the utilisation of the resources of the reserve on the economy of the State was assessed and reported on by EconSearch Pty Ltd.

Stakeholders have been involved in several ways. Letters with questionnaires were sent to over 40 key stakeholders and individuals, seeking input. The majority of contact with key regional stakeholders and Aboriginal community groups was undertaken by telephone between March and September 2001.

2 LAKE FROME AND STRZELECKI REGIONAL RESERVES

2.1 Introduction

Lake Frome Regional Reserve covering 259,239 hectares lies between the southern Strzelecki Desert to the east and the Gammon Ranges National Park to the west. The boundary of Lake Frome Regional Reserve follows the margin of Lake Frome (Figure 1).

Strzelecki Regional Reserve covers 1,165,350 hectares in the northeast of South Australia, south of Moomba, lies within the Strzelecki Desert and is traversed from north to south by the Strzelecki Track.

Lake Frome and Strzelecki Regional Reserves are in the Lake Eyre Basin Environmental Region (Laut *et al.* 1977) and surrounded mainly by Pastoral Leases. The area is generally arid, with a mean annual rainfall of 125-150 mm, and a mean annual evaporation of 3,100-3,800 mm.

2.2 Context for Management

Reserve Plan of Management

In managing reserves, and developing the management plan, the Minister is required to have regard for the objectives under section 37 of the Act which in sub-section (j) make special provision for multiple land use:

Section 37:

- a) The preservation and management of wildlife;
- b) The preservation of historic sites, objects and structures of historic or scientific interest within reserves;
- c) The preservation of features of geographical, natural or scenic interest;
- d) The destruction of dangerous weeds and the eradication or control of noxious weeds and exotic plants;
- e) The control of vermin and exotic animals;
- f) The control and eradication of disease of animals and vegetation;
- g) The prevention and suppression of bush fires and other hazards;
- h) The encouragement of public use and enjoyment of reserves and education in, and a proper understanding and recognition of, their purpose and significance;
- i) Generally the promotion of the public interest; and
- j) In relation to managing a regional reserve to permit the utilisation of natural resources while conserving wildlife and the natural or historic features of the land.

Plans of management for both Lake Frome and Strzelecki Regional Reserves are to be developed.

Figure 1: General Features of Lake Frome and Strzelecki Regional Reserves

Management and Consultative Structures

The Far North and Northern Consultative Committees are constituted under the Act to provide fora for stakeholders to comment and have input on reserve management. They provide feedback to the Regional Managers, who are directly responsible to the Director, NPWSA and also responsible for the direction of the relevant District Rangers.



Inclusion of Tinga Tingana Pastoral Lease Area

In 1993 land including the Tinga Tingana Pastoral Lease was gazetted to become part of the Strzelecki Regional Reserve. The proclamation at the time was made on the understanding that the Tinga Tingana Pastoral Lease would soon be surrendered and a lease for pastoral purposes would be issued to the existing lessees under section 35 of the *National Parks and Wildlife Act 1972*.

An agreement was drafted in 1992 with this intention though not signed by the parties. The draft agreement covers rights and obligations regarding ongoing management for pastoral purposes and any improvements within the leased area. The draft agreement provides for activities on the grazing lease area to be consistent with the Plan of Management for the reserve when this is in place. A new fence has been constructed along the lease boundary proposed in the draft agreement.

Surrender of the Tinga Tingana Pastoral Lease has been delayed to allow clarification of Native Title implications. As a result of court determinations with respect to native title issues and legislative changes, it is the Crown Solicitor's opinion that the process can now move to completion in a way satisfactory to all interested parties.

For the purposes of this review, the Tinga Tingana Pastoral Lease area has been included in consideration of the future of the Strzelecki Regional Reserve.

Native Title

In 1993 the *Native Title Act* was enacted. 'Native Title' is used to describe the interests Aboriginal and Torres Strait Islander people have in land and waters according to their traditional laws and customs.

The legislation was enacted to:

- (a) provide for the recognition and protection of native title,
- (b) establish ways in which future dealings affecting native title may proceed and to set standards for those dealings,
- (c) establish a mechanism for determining claims to native title, and
- (d) provide for, or permit, the validation of past acts, and intermediate period acts, invalidated because of the existence of native title.

Any development proposed for a reserve must be valid in terms of the Native Title Act 1993. Native Title may

exist on land and waters that have no extinguishing tenure. In South Australia, freehold land and land held under perpetual lease are tenures that have extinguished Native Title. The tenure histories show that it is likely that native title may not have been extinguished for the Reserves, but at the time of writing this review, there has been no determination of native title in relation to these Reserves. A 'determination' is a decision made by the Courts as to the extinguishment of native title rights.

One group has lodged a claim for recognition of their native title rights over the Lake Frome RR area. Five groups have lodged claims for recognition of their native title rights over part or all of the Strzelecki RR. Three of these claims have passed the 'Registration Test' administered by the National Native Title Tribunal pursuant to section 190B of the *Native Title Act 1993*, one claim has not yet been tested and another has not passed the 'Registration Test'.

LAKE FROME REGIONAL RESERVE

Registered Claim:

• SC99/001 - Adnyamathanha No 1 (passed Registration test)

STRZELECKI REGIONAL RESERVE

Registered Claims:

- SC98/001 Yandruwandha/Yawarrawarrka (passed Registration test)
- SC97/004 Edward Landers Dieri People (passed Registration test)
- SC99/001 Adnyamathanha No 1 (passed Registration test)



Non-Registered Claims:

- SC95/002 Dieri Mitha (not passed Registration test)
- SC00/003 Kujani (has not yet been tested)



Boundaries can change for claims that have not passed the Registration Test and procedural Rights under the *Native Title Act 1993* vary according to the status of claims (eg. Registered/non Registered).

In planning for any development where there has been no native title determination, or where there has been no clear extinguishment of native title, land managers must consider the possibility that native title may continue to exist.

In these circumstances, certain developments could constitute what are known as 'future acts'. These 'future acts' will be valid if they fit into one of the provisions in the *Native Title Act 1993* and any procedural requirements are met. One type of provision is for 'low impact future acts' that can include works done for public health and safety, revegetation, and the maintenance of existing facilities. 'Low impact future acts' can occur without undertaking formal notification.

The *Native Title Act 1993* also provides for other specified 'future acts', that are not deemed to be low impact, to be undertaken subject to notification and the provision of the opportunity to comment.

NPWSA will comply with any procedural requirements. NPWSA is committed to developing partnerships with Aboriginal people over and above the native title legislative requirements. NPWSA is also keen to pursue Indigenous Land Use Agreements (ILUAs) where appropriate. ILUAs are voluntary agreements between a native title group and other people about the use and management of land or waters. They are a practical method of resolving native title issues and once registered by the National Native Title Tribunal, are binding pursuant to the *Native Title Act 1993*.

Any activities undertaken within Strzelecki or Lake Frome Regional Reserves that may affect Native Title rights will comply with legislative requirements, or where appropriate will be subject to an ILUA.

Achievements in Partnerships

Transport SA, NPWSA and the Marree Soil Conservation Board have cooperatively undertaken the development of interpretive signage and picnic facilities at Montecollina Bore. No public access tracks exist aside from the Strzelecki Track, which is maintained and controlled by Transport SA.

The inclusion of maps and information about Strzelecki RR in the Desert Parks Pass (DPP) contributes to tourism in the region. The DPP is a NPWSA information and camping permit package developed in consultation with relevant stakeholders including the South Australian Tourism Commission.

NPWSA is committed to reconciliation and partnerships with Aboriginal communities to effectively manage parks and wildlife in a way that respects both contemporary and traditional culture, knowledge and skills. Partnerships involve the delivery of programs that promote reconciliation, cultural awareness, and indigenous

employment and training, joint management and indigenous cultural heritage management on parks. No such partnerships have occurred to date despite these good intentions.

Furthermore, consistent with South Australian Government policy, NWPSA is keen to pursue Indigenous Land Use Agreements (ILUAs) that are voluntary agreements between native title groups and other people.

The Lake Eyre Basin, covering about 1.2 million square kilometres in central Australia, includes five principal catchments including the Cooper Creek Catchment and the Lake Frome Catchment. The South Australian Government is represented on both the Lake Eyre Basin Coordinating Group (LEBCG) and the Cooper Creek Catchment Committee. These are both community-based catchment management groups, which bring together stakeholders, including Government, in partnerships to work toward sustainable and integrated natural resource management outcomes. The Lake Frome and Strzelecki Regional Reserves fall within the overarching LEBCG area. The Strzelecki RR also falls in the Cooper Creek catchment.

Complementary to this community-driven initiative the South Australian, Queensland and Federal Governments signed the Lake Eyre Basin Agreement on 21 October 2000. The Lake Eyre Basin Agreement establishes a cooperative framework enabling the South Australian, Queensland and Federal Governments to work together towards sustainable management of the cross-border river systems and their related natural resources, industries and communities. The Lake Eyre Basin Agreement area includes Strzelecki Regional Reserve. Under this agreement, with support from the appointed Community Advisory Committees and Scientific Advisory Panel, river and catchment management policies and strategies, underpinned by consultation and scientific data will be formulated and implemented.

Lake Callabonna Fossil Reserve

Lake Callabonna Fossil Reserve, immediately south of Strzelecki RR, was dedicated under the *Crown Lands Act 1929* in 1901 and the South Australian Museum has administrative responsibility. Lake Callabonna is where the first articulated skeletons of *Diprotodon*, extinct for 16,000 years, were found by the South Australian Museum in the late 19th century and has a very high palaeontological significance. Lake Callabonna receives negligible management effort as a Fossil Reserve under the *Crown Lands Act 1929*. Its proclamation as a reserve under the *National Parks and Wildlife Act 1972* is an option for further protection of this area against degradation arising from uncontrolled access.

2.3 Natural Features

Conservation Values

LAKE FROME REGIONAL RESERVE

Lake Frome has unique geological features including several mound springs along the eastern margin (Figure 3). Balcanoona Creek, which rises in the Gammon Ranges, flows to Lake Frome entirely through a NPWSA reserve and is the only arid catchment in Australia that is completely within a protected area. Mound Springs are listed as threatened ecological communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Lake Frome RR is within an area listed as significant wilderness (Environmental Research & Assessment 1999). STRZELECKI REGIONAL RESERVE

When in flood, Lake Blanche and the mouth of Strzelecki Creek provide habitat and breeding grounds for large numbers of endemic and migratory waterbirds. The various phases of flooding and drying regimes allow different types of waterbirds to feed and breed in the area at different stages. Lake Blanche is a good example of an arid zone floodplain and lake system (Morelli and DeJong 1996).

The Strzelecki Creek has one of the highest densities and numbers of raptor species found anywhere in Australia. Long-term studies have described breeding populations of half of Australia's raptor species in the Strzelecki RR (Falkenberg *et al.* 2000).

Wilderness value, particularly in the southern and southeastern part of the Strzelecki RR is high due to its inaccessibility and low level of impact from cattle grazing. The Tinga Tingana block, particularly the dunefield, has high wilderness value. The average stocking rate for the 10 year period from 1990 - 1999 was 0.22 cattle/km² for the entire Lindon Station area¹ (McDonald 2000). The southern part of the Strzelecki RR has had little petroleum exploration or cattle grazing pressure and is a good example of an arid dune environment. The infrequent grazing on the floodplain, limited lease development, restricted access to lower reaches of the Strzelecki Creek and difficulty of access to extensive areas north of Lake Callabonna all contribute to these wilderness values (McDonald 2000). The entire Strzelecki Regional Reserve is within an area listed as significant wilderness, despite its history of petroleum exploration and pastoralism (Environmental Research & Assessment 1999).

Two plants from the Strzelecki RR, Eichler's saltbush (*Atriplex eichleri*) and *Muehlenbeckia coccoloboides* are rated "Rare" and one, Australian broomrape (*Orobanche cernua* var. *australiana*) rated "Vulnerable" in South Australia.

Six birds, the Redthroat (*Pyrrholaemus brunneus*), Grey Falcon (*Falco hypoleucus*), Black-breasted Buzzard (*Hamirostra melanosternon*), Glossy Ibis (*Plegadis falcinellus*), Australasian Shoveler (*Anas rhynchotis*) and Musk Duck (*Biziura lobata*) are rated "Rare" in South Australia. A further three birds, the Blue-winged Parrot (*Neophema chrysostoma*), Australian Bustard (*Ardeotis australis*), and Brolga (*Grus rubicunda*) are rated "Vulnerable" in South Australia.

The Dusky Hopping-mouse (*Notomys fuscus*), known to inhabit the dunes in the south of Strzelecki RR is "Endangered" nationally and "Vulnerable" in South Australia.

A single mound spring occurs in the Strzelecki Regional Reserve at Lake Blanche, rated as having high to moderate biological value and a moderate conservation priority.

IBRA Bioregions

Both Lake Frome and Strzelecki Regional Reserves are almost entirely within the Simpson Strzelecki Dunefields biogeographical region, which consists of arid dunefields and sandplains with sparse shrubland and spinifex hummock grassland, and canegrass on deep sands along dune crests and some salt lakes (Thackway and Cresswell 1994).

Environments of South Australia

Lake Frome and Strzelecki Regional Reserves are in the Lake Eyre Basin Environmental Region (8.4) and span three environmental associations. Lake Frome and Lake Blanche are in the Lake Frome Environmental Association (8.4.1). The remainder of the Strzelecki Regional Reserve is covered by the Strzelecki Desert (8.4.2) and the Cooper Creek (8.4.4) Environmental Associations (Laut et al. 1977).

Strzelecki Desert Environmental Association is an extensive dunefield with numerous small claypans (Laut *et al.* 1977). Lake Frome Environmental Association is a chain of inter-connected salt lakes with gypsum dunes along the eastern margin (Laut *et al.* 1977).

Figure 2: Land Systems

¹ Average stocking rate of Tinga Tingana lease area would be lower than this because it is only stocked occasionally.

Land Systems

The following land system descriptions have been derived from the Marree Soil Conservation District Plan (Marree Soil Conservation Board 1997) (Figure 2).

Strzelecki Land System

The Strzelecki Land System comprises the dunefields of the Strzelecki Desert and its outliers, extending from the area east of Lake Frome, north to Innamincka and west to Sturt's Stony Desert. It is dominated by long parallel sandridges with semi-mobile crests, sandy and clayey interdunes and numerous claypans and internal soakages.

Dunes are red siliceous sands, deep, with semi-mobile crests and relatively stable slopes. Lower slopes and narrower interdunes are clayey sands to red sandy clay loams. Dune upper and mid-slopes support a low woodland or tall shrubland of whitewood, narrow-leaf hopbush, needlewood and sandhill wattle in the north, with whitewood becoming infrequent in the south. There is a mid-storey of lobed spinifex and thorny saltbush, or sandhill canegrass where crests are semi-mobile, and a groundcover of ephemerals and short-lived perennials particularly kerosene and mulga grasses, buckbush and grey copperburr.

Narrower (<300 m) interdunes are characteristically massive (non-cracking) red sandy clay loam, usually with a shallow veneer of loamy sand to a maximum of 20 cm depth. Tree cover diminishes on lower dune slopes and in narrower interdunes but species composition remains similar.

Wider interdunes, up to one kilometre between crests, have red self-mulching cracking clay soils with frequent areas of claypan and non-cracking massive red earths. Apart from occasional groves of very low senna or needlewood, wide interdunes are treeless. Cover is perennial grass and short-lived perennial copperburrs and similar: curly Mitchell grass, neverfail, mulka, copperburrs and poverty bushes.

Claypan swamps may be present in any interdune but are largest and most frequent in the wider interdunes. Although their soils and vegetation resemble those of Cooper and Strzelecki Creek floodplains, drainage is internal to the particular interdune and has no connection to flood flows. Margins of swamps have massive red earths with little vegetation, with brown or grey cracking self-mulching clays in lower parts of the swamp. The grey clays, at the terminus of drainage, support shrubland of lignum, Queensland bluebush and swamp canegrass, either mixed or in single-species stands, with perennial grasses neverfail and mulka. Following water run-on, ephemeral growth includes tall copperburr, common joyweed, bogan flea and pop saltbush.

Claypan swamps diminish in size and importance to the south. While claypans remain frequent, the development of the productive grey cracking clays of swamp centres is limited. Also, the Queensland bluebush component of swamp vegetation disappears, with swamp canegrass becoming more important.

Low limestone or kopi rises are present in some interdunes as a minor component. Surface soils remain sandy loams, becoming calcareous at depth. Trees are absent, and the main cover is low shrubland of low bluebush or cottonbush, with grey copperburr, buckbush, pale poverty bush, goathead burr, neverfail and annual grasses. Bladder saltbush appears to the south.

Cooper Land System

The Cooper Land System comprises the waterholes, channels, floodplains, ephemeral lakes of the Cooper and Strzelecki Creeks, and the field of parallel sandridges with interdune areas connected to and periodically flooded by them. There are multiple floodplain and lake land units that can be differentiated on the basis of frequency and intensity of flooding.

Dunes vary from red siliceous sands to whitish siliceous sands, and vegetation differs. Red dunes are older, and may have a clayey core. The larger are equivalent to the dunes of the Strzelecki Land System, supporting a low woodland or tall shrubland of whitewood, narrow-leaf hopbush, needlewood and sandhill wattle over kerosene and mulga grasses, buckbush and grey copperburr.

Pale dunes are recent deposition from the floodplains, and are more mobile. Perennial cover may be sandhill wattle, eurah and occasionally coolibah, with a hummock grassland cover of lobed spinifex, and ephemeral species.

Major waterholes are on the main and northwest channels of the Cooper. They are post-flooding freshwater pockets with salinity varying both in relation to time since flooding and salt input from saline alluvium or local springs. Soils are pale grey sandy to silty clays. Waterholes are effectively permanent, except during extended

drought and tall woodlands of river red gum and coolibah, with eurah, bean tree, Broughton willow, whitewood and native orange. There is usually an understorey of lignum, with groundcover of short-lived perennials or annuals including cannonball, tangled poverty bush, ruby saltbush and annual saltbushes.

The braided channels and temporary waterholes on both the Cooper and the Strzelecki have similar soils and vegetation. The overstorey is primarily coolabah with occasional river red gum and cooba. Lignum stands are dense, growing on pale grey self-mulching cracking clays.

Responses to rainfall events particularly in clay swales may be prolific growth, with buttongrass, New Zealand spinach, buckbush and pigweed common.

Sandplains are present slightly above the level of the coolibah flats. Soils are sandy loams, with a hardsetting layer at about 20 cm. They carry low open woodland including whitewood, prickly wattle, sandhill wattle, some coolibah, needlewood and beefwood over a mixed grass and subshrub groundcover of mulga grass, oatgrass, katoora, mulka, buckbush, goathead burr, tangled leschenaultia and copperburrs.

Blanche Land System

The Blanche Land System is a series of inter-connected salt lakes with channels, gypseous shorelines and plains, and gypsum dunes on the eastern margins running from Lake Frome to Lake Blanche.

The major unit is the salt lakes themselves. These are true salinas, with salt crusts. Vegetation cover is limited to the saline and gypseous shorelines, with low open perennial shrubland of samphires and nitre bush. Ephemerals appear when rainfall is sufficient to leach some salt out of the surface soil on shorelines.

There are isolated groups of mound springs on the eastern side of Lake Frome, around Lake Callabonna and Lake Blanche.

Dunes are light, gypseous sands, with a high degree of natural mobility. Where the gypsum content allows, sandhill wattle and needlebush tall shrubs are present, with an ephemeral understorey. Elsewhere, ephemeral herbs and grasses are sparse.

Interdunes and some plain areas have red earths, some with lime, and a sparse chenopod shrubland cover of low bluebush and bladder saltbush. More saline and heavier soils in interdunes may carry nitre bush, and lignum sometimes occurs in less saline run-on areas.

Pans supporting samphire shrubland or nitre bush occur in low-lying highly saline areas.

Figure 3: Mound springs in the Lake From area

Geology and Landform

Lake Frome and Strzelecki Regional Reserves are part of the Lake Eyre Basin Geological province formed during the Mid-tertiary to Quaternary period.

Lake Frome is an unvegetated saltpan (playa), containing islands that project well above the level of the southern coastal cliffs.

The Strzelecki Regional Reserve consists of dunefields with a salt lake deposit (Lake Blanche) and alluvial deposits associated with Strzelecki Creek (Tyler et al. 1990).

Landscape features of Lake Frome Regional Reserve

Salt Lake: Lake Frome is a dry salt pan (playa) and lies mostly below sea level (+0.5 to – 3.0m, AHD), and is 100km long and 40km wide. Lake Frome is the southern most of an arc of salt lakes northeast of the Flinders Range, including Lakes Gregory, Blanche and Callabonna, all sharing a common origin in a larger ancestral Lake Eyre (to the northwest). It is linked at its northern end, via Salt Creek, to Lake Callabonna and in contrast to Lake Eyre rarely fills. Callen (1983, p.2) attributed this to the large size of the lake in relation to the drainage area, but it may also be due to the difficulty of water travelling along the aeolian sand choked drainage channels. When Lake Eyre filled during the floods of 1972-74, water barely reached the shores of Lake Frome (Playfair and Robinson 1997). When it does fill, it is mainly from the Flinders Ranges streams, and exceptional flows in the Strzelecki Creek (Morelli and DeJong 1996).

Islands: The islands are aeolian and resemble elongate barchan dunes (Callen 1981). Pleistocene beach ridges can be traced around much of Lake Frome, reflecting a lake of once greater extent. Low angle alluvial fans, some of which have coalesced to form aprons rim part of the western and southern shore (eg. Pasmore Delta) and have partly built out over the lake surface. Associated are beaches, spits and bars (Playfair and Robinson 1997).

Mound Springs: There are isolated groups of mound springs on the eastern side of Lake Frome (Figure 3). The two northern groups are composed of fine clastic material, largely aeolian in origin, having accumulated during a dry-lake phase. These clastic mounds are circular or elliptical, up to 2m high and have a carbonate capping which helps preserve the mound. The largest elliptical mound is about 15m long and 5m wide. The southern carbonate mounds are 50-60 cm high and 1-2m wide. The mounds, some flowing, are largely made up of deposits of aragonite and calcite with quartz and dolomite. Others contain water standing above the level of the lake floor. Algae are associated with flowing water (Draper and Jensen 1976). No aquatic invertebrates or vertebrates have been recorded from any mounds, and only one plant species (*Halosarcia pergranulata*) has been noted at one spring (SEA 1986).

Landscape features Strzelecki Regional Reserve

Dunes: The Strzelecki Desert dunefields are longitudinal parallel sandridges with semi-mobile crests (Tyler, Twidale et al. 1990; Marree Soil Conservation Board 1997).

Interdunes: Narrower (<300m) interdunes are characteristically massive (non-cracking) red sandy clay loam, usually with a shallow veneer of loamy sand to a maximum depth of 20 cm. Wider interdunes (to 1km) have red self-mulching cracking clay soils with frequent areas of claypan and non-cracking massive red earths (Marree Soil Conservation Board 1997). Low limestone or kopi rises are a minor component in some interdunes (Marree Soil Conservation Board 1997).

Pans: Occasional claypan swamps are largest and most frequent in the wider interdunes. Although the soils and vegetation resemble those of Cooper and Strzelecki Creek floodplains, drainage is internal to the particular interdune and has no connection to flood flows. Margins of swamps are massive red earths with little vegetation, with brown or grey cracking self-mulching clays in lower parts of the swamp (Marree Soil Conservation Board 1997).

Strzelecki Creek: The Strzelecki Creek is an entirely unregulated arid zone river-floodplain system and a major distributary of the Cooper Creek. Strzelecki Creek is a tree-lined watercourse subject to intermittent flooding from the Cooper Creek and flows from Innamincka to Lake Blanche, approximately 200 km (Morelli and DeJong 1996). It is bordered by large parallel sand ridges and has a series of waterholes along its course.

Waterholes: Montecollina Bore is salty and Tinga Tingana Waterhole (Caroowinnie) becomes a freshwater swamp after rain. Other semi-permanent waterholes are spread along the Strzelecki Creek.

Lake Blanche: Lake Blanche is a shallow freshwater ephemeral lake connected by overflow channels to Lake Gregory in the northwest and Lake Callabonna in the southeast. As the lake dries, hundreds of low islands appear. The lake receives flows from Cooper Creek and Strzelecki Creek in the north, the Tooncatchyin, Petermorra and MacDonnell Creeks from the Flinders Ranges in the south, and from other localised drainages. Major floods filled it in 1974 and 1990 (Morelli and DeJong 1996). It is estimated that the Cooper Creek floods sufficiently to fill Lake Blanche every 10 to 15 years (Kingsford and Porter 1992). Salinity was 300-400 ppm and pH 8.4-8.5 (August 1990) (Morelli and DeJong 1996).

Mound Springs: The single spring at Lake Blanche has a low mound with a single seep and short tail. The mound is 1.5 m high and 16 m wide, with an associated wetland covering about 300 m². There is a small pool with a boarded edge at the source that discharges into the wetland. The boards are remnants from when cattle watered there. This ceased many years ago due to its remoteness and the spring does not appear to have become degraded (SEA 1986). Four plant species (*Cressa cretica, Halosarcia* sp., *Polypogon monspeliensis* and *Mimulus repens*) have been recorded. No aquatic vertebrates or invertebrates have been recorded (SEA 1986). (McLaren, Wiltshire et al. 1986) rated "naturalness" as moderate, biological value high to moderate, vulnerability as moderate.

Flora and Fauna

Flora of Lake Frome Regional Reserve

The lakebed is an unvegetated saltpan. Vegetated areas on the fringe of the lake are outside the Regional Reserve boundary and consist of tall shrubland, ephemeral herbland and chenopod shrubland.

Salt lake margin: low chenopod Shrubland (Nitraria billardierei, Halosarcia spp. Sclerostegia tenuis).

Flora of Strzelecki Regional Reserve

Dunes: The red siliceous sands support a tall shrubland of sandhill wattle (*Acacia ligulata*), needlebush (*Hakea leucoptera*) and whitewood (*Atalaya hemiglauca*), with a ground cover of kerosene grasses (*Aristida contorta* and *A. browniana*), forbs and ephemeral daisies. Yellow sands support hummock grassland of sandhill canegrass (*Zygochloa paradoxa*) with a ground cover of hard spinifex (*Triodia basedowii*) and kerosene grasses (*Aristida* spp.) (Laut et al. 1977).

Interdunes: Contain a dominant low shrubland of low bluebush (*Maireana astrotricha*) and Queensland bluebush (*Chenopodium auricomum*) and a ground cover of ephemeral herbs, bindyi, blackheads and kerosene grass (Laut, Keig et al. 1977).

Claypans: Low shrublands are dominant, with low bluebush (*Maireana astrotricha*), old man saltbush (*Atriplex numnularia*), Queensland bluebush (*Chenopodium auricomum*), canegrass (*Eragrostis australasica*) and a ground cover of samphire (*Halosarcia* spp.) and forbs. Low shrubland and grassland are subdominant on the claypans, with canegrass (*Eragrostis australasica*) and lignum (*Muehlenbeckia florulenta*), and a groundcover of forbs and short grasses (Laut et al. 1977). Claypan swamps become smaller to the south with Queensland bluebush disappearing, and canegrass becoming more dominant (Marree Soil Conservation Board 1997).

Lake Blanche: The shoreline supports coolabah (*Eucalyptus coolabah* ssp. *arida*), and *Acacia* spp. woodlands in the drainage lines and run-on depressions (Morelli and DeJong 1996).

Strzelecki Creek: Creek edges support woodlands of coolabah (*Eucalyptus coolabah* ssp. *arida*), *Acacia* spp. and beantree (*Lysiphyllum gilvum*) with understorey chenopods such as old man saltbush (*Atriplex nummularia*) and Queensland saltbush (*Chenopodium auricomum*) (Reid and Gillen 1988; Drewien 1992).

Fauna of Lake Frome Regional Reserve

Native Fauna: Nesting Red-necked Avocets and Red-capped Plovers have been observed at Lake Callabonna and Lake Frome between 1971-1972 and 1974-1975 (Morelli and DeJong 1996). In 1990-1991 when 50% of Lake Frome's surface area was covered with water, no waterbirds were observed (Kingsford and Porter 1992) suggesting potential as waterbird habitat is ephemeral.

Introduced Mammals: Foxes and rabbits are known to frequent the islands of Lake Frome. Since the release of Rabbit Calicivirus Disease (RCD) in 1995, rabbit numbers have dropped dramatically and have not significantly increased again since (Falkenberg 2001).

Fauna of Strzelecki Regional Reserve

Native Mammals: The dusking hopping-mouse (*Notomys fuscus*) is a small rodent of the arid regions in South Australia and southwest Queensland. The IUCN Australasian Rodent Specialist Group estimates a range reduction of greater than 90% since European settlement (Lee 1995). *N. fuscus* is nationally "Vulnerable" (Commonwealth of Australia 1999). Recent capture rates imply a total population less than 10, 000 but greater than 2,500 (Moseby et al. 1999b). Evidence of *N. fuscus* was found throughout the Strzelecki Desert east and south of the Strzelecki Creek in South Australia (Moseby et al. 1999b). Populations were located in a variety of sand habitats (excepting *Triodia* dominated) in dunefields, implying the species is a habitat generalist on its preferred substrate of sand. The Strzelecki Desert region encompasses some of the most severely degraded arid habitat in South Australia and the persistence of *N. fuscus* in such areas suggests a generalised and opportunistic ecology. Only two of the eight sites where *N. fuscus* were recorded are within conservation areas. It is probable that *N. fuscus* has a patchy distribution throughout Strzelecki RR and studies suggest that populations fluctuate with seasonal conditions.

Introduced Mammals: Foxes, dingoes and rabbits are known to inhabit Strzelecki RR, and pigs occasionally come down the Strzelecki Creek from Innamincka. Occasional herds of camels also come down from Innamincka (Crafter 2001). Since the release of Rabbit Calicivirus Disease (RCD) in 1995, rabbit numbers have dropped dramatically and have not significantly increased again since (Falkenberg 2001).

Birds: Lake Blanche and the Lower Strzelecki Creek, in flood years provide waterbird habitat. Forty-two species were recorded at Lake Blanche and the mouth of the Strzelecki Creek following flooding in 1990 (August 1990 to February 1991). An estimated total of 145,000 waterbirds were recorded on Lake Blanche in February 1991. The most common species (>1,500 individuals in February 1991) recorded at Lake Blanche include the Grey Teal (*Anas gracilis*), Banded Stilt (*Cladorhynchus leucocephalus*), Pink-eared Duck (*Malacorhynchus membranaceus*), Red-necked Avocet (*Recurvirostra novaehollandiae*), Silver Gull (*Larus novaehollandiae*), Black Swan (*Cygnus atratus*), Australian Wood Duck (*Chenonetta jubata*), Caspian Tern (*Sterna caspia*), and Gull-billed Tern (*S. nilotica*) (Kingsford and Porter 1992). Fifty-three species of non-waterbird were recorded at Lake Blanche (Drewien 1992).

Fifty-seven bird species were noted at Gurra Gurra Waterhole in September 1991 and 53 bird species, including 15 species of waterbird were recorded at Yaningurie Waterhole on the Lower Strzelecki Creek (Drewien 1992).

Fish and other aquatic fauna: Macroinvertebrates were found in Lake Blanche and the Strzelecki Creek, following the 1990 flood. (Puckridge and Drewien 1992) sampled four sites, Lake Blanche, the entry of Strzelecki Creek into Lake Blanche, Strzelecki Creek approx. 5km upstream from Lake Blanche and the Strzelecki - Cooper Creek junction. Rotifers, copepods, cladocerans and hemipterans were found at all four sites. Dipterans were found at all sites, except the mouth. Ostracods were recorded at three sites, but not at Lake Blanche. Coleopterans were found at Lake Blanche and the junction, and Hydrocarina and Arachnida at the mouth and junction (Puckridge and Drewien 1992).

The dense zooplankton and macroinvertebrate food base, and the shallowness of the contacting lake, are likely to have been important contributors to the preference for the area shown by large numbers of ducks and waders in the August-February period of Kingsford's waterbird study (Kingsford and Porter 1992, Puckridge and Drewien 1992).

In the same survey seven species of adult and juvenile fish were recorded. Bony Bream (*Nematalosa erebi*), callop (*Macquaria ambigu*) and Welch's grunter (*Bibyanus welchii*) were recorded in sites from Lake Blanche to the Cooper-Strzelecki junction. Larvae of Western Carp Gudgeon (*Hypseleotris klunzingeri*) were found in Strzelecki Creek and the Lake Blanche entrance. Two species of catfish (*Neosilurus argenteus* and *N. glencoensis*) and another grunter (*Leiopotherapon unicolour*) were also recorded at the junction (Puckridge and Drewien 1992).

The migrant species, bony bream, callop, Welch's grunter, western carp gudgeon, and particularly the juveniles of these species also readily migrate downstream with floodwaters in the northwest branch of the Cooper (Puckridge and Drewien 1988) and Strzelecki Creek channels (Puckridge and Drewien 1992).

The most common fish species throughout the lower Cooper and the Lake Blanche/Strzelecki Creek system is bony bream (*Nematalosa erebi*) (Puckridge and Drewien 1988, Puckridge and Drewien 1992). They mature early and adults feed on detritus and algae in the nutrient-rich lakes allowing large populations to develop. Ephemeral lakes like Lake Blanche are particularly important for waterbird breeding events, because as these lakes contract, they expose concentrated fish resources.

Research

Ten scientific permits were issued for flora, invertebrate, birds, vertebrates, and fossil research studies between June 1991 and January 2001 in the Strzelecki Regional Reserve and six in Lake Frome Regional Reserve. Research centring on plants, insects (ants as indicators of seismic line regeneration), bird migration, raptor ecology and fossils has been undertaken in both reserves. No publications have resulted from any of these research projects. During 2001, CSIRO have been accessing parts of Lake Frome for calibration studies for remote sensing projects. Access has been limited and impacts virtually nil.

The following biological surveys have been conducted:

- Biological Survey of the North Olary Plains (includes Lake Frome area) (Playfair and Robinson 1997);
- Rare Rodents project ecological distribution (*Notomys fuscus* and *Pseudomys australis*) is ongoing in Strzelecki Regional Reserve (Moseby et al. 1999a; Moseby et al. 1999b);
- Biological Survey of waterbirds on the Lower Strzelecki (Drewien 1992);
- Raptors at Risk Project (Falkenberg et al. 2000).

2.4 Cultural Features

Aboriginal Cultural Features

Lake Frome and Strzelecki Regional Reserves cover parts of the Wangkumara, Pilatapa, Yandruwandha, Yauroworka, Dieri and Adnymathanha peoples' areas. The Adnymathanha (hills or rock people) include the Guyani, Wailpi, Jadliaura and Pilatapa and other groups which share similar language and customs (Brock 1985).

Recent archaeological information establishes Aboriginal occupation of the area from about three thousand years ago, though there has probably been sparse Aboriginal occupation of areas north of Lake Eyre for more than 25,000 years (Nicholson *et al.* 1999). Aboriginal association with the land is expressed through the land's spiritual significance and social and personal responsibility to care for it.

Prior to non-Aboriginal settlement, the focus of trade around the eastern side of Lake Eyre and in the Cooper Basin was in the Kopperamanna area about 300 km north of Parachilna. A variety of items including grindstones and ochre were traded and transported far and wide throughout the region. Shared trade routes linked many groups over large distances.

Bonds between Aboriginal groups also include the possession of common laws centring on cultural heroes called mura-mura. The custodianship of the laws is a cooperative arrangement between groups. An example of this is the emu and red ochre law that covers an area over 1000 kilometres in length. It is associated with natural resources and localities all along its length. Different groups "own or manage" the keeping of different parts of the story. This creates a mutual economic dependency between groups through the sharing and preservation of the resources to which the story relates (Elkin 1979). These stories and songs can be related to books – they were the memory of the rules for the use of places and resources.

Numerous histories and stories exist in the north east of South Australia. Some focus on specific places and their role in the rituals of law and social order and some to and landscape features, plant and animal species' distribution and trails (Hercus & Potezny 1996, Tunbridge 1988). The visitation and use and management of the areas is important to protecting Aboriginal cultural practices and heritage.

The people's knowledge included trading practices and routes, laws for society and interrelationship and rules for the use of natural resources. Rules for living, such as family obligations and survival practices are remembered and recorded through rites, songs, dance and teaching.

The entire area of Lake Frome is very significant to the Adnymathanha people, as it is central to some of their *muda* (law and lore). Out of respect, they do not venture onto the lake surface. Remnants of campsites also occur in the dunes around the margins of the lake (pers. comm. Coulthard 2001).

Due to the size and remoteness of these reserves, State Aboriginal Affairs (DOSAA) has not undertaken any comprehensive surveys. The DOSAA Central Archive contains 15 sites in Strzelecki RR and none in Lake Frome RR. It should be noted that the Central Archive is not a comprehensive record of sites that are significant to Aboriginal tradition, archaeology, anthropology or history. Most of the listed sites are archaeological, and the material consists of a lithic scatter exposed on the surface, predominantly an eroding surface. Though they may not be listed anywhere, with the intensity of seismic survey work over the years, it is inevitable that sites of traditional significance that are often natural landscape features have been impacted in some way (State Aboriginal Affairs 2001).

Non-Aboriginal Cultural Features

Captain Charles Sturt, the first non-Aboriginal visitor to the region, saw Strzelecki Creek in August 1845 and named it after Polish Scientist and explorer Paul Edmond de Strzelecki (1797-1873) (Donovan and Donovan 1996). The earliest recorded encounter with a group of Aborigines was by John Harris Browne, a surgeon with Sturt's party (Tolcher 1986).

The Strzelecki Track is an important tourist and transport route. The track is used constantly by vehicles serving Moomba and tourists travelling through the Cooper Creek area to Innamincka and Coongie Lakes (McDonald 2000). The track extends 460km from Lyndhurst to Innamincka, (Donovan and Donovan 1996) originally following Strzelecki Creek for much of the route. The Strzelecki Track was pioneered as a stock route and identified with the pastoral industry between 1870 and 1930. After 1930 it was rarely used, primarily because of failure to maintain the bores during the depression. Since 1958 the track has served as an access route to the oil and gas fields in the northeast of South Australia (Donovan and Donovan 1996).

Harry Redford (better known as Captain Starlight) pioneered a route along Strzelecki Creek that the pastoralists were soon to follow, whilst droving stolen cattle from Bowen Downs in Queensland. John Conrick, who took up Nappa Merrie Station in western Queensland in 1873, was next to use the route in December 1874, to drove cattle and obtain supplies from Port Augusta (Tolcher 1977). A fortnightly mail-coach service was run along the Strzelecki Track between Farina and Innamincka from 1878 until the 1920s (Donovan and Donovan 1996). The South Australian Engineering and Water Supply Department stopped maintaining the wells and bores in 1933. Early in 1955 the South Australian Pastoral Board declined a lease application on the Strzelecki Creek. At the time the Board considered the land unsuitable for permanent occupation, and withdrew it from the list of leases available for application. In the Board's opinion the land '*could support no more than the impact of stock occasionally wandering on it during good seasons*'. In 1952 the Pastoral Board was asked to consider reopening the stock route between Murnpeowie and Innamincka. It remained closed (Donovan and Donovan 1996).

A track suitable for wheeled vehicles was built in 1958 to provide access into the area from South Australia. Without the development of the Strzelecki Track, mineral explorers and their teams and equipment would have had to travel through New South Wales via Broken Hill. Sir Thomas Playford, then Premier of South Australia, was determined to encourage prospecting, and to ensure that the benefits from economically viable petroleum discoveries would stay in South Australia, directed that a road be built. The track has been maintained, realigned and upgraded since, primarily to meet the needs of the petroleum and tourism industries. The northern section of the track originally followed the Strzelecki Creek and was often cut by floodwaters. Petroleum industry vehicles caused heavy wear and the increasing number of tourist vehicles caused rapid deterioration and constant maintenance problems. To avoid further degradation, maintain more constant access and minimise maintenance costs, the track was realigned away from the creek and floodplain in 1994 (Donovan and Donovan 1996).

LAKE FROME REGIONAL RESERVE

There are no places in Lake Frome RR on the State Heritage Register (Angas 2001).

STRZELECKI REGIONAL RESERVE

The following places in or close to the Strzelecki RR are listed on the State Heritage Register (Angas 2001):

- Tinga Tingana Homestead (Ruin). The ruins are significant because they date back to the original attempts at sheep production in the northeast of South Australia during the 1870s;
- Horse Capstan, Pump and Well at Old Mulga Bore, Merty Merty Station (outside Strzelecki RR) were built between 1914 and 1932. They highlight the importance of water supply in the remote areas of South Australia;
- Well and Whim, Coochilara Waterhole, on Merty Merty Station they relate to the extreme importance of water supply for stock along the Strzelecki Track (outside Strzelecki RR);
- Lake Callabonna Fossil Reserve (abuts southern boundary of Strzelecki RR).

There have been no specific heritage surveys undertaken since proclamation of Lake Frome or Strzelecki Regional Reserves. A heritage survey of the Birdsville and Strzelecki Tracks, including part of the Strzelecki Regional Reserve has been commissioned, and is expected to be complete by August 2002.

2.5 Resource Utilisation

Mineral Exploration

There has been no on-ground mineral exploration within either Lake Frome or Strzelecki Regional Reserves.

A number of surrounding Exploration Licences (ELs) have included small portions of the Reserves because of the coordinate system used to define lease boundaries. These companies had no intention of accessing the reserves for exploration. Their exploration targets included sedimentary uranium and celestite.

Only EL1850 granted in 1993 to BHP Minerals Pty Ltd was issued to allow for exploration for base and precious metals on Lake Frome. A desktop review of existing geophysical data indicated that basement targets were too deep and the EL was surrendered within six months (pers. comm. Minerals Group 2001).

Petroleum Exploration

Innamincka 1, the first petroleum exploration well drilled in the Cooper Basin, was sunk in April 1959, and on the 31 December 1963 gas flowed for the first time in the State from the Gidgealpa 2 well. More extensive discoveries in 1966 at Moomba resulted in plans to pipe Cooper Basin gas to Adelaide, and the government established the Pipelines Authority of South Australia in 1967. The 750 km Moomba to Adelaide gas pipeline was built in 1969 (Donovan and Donovan 1996).

During and including the period since the proclamation of Lake Frome and Strzelecki Regional Reserves in December 1991, 35 production licences have been active (Table 1).

Seismic Survey

LAKE FROME REGIONAL RESERVE

Prior to proclamation, within Lake Frome RR, 566 km of seismic lines had been surveyed (Figure 4). No seismic survey work has been undertaken since.

STRZELECKI REGIONAL RESERVE

Prior to proclamation, within Strzelecki RR, 8,297 km of seismic lines had been surveyed (Figure 4). 2,594 km of 2D seismic lines and 657.2 km² of 3D seismic survey have been recorded since proclamation (Figure 5).

Wells

LAKE FROME REGIONAL RESERVE No exploratory wells have been drilled in Lake Frome Regional Reserve.

STRZELECKI REGIONAL RESERVE

In Strzelecki RR, 88 wells were drilled before proclamation and 37 since (Figure 6). Of these, 15 have been abandoned and restored (Table 6). The remainder are within current PPL areas (Table 1). Some are producing, some partially restored and some suspended.

Figure 4: Seismic Surveys - Pre Proclamation

Figure 5: Seismic Surveys - Post Proclamation

Figure 6: Petrolium Exploration Wells

Oil and Gas Production

LAKE FROME REGIONAL RESERVE

There are no current (at September 2001) Petroleum Production Licences (PPL) in Lake Frome RR.

STRZELECKI REGIONAL RESERVE

35 current PPLs exist in Strzelecki RR (Table 1, Figure 7). Within these PPL areas, temporary campsites, access tracks, truck-mounted drilling operations, further 3D seismic survey can be undertaken pursuant to the provisions of the *Petroleum Act 2000*.

			D C 1 0 000 (C	
Table 1	Current Petroleum Production	Licences in Strzelecki Regional	Reserve at September 2001 (F	(/) gure
				· · · · · /

						Outside
Label	File reference	Granted	Expires	Field	Inside SRR (km ²)	SRR (km ²)
PPL 10	SR 28/1/45	01/01/1975	31/12/2005	Daralingie	226.2	(1111)
PPL 31	SR 28/1/99	07/05/1986	06/05/2007	Wancoocha	5.7	
PPL 37	SR 28/1/108	07/10/1986	06/10/2007	Spencer	6.7	0.9
PPL 38	SR 28/1/109	07/10/1986	06/10/2007	Dirkala	6.8	3.4
PPL 54	SR 28/1/140	16/06/1989	15/06/2010	Pintari North	0.1	
PPL 57	SR 28/1/146	17/07/1990	16/07/2011	Thurakinna	10.5	
PPL 65	SR 28/1/166	18/07/1991	17/07/2012	Kujani	6.4	
PPL 67	SR 28/1/169	18/07/1991	17/07/2012	Keena	10.9	
PPL 60	SR 28/1/187	26/05/1993	25/05/2014	Wirrarie north	6.5	
PPL 70	SR 28/1/186	26/05/1993	25/05/2014	Farina	5.7	
PPL 75	SR 28/1/197	27/10/1995	26/10/2016	Caladan	6.5	
PPL 82	SR 28/1/208	01/01/1996	31/12/2016	Waukatanna	5.7	
PPL 83	SR 28/1/209	01/01/1996	31/12/2016	Pogona	3.3	
PPL 81	SR 28/1/210	01/11/1996	31/10/2017	Caladan Northeast	4.4	
PPL 87	SR 28/1/222	01/01/1997	31/12/2017	Boobook	5.4	
PPL 88	SR 28/1/223	01/01/1997	31/12/2017	Lycosa	2.5	
PPL 89	SR 28/1/221	01/01/1997	31/12/2017	Bobs Well	5.8	0.6
PPL 84	SR 28/1/213	07/06/1997	06/06/2018	Barina	28.4	
PPL 94	SR 28/1/220	09/01/1998	08/01/2019	Atreides	7.1	
PPL 143	SR 28/1/259	01/01/1999	31/12/2019	Dorodillo	9.2	83.4
PPL 153	SR 28/1/313	01/01/1999	31/12/2019	Shiraz	29.4	13.5
PPL 126	SR 28/1/261	22/02/1999	21/02/2020	Daralingie North	1.2	
PPL 129	SR 28/1/281	21/04/1999	20/04/2020	Thurakinna South	0.6	
PPL 130	SR 28/1/289	21/04/1999	20/04/2020	Thurakinna East	0.6	
PPL 159	SR 28/1/323	23/07/1999	22/07/2020	Touriga	0.5	3.1
PPL 144	SR 28/1/276	11/08/1999	10/08/2020	Keena Southwest	7.3	
PPL 145	SR 28/1/262	11/08/1999	10/08/2020	Koree/Koree South	17.9	
PPL 157	SR 28/1/284	11/08/1999	10/08/2020	Muscat	2.9	
PPL 171	SR 28/1/304	15/05/2001	n.a.	Greater Atreides	22.1	1.5
PPL 172	SR 28/1/328	15/05/2001	n.a.	Big Lake (Bauhaus)	7.2	119.6
PPL 175	SR 28/1/315	15/05/2001	n.a.	Greater Caladan	45.9	
PPL 181	SR 28/1/327	15/05/2001	n.a.	Grenache	18.4	
PPL 190	SR 28/1/314	15/05/2001	n.a.	Greater Moomba-Big Lake	49.2	182.7
PPL 179	SR 28/1/280	15/06/2001	n.a.	Fortanna	6.1	
PPL 199	SR 28/1/330	22/06/2001	n.a.	Wooloo	12.8	
				Total	585.9	408.7

n.a. data not available

Figure 7: Current Petroleum Production Licences

Survey	Survey	Start	End	Lines	Length	Total Length
1991	91 CP11		16/1/1992	16	141.5	141.5
1000						
1992	92 CP01	23/2/1992	13/12/1992	24	321.0	
	92 CP10	16/5/1992	24/9/1992	6	44.1	
	92 CP11	12/6/1992	15/9/1992	8	49.3	414.4
1993	93 CP01	17/6/1993	20/12/1993	12	148.3	
	93 CP04	05/7/1993	07/7/1993	10	65.5	213.8
1994	94 CP21	06/7/1994	12/12/1994	37	706 7	706.7
17771	<i>y</i> + 0121	00/1/1991	12/12/1991	57	100.1	/ 001/
1005	95 CP01	22/2/1005	28/1/1006	30	481.0	481.0
1775	<i>))))(</i> 1 <i>)</i> 1	22/2/1995	20/1/1770	50	401.7	401.7
1006	06 CD01	22/1/1006	06/12/1006	27	562.0	5(2.0
1990	96 CP01	22/1/1996	00/12/1990	57	562.0	562.0
1000	00 0001	22/2/1000	24/0/1000	-	-	- 4 0
1998	98 CP01	22/2/1998	24/8/1998	1	/4.0	74.0
						2594.3

Table 2 Length of 2D Seismic Surveys

Table 3 Area covered by 3D Seismic Surveys

Survey	Field	Total area (km ²)	Inside SRR (km ²)
92 CP13	Dirkala	16.4	9.5
98 CP04	Barina / Farina	176.5	176.5
01 CP02	Caladan	823.6	471.2
	Total	1,016.5	657.2

Further Petroleum Exploration

Three Petroleum Exploration Licence Applications (PELAs) are currently being considered over parts of Lake Frome RR and nine over parts of Strzelecki RR (Figure 8).

Further seismic survey and drilling is expected in these new areas once they are granted (Table 4). A PEL cannot be granted until a Native Title Mining Agreement has been negotiated and this process of consultation is progressing.

Reserve	File reference	Application date	Area (km ²)	Offer no.	Proposed 5yr work program
Strz RR	SR 27/2/187	25/11/1999	836	СО99-Н	150 km seismic + 10 wells
Strz RR	SR 27/2/171	11/03/1999	1,884	CO98-H	870 km seismic + 12 wells
Strz RR	SR 27/2/173	11/03/1999	3,893	CO98-J	460 km seismic + 5 wells
Strz RR	SR 27/2/172	11/03/1999	2,703	CO98-I	400 km seismic + 4 wells
Strz RR	SR 27/2/174	11/03/1999	5,236	CO98-K	500 km seismic + 6 wells
Strz RR	SR 27/2/190	10/03/2000	2,847	CO2/2000	* no public information available
LF RR	SR 27/2/178	10/09/1999	9,861	CO5/2001	* no public information available
LF RR	SR 27/2/148	17/04/2001	9,945	CO3/2001	* no public information available
Srtz RR	SR 27/2/189e	29/06/2000	3,314	СО2000-Е	* no public information available
Strz RR	SR 27/2/199	28/09/2000	1,163	CO2000-F	* no public information available
LF & Strz RR	SR 27/2/190a	17/04/2001	9,955	CO4/2001	* no public information available

 Table 4
 Petroleum Exploration Licence Applications (August 2001)

Note: Some proposed exploration works will occur outside the boundary of Strzelecki RR (see Figure 8).

* "over-the-counter" applications for which details are unavailable to the public.

Pipelines

Two high capacity underground pipelines, one for gas and one for liquids, with compressor stations every 100

km run south from Moomba through Strzelecki Regional Reserve and to the west of Lake Frome Regional Reserve (Figure 1). Both pipelines follow the same route in this area. The liquids pipeline to Port Bonython is owned by Santos. Epic Energy owns the gas pipeline and maintains both. Epic Energy has responsibility for a service track (right-of-way not for public access) that runs adjacent to the pipelines.

Compressor Station 1 is 67 km south of Moomba in the Strzelecki RR. The self-contained accommodation is not permanently occupied. Water is trucked from Moomba as required, and all rubbish is removed. There is an airstrip 2 km south of Compressor Station 1. Service personnel permanently reside at Compressor Station 2, about 20 km south of Montecollina, outside the Regional Reserve area and use the pipeline service track for maintenance patrols.

There was an upgrade of the pipeline capacity within Strzelecki Regional Reserve in 2000 and 2001, and the compressors at Stations 1 and 2 were both replaced with quieter and more efficient facilities. A third pipeline, creating a loop, was laid in the existing easement for 14 km south of the compressor, to cope with the increased capacity of the new compressor. An overhead power line (Single Wire Earth Return, SWER), parallel to the pipeline was extended south from Compressor Station 1 (14 km). This SWER line replaced the solar facilities providing power to radios and cathodic protection sites along the pipeline. Another SWER line (6km into the northern end of Strzelecki RR) was constructed in 1997 running parallel and 100m east of the pipeline. Construction guidelines for the SWER lines required poles to be sited to avoid clearance of any native vegetation.

Tourists are discouraged from using the service track and Epic Energy has undertaken no track maintenance since 1996 (pers. comm. Fotheringham 2001).

Lindon Station, lessees of the Tinga Tingana block are approved "organic" exporters and have strict regulations regarding land use, particularly chemical usage. Epic Energy must get consent from the Lindon lessee to bring any chemicals onto the land and provide Lindon with "Fact Sheets" on their use.

In Strzelecki RR, there is a gas satellite plant at Daralingie (central PPL 10) that collects gas from the surrounding wells and pumps it to Moomba for further processing and distribution. Numerous lower capacity pipelines run between producing wells, nodal compressors, satellites and Moomba.

The Wancoocha oil satellite station (central PPL 31) is currently not in operation. It may be brought back on line some time in the future.

Figure 8: Petroleum Exploration Licence Applications

Tourism

A Desert Parks Pass (DPP) is not required to visit either Lake Frome or Strzelecki Regional Reserves. Access is only by public road and there are no visitor facilities or carparks on these reserves.

LAKE FROME REGIONAL RESERVE

Lake Frome RR has limited tourism potential. One track allows visitors access to the western shoreline. At the termination of this track is a small vehicle parking area, and barriers have been erected to discourage vehicle access onto the lake surface. The lake's surface crust can become damaged and vehicles bogged very easily.

STRZELECKI REGIONAL RESERVE

People visit the reserve mainly between April and October. Transport SA (TSA) estimate 6,000 vehicles per year travel between Merty Merty and Cameron Corner and 10,500 per year between Lyndhurst and Merty Merty (pers. comm. TSA 2001). Visitor numbers increase when rains and local flooding bring a flush of vegetation growth, wildflowers and bird life. Many of these recorded vehicles are pastoral and petroleum industry support vehicles enroute to Moomba and the surrounding pastoral area.

Many of the visitors passing through the Strzelecki RR along the Strzelecki Track are on their way to or from Innamincka or Cameron Corner on the New South Wales/Queensland/South Australian border. Few travellers camp overnight in the area. The Regional Reserve is therefore a transport corridor rather than a destination in its own right. The Strzelecki Track provides little opportunity for stopping and enjoying environmental and natural and cultural features.

The Strzelecki Track was realigned and upgraded in 1995 to improve access to Moomba. The old alignment south of the Strzelecki Crossing has been rehabilitated and is not accessible. The old alignment between Strzelecki Crossing and Merty Merty is washed out, eroded and no longer passable, and has been closed at the request of the lessees to allow rehabilitation. The old Strzelecki Track from Merty Merty to Innamincka is maintained by Santos and used primarily for access to oil and gas fields. This track is also used by some visitors travelling north to Innamincka.

Attractions

Historic sites along the Strzelecki Creek are attractive to visitors, but access is not provided. There are no visitor facilities, services or access to sites of interest.

Camping

Camping occurs at Montecollina and near the Strzelecki Creek Crossing, but little elsewhere in the reserve (McDonald 2000, pers. comm. Crafter 2001). A camping area at Montecollina Bore has a shaded picnic area, water tank and interpretive signage (developed by NPWSA, Marree Soil Board and Transport SA). NPWSA has recently constructed toilets to address sanitary and litter problems. Indiscriminate track development and uncontrolled camping is degrading Yaningurie Waterhole and its use for these purposes is being discouraged by NPWSA.

At this time there are no developments planned by the South Australian Tourism Commission in either Lake Frome or Strzelecki Regional Reserves (Clarke 2001).

Tours

Adventure holiday tour operators run tours periodically through the Strzelecki Regional Reserve, usually enroute from the Flinders Ranges to the Coongie Lakes, Innamincka or Lake Eyre. Some tour operators stop at Montecollina Bore to break the journey, though few camp overnight.

Strzelecki Track

There are nine borrow pit sites in Strzelecki Regional Reserve where clay has been taken to resurface the Strzelecki Track. Transport SA undertakes vegetation surveys to monitor the regeneration of these areas. At a number of existing pit sites there has been erosion and gullying on the steep sides whilst the pits were open for use. These have recently been rehabilitated. Reuse and rehabilitation has improved the profiling of the pit walls and should ease the erosion problems experienced in the past. The pits and their access tracks should be clearly identified as "no public access" to allow rehabilitation on completion of the project (pers. comm. Crafter 2001).

Pastoralism

LAKE FROME REGIONAL RESERVE Lake Frome Regional Reserve has never been stocked.

STRZELECKI REGIONAL RESERVE

The first pastoral runs along the Strzelecki Creek were taken up during the 1870s. By 1878 virtually all the land in the vicinity of the Strzelecki Creek had been acquired for pastoral purposes. The rabbit plague of the 1890s reduced the pastoral value of the country dramatically. Tinga Tingana lease had various lessees between 1874 and 1937, and then remained unoccupied until January 1969, when part of old Tinga Tingana was combined with Montecollina to create a new Tinga Tingana, which was worked in association with White Catch Station (Donovan and Donovan 1996). This is now run as part of Lindon Station. The Tinga Tingana Pastoral lease is within the mapped boundary of Strzelecki Regional Reserve.

The lease consists of two paddocks, Montecollina and Tinga Tingana. There is no pastoral infrastructure apart from fencing, and cattle rely on the natural waterholes of the Strzelecki Creek. Tinga Tingana lease is stocked only when the Strzelecki Creek flows sufficiently to fill Yaningurie and Tinga Tingana waterholes. Waterholes below Yaningurie are unreliable and become saline quickly after rains (McDonald 2000). Cattle feed primarily on annual pastures and perennial grasses in the swales of the dunefields or the Strzelecki Creek floodplain and channel.

New boundary fencing has been completed (pers. comm. Ogilvy 2001) and cattle are likely to be run on the Tinga Tingana block only when feed and water are available there and feed in other parts of Lindon is depleted.

Cattle have been run very occasionally over the last 10 years in the Tinga Tingana block.

3 IMPACTS OF RESOURCE UTILISATION ON WILDLIFE AND NATURAL FEATURES

3.1 Petroleum Exploration

Some level of environmental impact from exploration and development activities is inevitable, and with the changing exploration practices they are generally much improved when compared with earlier work. In the 1950 - 1974 period, activities were mainly confined to existing tracks, no bulldozers were used, and lines have almost disappeared in sandy environments. Heavy bulldozing required for the "Vibroseis" survey method that was used from 1975 to 1984 left substantial impacts, particularly where clay-capped access tracks were built (Langley 2001) (Environmental Research & Assessment 1999). Since 1989, Codes of Practice have been strengthened and particular efforts have been made to minimise impacts in all environments (Santos 1998). Codes of Environmental Practice have been in place and improved since this time. However, there is now a requirement to operate in accordance with PIRSA Statements of Environmental Objectives (SEO). There are currently SEOs for seismic and drilling and workover operations and a draft production and processing SEO is also currently being developed (pers. comm. Langley 2001).

LAKE FROME REGIONAL RESERVE

No seismic survey work has been undertaken and no production facilities have been installed in the Lake Frome Regional Reserve since proclamation, therefore there are no impacts during the reporting period. Some visual evidence still remains from the seismic survey work undertaken before proclamation (Figure 4).

STRZELECKI REGIONAL RESERVE

Impacts on Landscape Features

Impacts from petroleum exploration activities arise from seismic surveys, exploration and development wells, pipelines, access tracks and borrow pits.

Seismic Surveys

Assessments undertaken of early seismic lines and their rehabilitation (Social & Ecological Assessment 1987) in the dunefields of the Strzelecki RR show that rehabilitation has been "good to excellent" and suggest that revegetation of dunes proceeds relatively quickly and can be expected to be visually complete in 15 to 20 years if undisturbed. Seismic survey practices have been refined since these times and are now much less environmentally damaging. The persistence of windrows on dune flanks and swales is the principal long-term impact of earlier surveys conducted prior to proclamation.

Seismic line preparation practices in sandy country (Santos 1998) include:

- weaving the line 10 to 15 metres (> dozer blade width) either side of the programmed line at least every 75 metres. This reduces visual impact and enables avoidance of longer lived trees and shrubs;
- avoidance of windrows through strategic blading, use of "rill-kill" attachments to dozer blades and immediate remediation on survey completion. In most sandplains, dune swales and floodplains no blading is used. The dozer is "walked" with the blade slightly above ground level;
- avoidance of cutting dune crests. Where it is unavoidable, cuts are only deep enough to allow vehicle access and sand is mounded along the crest to facilitate rehabilitation through the natural movement of sand;
- avoidance of creek disturbance to ensure bank stability and obscuring line-of-sight. Lines are stopped before creek channels and cables and equipment hand carried if necessary. If clear areas are available to cross creeks, lines are deviated as necessary;
- avoidance of salt lake traverses. All seismic vehicles deviate around salt lakes.

Assessments are regularly carried out by the Petroleum Group, PIRSA using the Goal Attainment Scaling (GAS) assessment criteria outlined in (Petroleum Group 1998) and summarised in Appendix D.

Goal attainment scaling is a process in which stakeholders are required to participate in evaluating and seeking consensus on the most important aspects of the goals to be achieved within a particular time frame and the range of expected outcomes of the activities undertaken. Each outcome is allocated a score from +2 to -2. Expected outcomes are documented as:

- +2 much more than expected excellent
- +1 more than expected good
- 0 expected satisfactory
- -1 less than expected unsatisfactory
- -2 much less than expected very unsatisfactory.

As an indication of how practices have changed over time, the following series of GAS scores for the entire Cooper Basin in South Australia have been summarised for Linearity, Landscape Visibility, Vegetation Regrowth and Erosion. In all these categories, improvements over time are evident.

Linearity - extent to which "dog-legging" and weaving the line conceals the presence of seismic lines.



Landscape Visibility - level to which seismic lines are visible in the broader landscape.



Vegetation Regrowth - how closely vegetative regrowth resembles pre-survey conditions.



Erosion - amount of soil erosion caused by seismic line creation and subsequent use.



Exploration and Development Wells

Assessments are also carried out by PIRSA using the Goal Attainment Scaling (GAS) assessment criteria as they apply to abandoned wells. For the 15 abandoned and restored wells that were drilled since proclamation, the results of these assessments are given in Table 5 (Wright and Malavazos 2001).

Well	Inspection	Visual	Visual	Reveg for	Reveg for	Well	Site	Land Unit	Action
	Date	Impact of	Impact of	Well Sites	well sites	marked	rubbish		
		Access	Well Sites	less than 5	more than 5	and cellar	removed		
		Tracks		years old	years old	backfilled			
Augusta 1	24/05/98	0	0	0	N/A	0	0	Plain	None
Barra 1	24/05/98	+2	0	0	N/A	0	0	Floodplain	None
Bartilla 1	25/05/98	0	0	0	N/A	0	0	Plain	None
Cowan 4	Yet to be								
	inspected								
Farina 2	Yet to be								
	inspected								
Gamay 1	07/12/99	0	0	0	N/A	0	0	Dune	None
Jaspa 1	Yet to be								
	inspected								
Karina SW 1	25/05/98	0	0	0	N/A	0	0	Plain	None
Kujani 2	21/05/98	0	0	0	N/A	0	0	Dune	None
Mataro 1	20/05/98	0	0	0	N/A	0	0	Floodplain	None
Pampari 1	Yet to be								
	inspected								
Pando Sth 1	16/05/98	0	0	0	N/A	0	0	Plain	None
Verdelho 1	23/03/99	0	0	0	N/A	0	0		None
Warki 1	16/05/98	-1	0	0	N/A	0	0	Floodplain	None
Wooloo Sth 1	24/05/98	0	0	0	N/A	0	0	Swale	None

Table 5 Summary of GAS Scores for Plugged and Abandoned Well Sites in Strzelecki RR

The main objective of these assessments is to ascertain the integrity of Santos' own internal environmental audits of restored sites as detailed in Santos' annual environment report. A copy of this annual environment report is in the Petroleum Group's environmental register on the PIRSA Internet site (<u>http://www.pir.sa.gov.au/</u>).

For all well sites in the South Australian Cooper Basin assessed to date, an acceptable level of compliance against each objective has been achieved as shown in Table 6. This includes those within Strzelecki RR.

 Table 6
 Compliance of Well Site rehabilitation with Environmental Objectives

Environmental Objective	Level of Compliance
Visual impact of restored access tracks	98%
Visual impact of restored well site	94%
Revegetation for well sites restored less than 5 years ago	96%
Revegetation for well sites restored more than 5 years ago	94%
Well marker and backfill of cellar	99%
Rubbish removal	98%

The results of these assessments confirm the integrity of the restored well site environmental audit reports provided by Santos in the annual environment report (Wright and Malavazos 2001).

Formation Water

The disposal of formation water, a natural by-product of oil and gas production is usually by evaporation from ponds. Once wells are producing, this water is handled at the satellite station or nodal compressor. The annual evaporation rate in the region is very high (> 3,100 mm) which assists this process. At evaporation areas that are built in natural depressions, permanent free form wetlands are created. This brings with it the environmental "benefits" of increased waterbird habitat and potential environmental "costs" of groundwater seepage, soil salinisation and restoration after production ceases. Detailed investigations are undertaken of all environmental implications of formation water disposal before any disposal begins and regular water monitoring is undertaken to identify unforseen impacts (Santos 1997).
Since the provisions of the *Petroleum Act 2000* took effect, annual formation water quality monitoring is reported to PIRSA and Santos also undertakes an annual audit. Since 1999, the results of this audit have been reported to PIRSA in an annual report. No activities were undertaken in Strzelecki Regional Reserve during the 1999/00 audit reporting period. The report for the 2000/01 period is still in preparation. At the quarterly meetings held with PIRSA to discuss environmental management issues associated with Santos' operations in the South Australian Cooper Basin, no major issues relating to formation water management were raised (Santos 2000). Procedures for the siting of evaporation ponds are included in Santos Codes and Procedures.

Oil spills

Oil from the Cooper Basin is termed "light crude" and contains negligible amounts of heavy metals. Biological remediation techniques have been found to be very effective, reducing levels of contamination from petroleum hydrocarbons after minor spills to levels within EPA guidelines for clean fill (<0.1% w/w total petroleum hydrocarbons) with less than 6 months of treatment. All oil spills in Strzelecki Regional Reserve over the period since proclamation have been minor (Table 7). Bioremediation has consisted of treatment on site with fertiliser, water and aeration. No spills have been considered serious enough to require removal of contaminated soil to the "soil farm" at Moomba for more extensive treatment. Table 7 lists the reported incidents, inspected by PIRSA officers with estimates of volume spilt and area affected over the period since proclamation (pers. comm. Hough 2001)

Facility	Spill date	Spill Reported	Inspected	Volume (m ³⁾	Area (m ²⁾	Туре	Action
Spencer	13/05/1993	15/05/1993	15/05/1993	0.2	n.a.	Oil	Y
Wancoocha	18/05/1993	19/05/1993	18/05/1993	n.a.	50	Oil	Y
Spencer	20/10/1993	21/10/1993	21/10/1993	2	n.a.	Oil	Y
Wancoocha	25/06/1994	26/06/1994	25/06/1994	5	n.a.	Oil	Y
Spencer	30/08/1997	1/09/1997	30/08/1997	9	380	Oil	Y
Spencer	25/07/1998	27/07/1998	25/07/1998	0.9	75	Oil	Ν
Spencer	16/09/1998	18/09/1998	16/09/1998	0.8	60	Oil	Y
Spencer	22/10/1999	25/10/1999	22/10/1999	2	n.a.	Oil & Water	Y
Daralingie	12/11/2000	22/02/2001	12/11/2000	1	n.a.	Oil	n.a.
Pintari North	n.a.	n.a.	29/07/1992	n.a.	n.a.	Oil & Water	Ν
Pintari North	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Spencer	n.a.	5/02/1999	2/09/1998	n.a.	n.a.	n.a.	n.a.
Spencer West	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Wancoocha	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Well							
Spencer 4	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Spencer 5	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Spencer 8	n.a.	n.a.	4/05/1993	n.a.	50	Oil	Y
Spencer 8	n.a.	n.a.	18/06/1993	n.a.	n.a.	Oil	Ν
Spencer 11	n.a.	n.a.	22/09/1993	n.a.	80	Oil	Y
Spencer 8	12/05/1993	15/05/1993	15/05/1993	n.a.	n.a.	Oil & Water	Y
Wancoocha 2	15/05/1993	15/05/1993	15/05/1993	0.05	n.a.	Oil	Ν
Spencer West 2	19/01/1997	20/01/1997	19/01/1997	0.25	8	Oil	n.a.
Wancoocha 5	30/05/1997	2/06/1997	30/05/1997	1	40	Oil & Water	Y
Wancoocha 4	30/07/1999	4/11/1999	30/07/1999	0.25	n.a.	Oil & Water	Y

Table 7 Oil Spills in Strzelecki Regional Reserve.

n.a. data not available

Pipelines

Epic Energy maintains both the liquids and gas pipelines that pass through the Strzelecki RR. Santos manages and maintains the network of underground gas (approx. 100km) and above-ground oil (approx. 40 km) trunklines and flow lines in Strzelecki RR.

The Epic Energy Environmental Management System (EMS) covers all activities undertaken by Epic Energy including pipeline construction (route selection, design, land access, and construction activities), pipeline

operations, and operation of ancillary facilities (Epic Energy 2001a).

The EMS Aspects Register outlines Epic Energy's key activities, potential environmental incidents, potential environmental impacts and control measures. Each activity has been assessed for environmental risk. Activities with the assessment resulting in either a high, significant or moderate rating (Significant Aspects) are the priorities for actions to adequately manage or reduce the risk. The Register has been structured to identify those activities that are applicable to all areas of operations, and those areas that are specific to a particular location or operational activity.

A list of the Significant Aspects identified from Epic Energy's Aspects Register is summarised in Table 8 (Epic Energy 2001b). The EMS Aspects Register also details the potential impacts, business consequences, suggested remediation, frequency and consequences of each aspect listed below.

Activity	Aspect	Risk
General Waste Management	On-site domestic waste pits	Significant
	On-site septic tanks	Moderate
	On-site evaporation ponds	Moderate
Waste Oil Management	Underground storage tanks	Significant
	Above ground storage tanks	Moderate
	Burning waste oil	Significant
Compressor Station Operation	Exhaust Emissions	Moderate
	Leaks/fugitive emissions	Moderate
	Venting/purging	Moderate
	Spills	Moderate
	Wastes from pigging	Moderate
	Noise	Moderate
Airstrip Maintenance	Vegetation clearing	Moderate
Hazardous Materials	Transport/storage/handling	Moderate
Pipelines	Oil spill	High
	Gas release	Significant
	Water table contamination	Moderate
Right of Way (ROW)	Dieback	High
	Damage resulting from driving on ROW	Slight
	Damage to flora or fauna	Moderate
	Trenching	Moderate
	Watercourse crossings	Significant
	Hydrotesting	Moderate
	Weed control (spills, washdown)	Significant
	3 rd party access	Moderate

Table 8 Summary of Epic Energy Environmental Management System, Aspects Register

There have been no reported incidents from any of the pipelines, trunklines or flowlines in Strzelecki RR since proclamation. The only impacts arising from pipeline maintenance and construction are associated with occasional the use of the right-of-way by patrol vehicles and tourists (pers. comm. Fotheringham 2001,pers. comm. Petroleum Group 2001).

Access Tracks And Borrow Pits

Access roads to well locations are rehabilitated after they are no longer required. There are comprehensive guidelines on the construction, maintenance and restoration of these tracks and the borrow pits that are required to provide the clay capping material (Santos 1997b, Santos 1997c). These guidelines are aimed at minimising construction and maintenance costs as well as environmental costs. A substantial network of tracks has developed and numerous borrow pits which even after restoration are a significant visual impact and provide "artificial" semi-permanent wetlands for waterbird habitat.

It is estimated that approximately 619 km of track has been constructed and 122 km restored in Strzelecki RR since exploration began in 1959 (pers. comm. Santos 2001). Restoration has been by ripping or through natural regrowth of vegetation. Since proclamation, approximately 35 km of access tracks to plugged and abandoned wells have been rehabilitated. This still leaves a network of approximately 500 km of access tracks (some clay-capped) in Strzelecki RR.

Ongoing oil and gas production activities as well as new exploration and future production will increase this impact. Monitoring of the impacts of tracks and borrow pits and rehabilitation assessment must be a part of the ongoing management of the reserve.

No activities relating to access tracks were undertaken in Strzelecki Regional Reserve during the 1999/00 audit reporting period. The report for the 2000/01 period is still in preparation. At the quarterly meetings held with PIRSA to discuss environmental management issues associated with Santos' operations in the South Australian Cooper Basin, no major issues relating to road and access track construction were raised (Santos 2000).

Rehabilitation

To encourage restoration, techniques that encourage rapid regrowth of native vegetation are used. This stabilises the soil surface, initiates natural regeneration processes and discourages further impacts from vehicular traffic. These techniques include ripping and tyne-pitting to prepare the surface, respreading topsoil to recreate the original surface profile and respreading vegetation to replace natural seed sources.

Avoidance of any further use of rehabilitated areas by vehicles is also an essential part of the restoration process. Any use of restored tracks and seismic lines is considered a serious threat to the naturalness of the reserve. Techniques to minimise this third party or post-rehabilitation use include doglegging and careful concealment at intersections. Access roads to abandoned wells are deep-ripped and spread out so that they are not raised above the natural surface to dissuade further use and restore natural drainage patterns (Santos 1997b).

Impacts on Wildlife

Impacts on wildlife and their habitat may arise from:

- disturbance to flora and fauna from track construction and maintenance;
- habitat damage on seismic lines, tracks and at drill sites;
- third party use of tracks and seismic lines;
- formation water disposal;
- spread of pest plant species.

Disturbance of Flora and Fauna

The local impacts to the land surface and biota are difficult to quantify and recovery rates depend on land type, rainfall degree and type of impact. Direct impacts are generally restricted to small mammals, reptile and invertebrates that have a home range small enough to be affected by the width of seismic lines (5 m) or pipeline rights-of-way (15 m). The open time of trenches when laying pipelines is kept to less than 24 hours where possible. Clearance and damage to vegetation are also variable impacts. Care is taken in all operations to minimise these impacts (Santos 1997) and the GAS assessments undertaken by PIRSA show a generally high level of compliance with acceptable levels of impact (Wright and Malavazos 2001).

Assessment of Impacts

The Goal Attainment Scaling process undertaken by PIRSA does not measure any biodiversity indicators directly, except for a visual assessment of vegetation regeneration, and therefore does not provide a clear indication of impacts on flora and fauna.

The Petroleum Geophysics Branch of PIRSA has contracted the South Australian Museum to undertake a study of the viability of the use of ants as indicators of ecological damage.

The use of ants as bio-indicators is not a new process. A large volume of academic work has been conducted in various educational and Government institutions on the uses of ants to measure the rate of environmental recovery of areas that have been impacted by activities such as mining.

The main impact of seismic lines is often visual rather than environmental. Fauna appears to recover in about three to seven years, depending on environmental conditions, but the full impact of the seismic lines on the ecology may not be visibly discernible. PIRSA hopes that this group of invertebrates will be an effective indicator of impacts to ecological systems and native fauna in general.

The objective of this project is to provide rigorous statistical evidence of the level of impact on ant communities and their rate of recovery from such impacts (Langley 2001).

No formalised system is in place for assessing the impact of petroleum exploration and production on biodiversity. A suggested method for landscape scale biodiversity assessments (pers. comm. Possingham 2000) is a "replicated before and after, control and impact" process. Before any impact there needs to be a quantitative survey of key biodiversity elements both at the impact site and a carefully chosen control site. This survey needs to be replicated both spatially and over time, and focus on easily measured biodiversity attributes and ecological indicators. Data obtained from biological surveys are inappropriate and inadequate for this purpose. Ongoing management should incorporate such data collection.

3.2 Tourism

LAKE FROME REGIONAL RESERVE

Visitation of Lake Frome Regional Reserve by tourists is minimal, because access to the lake edge is limited. Access to all but a small section of lake edge (in Gammon Ranges National Park) is across pastoral leases and controlled by lessees. Lessees are often not able to adequately control all access across their leases, so some unauthorised access occurs, but is unquantified.

STRZELECKI REGIONAL RESERVE

Tourism and recreation impacts are focused along tracks and areas where visitors stop to rest or camp overnight. Track proliferation around Yaningurie Waterhole has increased since signage was erected on the Strzelecki Track identifying the location of and directing traffic to the waterhole. Old seismic lines that intersect the Strzelecki Track are generally difficult to see, though around Yaningurie Waterhole and the Strzelecki crossing, third party access impacts are evident. These tracks and seismic lines should be rehabilitated to discourage third party use that slows the rehabilitation process.

The spread of exotic or naturalised plants, whilst not a serious issue in Strzelecki Regional Reserve has the potential to increase along with the increase in tourist vehicular traffic.

Habitat destruction and uncontrolled collection of wood for campfires is an increasing problem in areas used by campers such as Yaningurie Waterhole, Strzelecki Crossing and Montecollina Bore. Management action to modify visitor behaviour before damage becomes irreversible would assist the maintenance of the scenic and biological value of these areas. Strzelecki Crossing is undesirable as a campsite due to flooding of the creek and inappropriate access to historic sites and the old Strzelecki Track. Montecollina is being encouraged as the preferred camping area (pers. comm. Crafter 2001).

Marketing through popular media, Internet and adventure tourism magazines is common. Traversing the "old Strzelecki Track" is being promoted on the Internet. The Internet is also being used to relate stories of personal adventures and provide accurate location details of sites to visit and tracks to use. This type of promotion is not consistent with NPWSA management of the reserve.

Impacts associated with tourism are becoming increasingly important. As remote areas become more accessible and tourist numbers increase demand grows for tourist facilities and infrastructure. Modern communications provide tourists with greater confidence and 4WD ownership is increasing. Drivers who have little or no experience or understanding of the countryside can quickly find themselves in situations that expose them to extreme risk. Infrastructure to deal with this may need to be developed.

Many visitors are unaware that permission for access is required to visit areas not dedicated as reserves. Most of the "outback" is held under pastoral lease or is in Aboriginal ownership.

3.3 Feral Animals and Pest Plants

LAKE FROME REGIONAL RESERVE

Exotic or naturalised plants are not a serious issue in Lake Frome Regional Reserve. Foxes and rabbits are known to frequent the islands.

STRZELECKI REGIONAL RESERVE

Feral pigs are resident in the upper reaches of the Strzelecki Creek in the reserve and occur as far south as the Strzelecki Crossing. Camels reside in small groups in the areas around the Yaningurie and Montecollina Waterholes and range across the eastern part of the reserve as conditions permit.

Exotic or naturalised plants are not a serious issue in Strzelecki Regional Reserve. Wild tobacco (*Nicotiana glauca*) is the most noticeable weed, and is concentrated mainly along the margins of Strzelecki Creek. Though not recorded in Strzelecki RR, Mexican poppy (*Argemone subfusiformis*) is moving north from the Flinders Ranges along the Strzelecki Track. Off-track driving is a concern in terms of weed introduction as seeds can be easily imported and infestations not noted until they are too serous to treat effectively (pers. comm. Crafter 2001). All petroleum industry vehicles operating in PPLs are steam cleaned prior to entering the area. No formal weed control is undertaken in the reserve.

Rabbits were a serious problem in Strzelecki RR prior to the release of Rabbit Calicivirus Disease (RCD) in 1995. RCD reduced rabbit numbers dramatically and continues to have an effect that is evident in the significant recovery of vegetation. The prolonged rains in early 2001 have brought about a flush in ephemeral vegetation and increased perennial vigour, which has in turn caused a noticeable increase in rabbit numbers. These seasonal fluctuations need to be monitored and control programs instituted if necessary (pers. comm. Crafter 2001).

Rabbit numbers stayed low in the Strzelecki Creek area at least until 1999 (pers. comm. Falkenberg 2001). Preliminary findings of a study of raptor dependence on rabbits as prey suggest that population sizes and breeding success of Wedge-tailed eagles and Black-breasted buzzards have been significantly affected by the massive decline in rabbit populations. This is particularly important for these species due to limited alternative prey (Falkenberg *et al.* 2000).

3.4 Pastoralism

LAKE FROME REGIONAL RESERVE

Lake Frome Regional Reserve has no pastoral value and hence impacts from pastoral activities are nil.

STRZELECKI REGIONAL RESERVE

Impacts of pastoralism on wildlife include compaction, pugging and bank erosion at waterholes and selective grazing of vegetation.

Surface water in both Strzelecki Creek and the surrounding dunes country of the Strzelecki Land System is very rare and often only available for short periods. The numerous borrow pits associated with track construction and maintenance creates temporary waters which may be used by stock.

Stocking rates over the period since proclamation have been extremely low and cattle have only been run occasionally in the Tinga Tingana block when feed and surface water is available and feed has become depleted on other parts of the Lindon Station. No artificial water points have been built and stock must rely on the natural waterholes along Strzelecki Creek, borrow pits and temporary pools in swales. This lack of suitable quality water has historically been a major factor in keeping stocking rates low.

Impacts associated with stock grazing have been correspondingly very low.

Ongoing pastoral use of the Tinga Tingana Pastoral Lease area will be subject to the provisions of a reserve plan of management and any improvements subject to the provisions of a lease under section 35 of the *National Parks and Wildlife Act 1972*.

3.5 Strzelecki Track / Transport Corridor

Upgrading and ongoing maintenance of Strzelecki Track has some minor impacts associated with it. There are nine borrow pit sites in Strzelecki Regional Reserve where clay has been taken to resurface the Strzelecki Track. Transport SA undertakes vegetation surveys to monitor the regeneration of these areas. "A number of existing pit sites need rehabilitation to reduce the amount of erosion and gullying which is occurring on the steep sides. Reprofiling the walls will help to reduce this erosion and also reduce the visual impact of the pit on the surrounding landscape. Some of these pits stand out in the landscape whilst others, which have been rehabilitated, have less visual impact. Access to and from pit sites should be controlled to minimise impact on surrounding vegetation" (pers. comm. Crafter 2001).

Temporary Transport SA work camps also create localised impacts from vehicular traffic, compaction, disturbance to wildlife and clearance of vegetation.

4 IMPACTS OF RESOURCE UTILISATION ON CULTURAL FEATURES

4.1 Aboriginal Culture

Aboriginal sites are easily damaged or destroyed by natural processes as well as by development and land use.

LAKE FROME REGIONAL RESERVE

Whilst Lake Frome Regional Reserve has no listed sites of Aboriginal heritage significance, the lake surface is very significant to their culture and any activities undertaken on Lake Frome are of spiritual concern to them regardless of any physical impacts.

STRZELECKI REGIONAL RESERVE

Those sites listed in the Central Archives (State Aboriginal Affairs 2001) have not been officially revisited since their initial recording and their current condition is unknown. Currently DOSAA is conducting a program to visit all recorded sites, and these will be assessed in due course. Recommendations for conservation will be made if required. Recorded sites are assessed as to their conservation status and therefore can be better protected than unrecorded sites. None of these sites have been disturbed with the permission of the Minister for Aboriginal Affairs.

Petroleum Exploration and Production

Santos adheres to the requirements of the *Aboriginal Heritage Act 1988* with respect to the preservation of sites of Aboriginal significance. To minimise destruction of Aboriginal cultural heritage, Santos has produced a guide for contractors and staff that provides an outline of the different types of archaeological sites, their importance and procedures to follow for reporting, avoiding, preserving and recording sites (Santos 1998). Whilst this will not ensure preservation of this aspect of Aboriginal culture in the region, it goes some way towards minimising damage through ignorance and negligence. Impacts are unquantified and potentially could be significant due to illicit collecting and souveniring.

Pastoralism

Impacts of pastoral activities have not been quantified. Sites around waterholes are potentially at risk from trampling by stock.

Tourism

Damage to sites from tourists can be intentional or not. These impacts include digging up and collection of artefacts, driving over sites and camping on them. The level of destruction of items of Aboriginal cultural significance through souvenir hunting, vandalism or ignorance is unknown. Archaeological and anthropological surveys planned or currently being undertaken will assist the protection of these sites.

More anthropological and archaeological survey work is required in the area to determine the broader implications of mixed land use on the reserves and representatives of the Flinders Ranges Aboriginal Heritage Committee and Native Title claimant groups must be adequately consulted. Any proposed activities that may impact on possible sites of significance should incorporate an appropriate anthropological and archaeological survey to identify any possible heritage issues and consultation with the appropriate Aboriginal people.

Mythological sites and lines can only be identified by Aboriginal people who have the cultural knowledge of the country.

Current management of Aboriginal cultural features is based on non-intervention and discouragement of visitation of significant sites. Sites are not identified or marked in any way, and there have been no recorded impacts of tourism and recreation activities on the Aboriginal cultural features within the Regional Reserves since proclamation.

4.2 Non-Aboriginal Culture

LAKE FROME REGIONAL RESERVE

Lake Frome Regional Reserve has no sites of non-Aboriginal heritage significance.

STRZELECKI REGIONAL RESERVE

Much of the non-Aboriginal heritage in the Strzelecki RR is centred on the transportation of stock along the original Strzelecki stock route that roughly followed Strzelecki Creek. Access to these areas is difficult and original tracks overgrown and indistinct, which means visitation has been limited. The natural processes of erosion by the elements are inevitably slowly degrading these features and the impacts of any visitation are difficult to quantify. An inventory of non-Aboriginal heritage sites will be completed by June 2002. This will provide an assessment of their heritage value and conservation requirements and a baseline from which future assessments of impacts can be made.

5 IMPACTS OR POTENTIAL IMPACTS OF RESOURCE UTILISATION ON THE STATE ECONOMY

The "uses" of the Strzelecki and Lake Frome Regional Reserves can be classified into six broad categories:

- petroleum exploration and production;
- conservation;
- pastoral;
- transport corridor;
- tourism; and
- management/research.

The economic impact on the State economy of each of these categories of resource utilisation for the review period (1991 to 2001), and an indication of potential impacts, are briefly described in this section. Impacts have been measured using four indicators, namely:

- value added (gross state product)²;
- business turnover;
- employment; and
- household income³.

The total economic impact is comprised of both direct⁴ and flow-on⁵ effects.

The brief for this study specified that the economic impact of activities utilising the Lake Frome and Strzelecki Regional Reserves be measured using an input-output analysis framework. This implies that expenditures associated with each of the uses of the reserves need to be estimated. These estimates can then be incorporated into the input-output model to estimate Statewide economic impacts. It is important to note that a drawback of this approach arises when there are uses of the reserves (eg. conservation) for which there are no financial transactions and therefore no quantifiable economic impacts.

5.1 Petroleum Exploration and production

During the period of this review (1991 to 2001) there were no active exploration or production licences in the Lake Frome Regional Reserve⁶. However, over this period, 35 petroleum production licences have been active in the Strzelecki Regional Reserve, combined with significant exploration activity.

The economic impact of this petroleum extraction and exploration activity in the Strzelecki Regional Reserve on the State economy, over the review period, was comprised of several components. The direct effects included:

- the gross value of petroleum products extracted by Santos from wells within the reserve⁷;
- expenditure by Santos on petroleum exploration within the reserve; and
- expenditure by EPIC Energy on Compressor Station 1 (located within the reserve).

Each of these direct effects is briefly described below. Estimates of the total economic impact of each, including flow-on effects, are also detailed.

⁶ As outlined on Page 19, EL1850, granted to BHP Minerals Pty Ltd in 1993, was surrendered within 6 months.

² *Value added* is calculated as the value of output less the cost of goods and services (including imports) used in producing the output. It represents payments to the primary inputs of production (labour, capital and land). Value added is consistent with standard measures of economic activity, such as gross domestic, State or regional product, and it provides an assessment of the net contribution to regional economic growth of a particular enterprise or activity.

³ *Household income* is wages and salaries and other payments to labour including overtime payments and income tax, but excluding payroll tax.

⁴ *Direct Effects* are the initial round of output, employment and income generated by an economic activity.

⁵ *Flow-on Effects* are the sum of the indirect effects and the induced effects. *Indirect Effects* are additional output, employment and income resulting from re-spending by firms that receive income from the sale of goods and services to firms undertaking, for example, mining activities. *Induced Effects* are additional output, employment and income resulting from re-spending by households that receive income from employment in direct activities.

⁷ Includes the impact of expenditure by PIRSA Petroleum Group on regulatory, monitoring and licensing activities.

Economic Impact of Oil and Gas Extracted from Strzelecki Regional Reserve

Over the ten-year review period, significant petroleum mining or extraction activity was undertaken by Santos within the Strzelecki Regional Reserve. The estimated volume and value of petroleum products extracted from wells within the reserve are summarised in Table 9. With appropriate adjustments, these data were incorporated into the State input-output table to derive estimates of the economic impact on the State economy. The estimated impacts are provided in Table 10.

	Natural C	Gas	Crude (Dil	LPG		Conden	sate	Ethan	е
	Gm ³	\$m	kL	\$m	t	\$m	kL	\$m	t	\$m
1991/92	0.309	25.5	79,080	13.8	58,315	12.2	72,338	13.7	45,214	4.9
1992/93	0.274	23.3	45,635	8.1	50,055	12.2	61,312	11.6	37,782	4.3
1993/94	0.280	24.0	34,051	5.9	42,432	10.0	52,709	9.2	33,581	3.8
1994/95	0.287	23.8	25,279	3.7	41,719	9.2	50,442	7.6	33,403	3.9
1995/96	0.373	33.0	15,027	2.4	47,285	13.0	58,598	9.3	40,838	4.8
1996/97	0.360	34.5	13,637	2.5	36,215	11.0	71,491	13.5	32,916	2.9
1997/98	0.265	25.8	10,952	1.8	26,783	7.3	41,883	7.4	24,647	3.1
1998/99	0.219	21.8	7,289	1.1	26,115	6.1	32,488	5.1	22,984	2.9
1999/00	0.217	20.6	4,286	1.2	26,996	11.7	33,099	8.5	23,922	3.1
2000/01	0.210	19.9	3,138	0.8	26,753	11.6	32,639	8.4	23,474	3.0

Table 9 Petroleum Products Extracted from Wells within the Strzelecki Regional Reserve, 1991 to 2001^{a, b}

^a Estimates of petroleum production for the period after July 2001 were unavailable at the time of publication of this report.

^b Values are in millions of dollars (nominal).

Source: PIRSA Petroleum Group

It was estimated that extraction by Santos of petroleum products from within the Strzelecki Regional Reserve generated approximately 281 full-time equivalent jobs per annum (direct and flow-on) over the ten-year period. These jobs, in turn, provided an estimated \$145 million in household income (1999/00 dollars) over the ten-year period. Petroleum extraction by Santos also contributed an estimated \$551 million in value added⁸ to the State economy over the ten-year period.

Table 10 Economic Impact of Petroleum Production in Strzelecki RR on the SA Economy, 1991 - 2001 (99/00 \$)

Sector	Employment per annum (fte) ^a	Household Income (\$m)	Value Added (\$m)
Direct Impact	67	63.1	368.3
Indirect Impact	214	81.9	183.0
Total Impact	281	145.0	551.3

^a Full-time equivalents.

Note: Totals may not tally due to rounding

Economic Impact of Petroleum Exploration in Strzelecki Regional Reserve

Over the ten-year review period significant petroleum exploration activity, both 2D and 3D seismic surveys, has been undertaken by Santos within the Strzelecki Regional Reserve. The extent of and direct (nominal) expenditure on these surveys is summarised in Table 11. With appropriate adjustments, these data were incorporated into the State input-output table to derive estimates of the economic impact on the State economy. The estimated impacts are provided in Table 12.

⁸ Value added is consistent with standard measures of economic activity, such as gross domestic product and gross state product. It provides an assessment of the net contribution to regional economic growth of a particular enterprise or activity.

	2D Sei	smic	3D Se	ismic
	Total length	Total cost	Total area	Total cost
	(km)	(\$'000 nominal)	(square km)	(\$'000 nominal)
1991/92	414	683	10	87
1992/93	214	373	-	-
1993/94	707	1,372	-	-
1994/95	482	1,029	-	-
1995/96	562	1,028	-	-
1996/97	-	-	-	-
1997/98	74	186	177	1,320
1998/99	-	-	-	-
1999/00	-	-	-	-
2000/01	-	-	471	3,351

Table 11	Estimated Er	mlonotion Do	lated Erman	n dituma in	Starala alri 1	Danianal	December he	· Contos	1001	to 2001
rable rr	ESHIDAIEO EX	DIOPATION RE	лагео схрег	namure m	SITZEIECKI	Regional	Reserve Dy	/ Samos.	1991	10 ZUUT
14010 11	Dottimated Di	proration ree	nated Emper		Stribereettin 1	Biomai	110001100	, Surros,		

Source: PIRSA Petroleum Group and Santos

It was estimated that expenditure by Santos on petroleum exploration within the Strzelecki Regional Reserve generated approximately 16 full-time equivalent jobs per annum (direct and flow-on) over the ten-year period. These jobs, in turn, provided an estimated \$9.0 million in household income (1999/00 dollars) over the ten-year period. Exploration expenditure by Santos also contributed an estimated \$13.5 million in value added⁹ to the State economy over the ten-year period.

Table 12 Economic Impact of Petroleum Exploration in Strzelecki RR on the SA Economy, 1991 to 2001 (99/00 \$)

Sector	Employment per annum (fte) ^a	Household Income (\$m)	Value Added (\$m)
Direct Impact	9	6.8	8.2
Indirect Impact	7	2.2	5.3
Total Impact	16	9.0	13.5

^a Full-time equivalents.

Note: Totals may not tally due to rounding

Economic Impact of EPIC Energy expenditure in Strzelecki Regional Reserve

Expenditure by EPIC Energy on Compressor Station 1 (Crown Lease 1644/80 encompassed by Strzelecki Regional Reserve) involved an upgrade of the compressor to increase its capacity and efficiency and the laying of a third pipeline, creating a loop, to cope with the increased capacity. The work was undertaken in the year 2000, with total expenditure of approximately \$5 million (pers. comm. Fotheringham 2001). With appropriate adjustments, these data were incorporated into the State input-output table to derive estimates of the economic impact on the State economy. The estimated impacts are provided in Table 13.

It was estimated that expenditure by EPIC Energy on infrastructure within the Strzelecki Regional Reserve generated approximately 20 full-time equivalent jobs (direct and flow-on) over the ten-year period. These jobs, in turn, provided an estimated \$0.9 million in household income (1999/00 dollars) over the ten-year period. Expenditure by EPIC Energy also contributed an estimated \$1.8 million in value added¹⁰ to the State economy over the ten-year period.

⁹ Refer to previous footnote.

¹⁰ Refer to previous footnote.

Sector	Employment (fte) ^a	Household Income (\$m)	Value Added (\$m)
Direct Impact	6	0.5	0.8
Indirect Impact	14	0.5	1.0
Total Impact	20	0.9	1.8

Table 13 Economic Impact of EPIC Energy Expenditure in Strzelecki RR on the SA Economy, 1991 - 2001 (99/00 \$)

^a Full-time equivalents.

Note: Totals may not tally due to rounding. All of these impacts occurred in the one year (2000), unlike the impact of other activities, for example petroleum production, which is ongoing (recurrent).

Future mineral and petroleum resource prospects

The prospectivity of the Strzelecki Regional Reserve for petroleum and gas reserves remains high, despite the Cooper Basin, as a whole, being a mature petroleum province¹¹.

In 1995 the South Australian Government confirmed that no rights of renewal would be applied to Petroleum Exploration Licences (PELs) 5 and 6 on expiry¹², which occurred on 27 February 1999. The former exploration licence area has been divided into smaller blocks (Figure 8, p.28), which have been progressively released for licence applications. As an indicator of the level of interest in the petroleum and gas reserves within Lake Frome¹³ and Strzelecki Regional Reserves, the Cooper Basin petroleum acreage release results, South Australia, 1998 - 2000 (PIRSA 2001)¹⁴, are instructive. These results, for blocks either wholly or partly within the Strzelecki Regional Reserve, are summarised in Table 14.

For blocks located predominantly within the Strzelecki Regional Reserve (i.e. 98-H, 98-I, 98-K and 2000-F), a total of \$25.8 million in exploration expenditure has been guaranteed within the next five years and a further \$4.9 million of exploration expenditure is possible. For blocks located predominantly outside the Strzelecki Regional Reserve, but in which exploration activity within the Reserve is possible (ie. 98-J and 2000-E), a total of \$4.5 million in exploration expenditure has been guaranteed within the next five years and a further \$2.7 million of exploration expenditure is possible.

It is important to note that native title issues associated with these new exploration leases are currently constraining any exploration activity and could pose a continuing constraint to such activity in the short to medium term. However, if this expenditure does take place, it will have significant direct and flow-on effects on the State economy.

The world trade weighted price of oil is forecast to be down significantly in 2001 and to ease further over the next five years. Australian exports of primary petroleum (including gas) are expected to peak in 2000/01. However, with oil prices projected to be easing to 2005/06, the real value of crude oil exports in that year is projected to be down 35 per cent from their peak and liquefied petroleum gas down 57% (ABARE 2001a).

Furthermore, while Australia's natural gas exports are projected to be boosted in 2004/05 by substantial new production capacity coming online, lower world energy prices and increased competition among natural gas producers will moderate prices and expected growth in export earnings (ABARE 2001a).

These forecast price effects may reduce future earnings from current and proposed mining activities and could dampen exploration activity over the medium term.

¹¹ The potential prospectivity remains high for discoveries in stratigraphic and sub-unconformity traps. For more detail refer to <u>Cooper Basin</u> (PIRSA Petroleum Group website).

¹² SANTOS became exploration and production operator for PELs 5 and 6 in 1987.

¹³ The nature of exploration activity to be undertaken in block CO3/2000 was commercially confidential at the time of publication of this report.

¹⁴ Refer also to: <u>SA Cooper Basin Acreage Release Results 1998-2000</u> – Earth Resources Information Sheet P7.

Block	Company	Expenditure	e (5 years)	Year	Work Program (Guaranteed program in
		Guarantee	Estimated	-	italics)
		d	Total		
СО98-Н	Stuart Metals	4,000	4,000	1	250 km seismic (plus reprocessing)
		,		2	Two wells
				3	400 km seismic
				4	Three wells, 220km seismic
				5	Seven wells
CO98-I	Beach Petroleum,	3,300	4,200	1	One well, 260 km seismic, 200 km
	Magellan Petroleum	,	,		reprocessing, geological and geophysical
	C				studies
				2	One well, 90 km seismic, geological and
					geophysical studies
				3	One well, geological and geophysical
					studies
				4	50 km seismic, geological and
					geophysical studies
				5	One well, geological and geophysical
					studies
CO98-J	Beach Petroleum.	4.100	6.100	1	One well. 260 km seismic. 200 km
	Magellan Petroleum	,	-,		reprocessing, geological and geophysical
					studies
				2	One well, 90 km seismic, geological and
					geophysical studies
				3	One well, geological and geophysical
				-	studies
				4	50 km seismic, geological and
					geophysical studies
				5	One well, geological and geophysical
					studies
CO98-K	Strike Oil, Australian	1.200	5.200	1	500 km seismic reprocessing, geological
	Gasfields	-,_ • •	-,	-	and geophysical studies
	Cabilletas			2	Two wells
				-3	One well, geological and geophysical
				U	studies
				4	200 km seismic
				5	Three wells
CO2000-E	Australian Canadian Oil	400	1 090	1	Geological and geophysical studies
202000 E	Royalties. Mr Ely Sakhai		1,020	-	2220 Stoat and Scophysical states
	Junites, ini Erj Sumitur			2	Seismic survey
				-3	Geological and geophysical studies
				4	Seismic survey
				5	One well
CO2000-F	Stuart Petroleum	17 250	17 250	1	Two wells 300 km seismic geological
02000-1	Stuart I en oleum	17,230	17,250	1	and geophysical studies
					Eour wells 200 km seismic geological
					and geophysical studies
					Four wells 300 km seismic apological
					and acophysical studies
					Three wells 100 km asignia analogi -1
					intee wells, 100 km selsmic, geological
					ana geophysical studies
					studios
					stuales

Table 14 Cooper Basin Petroleum Acreage Release Results with Relevance to the Strzelecki Regional Reserve, 1998 – 20	2000
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Source: PIRSA 2001.

5.2 Conservation

Economic impact of conservation

The economic value of the Lake Frome and Strzelecki Regional Reserves, derived from their environmental amenities, comprises explicit use benefits as well as implicit non-use benefits. Use benefits are those that accrue from the physical use of the reserves, such as touring, camping and adventure treks. The implicit non-use values

are more aligned with conservation and environmental preservation.

The conservation use of the reserves is, to some extent, associated with the demand for tourism in the area. Expenditure on research and on the management of the reserve, necessary to ensure that the conservation values are protected, adds to this economic impact.

The economic value of the Lake Frome and Strzelecki Regional Reserves derived from their environmental amenities, however, is greater than that implied by demand for tourism in the area and expenditures on management and research. In a market economy, issues of valuation and choice between conflicting uses are normally resolved by the interaction of consumers and producers trading goods in the market place. This means that the value of oil and gas, for example, can be based on the market price of the good that is produced and the wealth that it generates in the economy. However, determining comparable values of non-market uses, such as conservation (including the value of the harmful consequences on these uses from resource utilisation activity) is more difficult and was beyond the scope and resources of this review. As stated previously, the physical (biological and ecological) data on which to base this assessment are limited.

These types of environmental "goods", which obviously have a value to society, are not traded in the market place and so do not have an obvious price. They have economic meaning because any thing or action from which individuals gain satisfaction is deemed to be of value. However, because there is no price attached to the "goods", there are no financial transactions incurred in the "consumption" of those goods, and hence there is no economic impact that can be measured.

Future prospects for conservation

Increased awareness of the unique biodiversity¹⁵ of the Strzelecki Desert and Lake Frome salt-pan environments and the values attached to this biodiversity¹⁶ could lead to increasing demand for the conservation amenities of areas such as the Lake Frome and Strzelecki Regional Reserves. Whilst the demand for conservation amenities will be reflected partly in the tourism activity in the Reserve, the conservation value will also manifest as non-use benefits. These are the benefits individuals may obtain from environmental resources without directly using or visiting them. They are normally classified into five types (Commonwealth of Australia, 1995):

- 1. Existence values the welfare obtained from the knowledge than an environmental resource exists. The concept may also include the benefits obtained from knowing culturally important resources and native flora and fauna are protected.
- 2. Vicarious values the welfare obtained from the indirect consumption of an environmental resource through books and other media.
- 3. Option value the welfare obtained by retaining the option to use an environmental resource at some future date. Option value stems from the combination of the individual's uncertainty about future demand for the resource and uncertainty about its future availability.
- 4. Quasi-option value the welfare obtained from the opportunity to get better information by delaying a decision that may result in irreversible environmental loss. This kind of value may be obtained when future technologies or knowledge enhance the value of the natural resource.
- 5. Bequest value the welfare that the current generation obtains from preserving the environment for future generations.

Each of these values is relevant to the Lake Frome and Strzelecki Regional Reserves and applies, not only to the demand for conservation, but some (e.g. options values) could apply to other development initiatives such as petroleum and gas exploration and mining.

5.3 Pastoral Activities

Economic impact of pastoral activity

There was no pastoral activity in the Lake Frome Regional Reserve during the review period.

Tinga Tingana Pastoral lease, run as part of Lindon Station, is within the mapped boundary of Strzelecki Regional Reserve. The lease consists of two paddocks, Montecollina and Tinga Tingana. There is no pastoral

¹⁵ The *Convention on Biological Diversity* (UN 2000), defined biodiversity as 'the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species (genetic), between species and of ecosystems' (Turner 2001).

¹⁶ Values of biodiversity are commonly placed into three categories; ecosystem services (e.g. soil formation), biological resources (e.g. medicinal resources), and social benefits (e.g. recreation). A fourth category has also been suggested; psycho-spiritual value (e.g. aesthetics) (Turner 2001).

infrastructure, apart from fencing, and cattle rely on the natural waterholes of the Strzelecki Creek. Tinga Tingana lease is stocked infrequently, and only when the Strzelecki Creek flows sufficiently to fill Yaningurie and Tinga Tingana waterholes.

Over the ten-year period since the Strzelecki Regional Reserve was proclaimed, the Tinga Tingana lease has only been infrequently stocked. While there was some economic impact associated with this activity and with expenditure on fencing and rent on the lease, it is clear that these expenditures were relatively small and have had negligible impact on the State economy.

Future prospects for pastoral activity

Beef cattle returns in Australia will be influenced by buoyant demand and lower global supplies in the short term as the United States commences a period of herd rebuilding. Over the medium term, however, beef cattle prices are projected to decline as US beef production and trade rises (ABARE 2001b). Despite recent improvements in market conditions for beef cattle, the easing of beef cattle prices in the medium term and the lack of cattle watering infrastructure¹⁷ within the Strzelecki Regional Reserve are likely to limit the extent to which pastoral activity could be increased in the short to medium term.

5.4 Transport Corridor

Whilst there are no transport corridors through the Lake Frome Regional Reserve, the Strzelecki Track runs through the centre of the Strzelecki Regional Reserve for a distance of approximately 100 km.

Based on information obtained from Transport SA (pers. comm. Shelton 2001), the agency responsible for maintenance of the track, it is clear that expenditure on road maintenance activities in the reserve over the review period was relatively significant. Table 15 provides the estimated profile of final expenditure by Transport SA within the Strzelecki Regional Reserve over this ten-year period. With appropriate adjustments, these data were incorporated into the State input-output table to derive estimates of the economic impact on the State economy. The estimated impacts are provided in Table 16.

	Expenditure, 1991 - 2001
	(\$'000 nominal)
Routine maintenance patrols	270
Re-sheeting projects	5,600
Supporting infrastructure (bores, dams, signage, grids, culverts)	190
Montecollina rest area	37
Total	6,097

Table 15 Estimated Expenditure in Strzelecki Regional Reserve by Transport SA, 1991 to 2001

Source: Transport SA, Port Augusta

It was estimated that expenditure by Transport SA on maintenance of the Strzelecki Track within the reserve generated approximately 13 full-time equivalent jobs per annum (direct and flow-on) over the ten-year period. These jobs, in turn provided an estimated \$3.9 million in household income (1999/00 dollars) over the ten-year period. Expenditure by Transport SA has also contributed an estimated \$7.3 million in value added¹⁸ to the State economy over the ten-year period.

A Review of Lake Frome and Strzelecki Regional Reserves - 1991 - 2001

¹⁷ Significant rainfall in the Strzelecki Creek catchment could overcome this constraint.

¹⁸ Refer to p.38, footnote 2

Sector	Employment per annum (fte) ^a	Household Income (\$m)	Value Added (\$m)
Direct Impact	7	2.1	3.4
Indirect Impact	6	1.8	3.8
Total Impact	13	3.9	7.3

Table 16 Economic Impact of Expenditure by Transport SA in the Strzelecki RR on the SA Economy, 1991 - 2001 (99/00 \$)

^a Full-time equivalents.

Note: Totals may not tally due to rounding

5.5 Tourism

Tourism into the outback started to grow during the 1970s, with increased leisure time, higher disposable incomes, improved vehicle technology and availability (eg. easier access to four wheel drive vehicles), and greater exposure to the attractions of the desert.

Accessibility to the Lake Frome and Strzelecki Regional Reserves has increased further over the past two or three decades with continued improvements in the four factors mentioned above; leisure time, disposable income, four wheel drive vehicle technology and comfort, and knowledge about and interest in the parks of the region, including Innamincka Regional Reserve and the Flinders and Gammon Ranges National Parks.

However, for the purposes of this analysis, it was not possible to separately quantify the economic impact on the State economy of tourist visits to the reserves from their visits to the region in general. Furthermore, it was difficult to determine the number of visitors whose decision to visit the reserves was influenced by the existence of the reserve or whether it was merely a convenient stopover, en-route to their destination.

In the case of the Strzelecki Regional Reserve, visits were predominantly day visits with some people camping overnight along the Strzelecki Track as part of visits to the broader region. For the Lake Frome Regional Reserve, visits were largely a sideline of visits to the Gammon Ranges National Park. For these reasons, the tourism value of the Lake Frome and Strzelecki Regional Reserves was considered to be intangible.

Future prospects for tourism

It has been suggested that "the tourism industry in South Australia is a major contributor to the economy – in terms of dollars spent by tourists, the exports that expenditure represents and the jobs that it creates. As such, it deserves a central place in the State's future economic development strategy" (Arthur D Little International 1992).

The tourism industry in South Australia, however, is dependent on the growth and development of the State's economy, of the national economy, and the economic activity of overseas countries. Recent strong growth in the national and State economies could decline over the medium-term (Reserve Bank 2001, Bank SA 2001). Promotional activities such as the designation of the year 2002 as the 'Year of the Outback' could, however, stimulate the demand for tourist activity in these reserves.

Expansion of tourist activity in the reserves is partly dependent on increased resources for the management of the reserves and for the development of infrastructure in the region. Without such resources, tourism activity is unlikely to increase at more than its current low rate of growth. There are no indications that resources for management of the Lake Frome and Strzelecki Regional Reserves are likely to increase substantially above present low levels.

5.6 Management and Research

To enable appropriate utilisation of the Lake Frome and Strzelecki Regional Reserves consistent with the *National Parks and Wildlife Act 1972* for both commercial and conservation purposes, on-going management of the reserves is required. Responsibility for management of the reserves rests with NPWSA.

As noted in the introduction to this report, the regional reserve mechanism provides for:

- a conservation focus;
- conservation management planning and implementation;
- security of tenure for lands reserved under the Act; and
- regulation for the management of human activity.

Major objectives for regional reserve management are to establish strategies that successfully integrate the different uses for which the reserve has been proclaimed. In practical terms, management of the reserves involves maintenance of public services, infrastructure and facilities (including roads, signs, emergency search, rescue and medical services and other policing capabilities).

An important dimension associated with the management of Lake Frome and Strzelecki Regional Reserves is the conduct of research into the flora, fauna and land systems, as well as their Aboriginal and non-Aboriginal history.

Based on information obtained from DEH, it is clear that expenditure on management and research activity in the both the Strzelecki and Lake Frome Regional Reserves between 1991 and 2001 was relatively small and has had a negligible impact on the economy of the State over this review period.

5.7 Conclusion

LAKE FROME REGIONAL RESERVE

There were no quantifiable economic impacts on the State economy generated by activities utilising the resources of the Lake Frome Regional Reserve over the review period.

STRZELECKI REGIONAL RESERVE

In Strzelecki Regional Reserve, both petroleum products extraction/exploration activities and maintenance of the Strzelecki Track by Transport SA generated significant quantifiable economic impacts on the State economy over the review period. The aggregate economic impacts of these activities over the ten-year period are summarised in Table 17. Impacts are specified for each of the three economic indicators, these being value added (gross state product), employment and household income.

Table 17 Total Economic Impact on the SA Economy of Activities Utilising the Resources of the Strzelecki Regional Reserve, 1991-2001 (99/00 \$)

	Employment per annum (fte) ^{a,b}	Household Income (\$m)	Value Added (\$m)
Direct Impact	84	72.5	380.7
Flow-on Impact	228	86.4	193.1
Total Impact	312	158.9	573.8

^a Full-time equivalents.

^b The employment impacts of EPIC Energy's infrastructure expenditure occurred in the one year, 2000. However, to enable comparison with other activities (e.g. Transport SA), the average employment impact per annum, over the review period, has been included in this estimate.

Note: Totals may not tally due to rounding.

Gross State Product (GSP) in South Australia in 1999/00 was estimated to be \$42.3 billion (ABS 2000). Based on the data in Table 17, the (quantifiable) economic activity within the Strzelecki Regional Reserve has contributed approximately 0.14 per cent of GSP on an annual basis.

It has been beyond the scope and resources of this study to determine the full economic value of the conservation attributes of the Lake Frome and Strzelecki Regional Reserves. While the measurement of mining-use values is relatively straightforward, the estimation of conservation values is more problematic. Nevertheless, it is important to keep in mind the possible need to include such assessments in future reviews of Regional Reserves. This is particularly so should tourism or mining activities increase to such an extent that the conservation values of the reserve are compromised.

If the effects of human activity on the natural environment are ignored and the values that people place on conservation and such uses are overlooked, then there is a danger that decisions regarding the allocation and use of the resource will not be in the best interests of society.

6 SUBMISSIONS TO THE REVIEW

6.1 Submissions Received

Submissions for the review of the reserves were received from the following groups or individuals:

Primary Industries and Resources SA - Mineral Resources (George Kwitko)

Information regarding past and present mineral exploration activities. ref. 313/99

Primary Industries and Resources SA - Petroleum Group (David Cockshell)

Information regarding past and present petroleum exploration and production activities and details of relevant OMER environmental audits.

State Aboriginal Affairs (Heidi Crow)

Information regarding listed Aboriginal cultural features and their condition. ref. DOSAA 106/85-20

National Native Title Tribunal (Claude Garnelli)

Details of current Native Title Claims.

The views of Aboriginal people were sought via the relevant legal representatives for the Native Title Claimant groups. Nothing was received in writing.

Heritage SA (Hamish Angas)

Information regarding listed non-Aboriginal cultural features and their condition. ref. 13149

S Kidman & Co (Greg Campbell)

Clarification of Quinyambie boundary fencing issue and information on current stocking practices in adjacent areas.

Tourist Operators

Responses were received from two operators both of whom run occasional trips through the area and generally do not stay overnight within either reserve.

South Australian Association of Four Wheel Drive Clubs

Concern was expressed that access tracks created by the petroleum industry are not available for public access and more areas should be made accessible to the public.

South Australian National Parks and Wildlife Council

A number of issues were raised, mainly relating to ongoing management. These are appropriate for inclusion in the plans of management for the reserves.

In the context of wilderness value maintenance, the need for ongoing pastoral use of Strzelecki RR was questioned.

It was suggested that more resources be recommended to enable the description and documentation of the values of the reserves to enhance tourism marketability.

The lack of appropriate biological indicators to assist with ongoing management decisions was noted and a landscape scale survey method suggested to provide the necessary data.

It was suggested that the dedication of Lake Frome as a National Park may raise its profile as a tourist destination, placing further demands on NPWSA management, particularly with respect to control of public access.

Concern was expressed that the elevation of Lake Frome to National Park status will affect the availability of the area for future mineral or petroleum exploration.

7 DISCUSSION

Whether these areas are Regional Reserves or jointly proclaimed Conservation or National Parks, the workability of the multiple-use concept is totally dependent on a management regime that clearly defines the limits of sustainability and provides adequate protection for the natural and cultural features. A significant difference between these classifications is the level of control the Minister for Environment and Conservation has over the conduct of land uses other than nature conservation. In the case of Conservation Parks and National Parks, the Minister for Environment and Conservation must approve rather than be consulted with regard to proposals for mining or exploration activities.

Lake Frome has significant importance to Aboriginal people and unique geology including islands and mound springs. Mound Springs are listed as a 'threatened ecological community' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Biologically, little is known. Neither petroleum nor mineral exploratory work has uncovered anything of economic interest to date, the lakebed is of no pastoral value and has limited potential for tourism use. There appears little need for a multiple-use regime of management. Reclassifying this area as a National Park under a joint proclamation with provision for potential future resource exploration would be consistent with Lake Gairdner, Lake Torrens and Lake Eyre National Parks, and may be more appropriate. Any future review of the classification of NPWSA reserves needs to establish criteria for multiple land use under the Regional Reserve classification, and assess the suitability of this classification for this reserve.

Pressure from competing land uses (ie. other than conservation), such as tourism and recreation, petroleum exploration or production, and pastoralism, are significant in some parts of the Strzelecki Regional Reserve. The Regional Reserve status of this area is appropriate to provide a conservation framework for a multiple use area that has significant economic value for the State.

Landscape and Wildlife Features

Available evidence suggests that the current management regime and level of resource utilisation is not having a significant effect on the wildlife and natural and cultural features of the reserves areas. Due to a lack of data, or a lack of appropriate indicators, it could be assumed that there may be impacts of which we are unaware. This lack of information suggests that more biological research and data collection is necessary to assist in understanding the implications of current and ongoing land uses. A landscape approach to data collection and impact assessment would provide more meaningful and applicable outcomes than the site-based approach currently used for biological surveys. More management effort directed toward the control of feral camels and pigs, an ongoing vigilance with respect to the potential resurgence of rabbit populations, and the control and direction of visitors to minimise their negative effects will be beneficial to the natural and cultural features of the reserve. Currently, there are no known causes for concern.

Aboriginal Cultural Heritage

Current management is based on non-intervention and discouragement of visitation of significant sites. There are no recorded impacts, human or other, on the Aboriginal cultural features in either the Strzelecki or the Lake Frome Regional Reserves. Future management of significant sites will be negotiated with the appropriate Aboriginal people. Significant impacts, unintentionally from petroleum exploration activities and by illicit collectors and souvenir hunters are highly likely and largely unrecorded.

Non-Aboriginal Cultural Heritage

A heritage survey is currently being undertaken and will be finalised in mid 2002. No significant management effort has been expended on the maintenance of these heritage places since proclamation.

Petroleum Exploration

In the period since proclamation, extensive petroleum exploration has been undertaken in the northern part of the Strzelecki RR. Short-term impacts, particularly of 3D seismic surveys, are mainly visual and are quite severe. In the current production licence areas, localised impacts are visually obvious and NPWSA and PIRSA need to work closely with the existing and new exploration companies to ensure appropriate practices are adhered to. Disused seismic lines, tracks and wells have recovered or been rehabilitated to varying degrees and there is considerable interest in further seismic survey work in localised areas. The most lasting impacts on the environment are the clay-capped access tracks and borrow pits created for track and well construction and maintenance.

Tourism and Recreation

Over the ten years since proclamation tourism activity has steadily increased, placing more degrading pressures on certain highly trafficked areas. However, as a whole, much of the area covered by the Regional Reserves has not been adversely affected by the increasing visitation because it has been focussed around the Strzelecki Track. As a wilderness area, much of its value comes from the lack of human visitation, and the continuation of the current low levels of access to the majority of these areas will help maintain these values.

Tourism and recreational activities do not appear to be having significant impacts, positive or negative, on the natural or cultural features of either the Lake Frome or Strzelecki Regional Reserves.

Pastoralism

No improvements have been made on the Tinga Tingana block and stocking rates have been very low over the review period. The contribution to the State economy has been relatively small, and Impacts of pastoral activities on natural and cultural features have not been quantified. Heritage sites around waterholes are potentially at risk from trampling by stock. Impacts of pastoralism on wildlife include compaction, pugging and bank erosion at waterholes and selective grazing of vegetation.

Wilderness value relies in part on a lack of evidence of human presence, and the running of domestic livestock even at low rates is not consistent with the maintenance of these values. Careful and conservative stocking practices are required to ensure that these wilderness qualities are maintained.

Economic Contribution

There were no quantifiable economic impacts on the State economy generated by activities utilising the resources of the Lake Frome Regional Reserve over the review period.

In Strzelecki Regional Reserve, both petroleum product extraction/exploration activities and maintenance of the Strzelecki Track by Transport SA generated significant quantifiable economic impacts on the State economy over the review period. Refer to Table 17.

Gross State Product (GSP) in South Australia in 1999/00 was estimated to be \$42.3 billion (ABS 2000). Based on the data in Table 17, the (quantifiable) economic activity within the Strzelecki Regional Reserve has contributed approximately 0.14 per cent of GSP on an annual basis.

It has been beyond the scope and resources of this study to determine the full economic value of the conservation attributes of the Lake Frome and Strzelecki Regional Reserves. While the measurement of mining-use values is relatively straightforward, the estimation of conservation values is more problematic. Nevertheless, it is important to keep in mind the possible need to include such assessments in future reviews of Regional Reserves. This is particularly so should tourism or mining activities increase to such an extent that the conservation values of the reserve are compromised.

If the effects of human activity on the natural environment are ignored and the values that people place on conservation and such uses are overlooked, then there is a danger that decisions regarding the allocation and use of the resource will not be in the best interests of society.

	Regional Reserve	Landscape Features	Wildlife Features	Aboriginal Cultural Features	Non- Aboriginal Cultural Features	Contribution to State Economy 1991 – 2001 Value added (\$million)
Petroleum	L Frome	Low	Low	Low	Low	0
Production	Strzelecki	Mod	Low	Low	Low	566.5
Tourism	L Frome	Low	Low	Low	Nil	0
	Strzelecki	Mod	Low	Low	Low	relatively small
Pastoralism	L Frome	Nil	Nil	Nil	Nil	0
	Strzelecki	Low	Low	Low	Low	relatively small
Feral Animals	L Frome	Low	Low	Low	Low	0
& Pest Plants	Strzelecki	Low	Low to Mod	Low to Mod	Low	0
Strzelecki	L Frome	Nil	Nil	Nil	Nil	0
Corridor	Strzelecki	Low	Low	Low	Low	7.3

Table 18	Summary o	of Resource	Utilisation	Impacts in	Lake Frome	and Strzelec	ki Regional	Reserves
10010 10	Dummin y (n nessource	Ounsuion	impacts m	Luke I follie	und Dulleice	Ki Kegionai	100001 100
							0	

8 **RECOMMENDATIONS**

8.1 Status of Reserves under the Act

Based on the available information, the impacts, positive or negative, of regional reserve status on wildlife and natural and historical features of Lake Frome and Strzelecki Regional Reserves appear to have been insignificant in the period since proclamation. Benefits to environmental management over the review period have accrued from an improvement in petroleum exploration practices. This may have happened regardless of the presence of NPWSA reserves in the region. Nevertheless, the vigilance of NPWSA as a monitoring agency and the auditing procedures now being undertaken by PIRSA were part of a process that has encouraged petroleum exploration companies to move toward more sensitive practices.

Significant wealth has been generated for the State by the petroleum industry through the application of multipleuse management principles in Strzelecki Regional Reserve. Over the review period, the net contribution to the South Australian economy of the Lake Frome and Strzelecki Regional Reserves combined, being managed and administered as Regional Reserves since 1991, is estimated to be approximately \$573.8 million. Future projections are for the benefits to the State economy to increase from petroleum exploration and production from the Strzelecki Regional Reserve area.

Lake Frome has significant importance to Aboriginal people and unique geology including mound springs and islands. Neither petroleum nor mineral exploration has uncovered anything of economic interest to date. The lakebed is of no pastoral value and has limited potential for tourism use. A multiple-use regime for management appears unnecessary.

Recommendation

- The classification of Lake Frome as a Regional Reserve is reconsidered as part of any future review of *National Parks and Wildlife Act 1972* reserve classifications taking into account the findings of this report.
- Strzelecki Regional Reserve remains a Regional Reserve under the National Parks and Wildlife Act 1972.

8.2 Plan of Management

No plans of management exist for either Lake Frome or Strzelecki Regional Reserves. Management of Tinga Tingana pastoral lease area will be reflected in the provisions of a lease and the plan of management for Strzelecki Regional Reserve. With new companies entering into petroleum exploration in the area, it is imperative that PIRSA, DEH and exploration companies work together to ensure ongoing good land management. The plan will assist NPWSA future management of the reserve. The Plans of Management should include some systematic, well-designed biological monitoring programs that will aid the collection of relevant baseline and biological trend information.

Recommendation

• Plans of management of Lake Frome Regional Reserve and Strzelecki Regional Reserve be formulated, which include clear objectives and clearly defined environmental and economic indicators which enable adequate data collection for future assessments of management performance.

8.3 Petroleum Exploration

With increasing pressure on Strzelecki Regional Reserve for petroleum exploration and production comes a need for NPWSA to be increasingly vigilant and work closely with the petroleum industry and regulators to ensure that conservation objectives in the reserve area are met.

Recommendation

• PIRSA and NPWSA work together to ensure that at least the current level of regulation is applied to future petroleum exploration and production licence holders to maintain the current level of protection of natural and cultural features.

8.4 Pastoralism

Administrative processes have been clarified and the transfer of Tinga Tingana pastoral lease area to the Strzelecki Regional Reserve can now proceed.

Recommendation

• NPWSA facilitate the surrender of Tinga Tingana Pastoral Lease and issue a lease under section 35 of the *National Parks and Wildlife Act 1972* that adequately protects and maintains the natural and cultural features of Strzelecki Regional Reserve. Monitoring of impacts of pastoral use must be included in the plan of management.

9 REFERENCES

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10 APPENDICES

10.1 Appendix A - Interpretation of Section 34A of the National Parks and Wildlife Act, 1972

In undertaking this review, it has been necessary to ensure that the requirements of the Act are properly addressed. To facilitate this process, an interpretative analysis of section 34A was conducted and is provided below. This analysis has been used to guide the conduct of the review. It is also useful in guiding readers of the report.

For the purposes of section 34A (5)(a)(i) and (ii), natural resources are considered to be:

- native vegetation which is utilised by pastoral stock for feed
- petroleum and any mineralisation that require the process of recovery to be undertaken by operations that take place within the boundaries of the reserve
- native vegetation which is utilised by pastoral stock for feed
- landscapes and natural features including native vegetation, native animals, birds, insects and other small fauna that are of recreational and educational value to visitors to the reserve and which are accessible to visitors in accordance with the management plan for the park, and
- surface and sub surface water recovered from within the boundaries of the reserve.

For the purposes of section 34A (5)(a)(i) and (ii), utilisation of natural resources is taken to mean:

- recovery (petroleum), mining, grazing (pastoralism), environmental appreciation and recreation activity (tourism) and water recovery and use (general) and includes the infrastructure necessary to facilitate such utilisation
- recovery and utilisation of water prior to its inflow to the reserve and

where such utilisation is consistent with the specific objective in the Act in relation to the management of regional reserves, that is to say 'to permit the utilisation of natural resources while conserving wildlife and the natural or historic features of the land'. (Section 37j)

For the purposes of section 34A (5)(a)(i), i.e. in the context of conservation, *impact of utilisation* is taken to mean:

- the effects upon the condition of the wildlife and natural features of the reserve and the management strategies that are considered necessary and adequate to sustainably conserve the wildlife and natural features of the reserve, and
- the effect upon the approach taken to managing the wildlife and natural features of the reserve as a response to a regime that provides for land uses other than those characteristics of other classifications of reserve under the Act.

For the purposes of Section 34A (5)(a)(i), *conservation of natural and historical features of the reserve* is to have such a meaning as to be consistent with the relevant objectives for managing reserves as set out in Section 37 of the Act, the relevant objectives being:

- (a) the preservation and management of wildlife
- (b) the preservation of historic sites, objects and structures of historic or scientific interest within reserves
- (c) the preservation of features of geographical, natural or scenic interest

and where such preservation is undertaken in accordance with other objectives of the Act as set out in paragraphs (d) to (g) which address the deleterious impact of weeds and exotic plants, vermin and exotic animals, diseases of animals and vegetation and bush fires and other hazards.

For the purposes of Section 34A (5)(a)(ii), i.e. in the context of the economy of the State, *impact of utilisation* is taken to mean:

- the contribution of utilisation to the economy of the State in dollar terms, and
- any offsets to benefits that might be occasioned by one form of utilisation as a result of another.

For the purposes of section 34A (5)(a)(iii), *the future status under this Act of the land constituting the reserve* is taken to mean the classification of the reserve under Part 3, Divisions 1 - 4 and 4A of the Act, the classifications available being National Park (Division 1), Conservation Park (Division 2), Game Reserve (Division 3), Recreation Park (Division 4) and Regional Reserve (Division 4A).

Further, for the purposes of section 34A (5)(a)(iii), *recommendations as to the future status of the reserve* are taken to relate to recommendations made in consideration of:

- the original intent of the reserve classification in providing for the management of the reserve for the purposes of conserving wildlife and natural features and utilising natural resources, and
- any factors that as a result of the review, significantly appear to work against the purpose of the Regional Reserve classification in providing direction for, and facilitating the management of, the reserve.

While the Act, at section 34A, does not provide for the framing of recommendations regarding the ongoing management of the reserve, section 38 of the Act does provide for the preparation and periodic review of reserve management plans.

During the conduct of the review, issues emerged that will need to be addressed in the ongoing management of the reserve. Some of these issues relate to the scope and quality of baseline data upon which critical analysis of management should rely and which will be essential for the conduct of future section 34A reviews. Other issues relate directly to the standards and aspects of management that need to be addressed on an ongoing basis.

Recommendations for management, therefore, while not a requirement in the context of the section 34A report, are nonetheless included in this report for the purposes of foreshadowing those issues that will be need to be addressed in reviewing the plan of management for this reserve.

10.2 Appendix B - List of Vascular Plants

Site records for Strzelecki and Lake Frome Regional Reserves in the South Australian Biodiversity Database, May 2001. * designates introduced species. State Herbarium records are not included. National Conservation Status is from the Environment Protection and Biodiversity Conservation Act, 1999 (AUS) and South Australian status is from the National Parks and Wildlife Act, 1972 (SA).

FAMILY	Species	Common Name
LORANTHACEAE		
	Amyema preissii	wire-leaf mistletoe
POLYGONACEAE		
	Acetosa vesicaria*	rosy dock
	Muehlenbeckia coccoloboides SA:R	
	Muehlenbeckia florulenta	lignum
AIZOACEAE		
	Tetragonia eremaea	desert spinach
CHENOPODIACEAE		
	Atriplex angulata	fan saltbush
	Atriplex cordifolia	
	Atriplex eardleyae	Eardley's saltbush
	Atriplex eichleri SA:R	Eichler's saltbush
	Atriplex holocarpa	pop saltbush
	Atriplex incrassata	
	Atriplex nummularia ssp.	old-man saltbush
	Atriplex nummularia ssp. nummularia	old-man saltbush
	Atriplex spongiosa	pop saltbush
	Atriplex velutinella	sandhill saltbush
	Enchylaena tomentosa var.	ruby saltbush
	Maireana aphylla	cotton-bush
	Maireana appressa	pale-fruit bluebush
	Maireana astrotricha	low bluebush
	Osteocarpum acropterum var.	bonefruit
	Osteocarpum acropterum var. acropterum	tuberculate bonefruit
	Osteocarpum aipterocarpum	two-wing bonefruit
	Rhagoala parabolica	meary saltbush
	Rhagoala spinescens	spiny saitousn
	Salsola kali Selerolaena intrioata	tangled bindyi
	Sclerolaena muricata var	five spine bindvi
CRUCIFERAE	Scierolaena maricala var.	nve-spine bindyr
CRUCHERAE	Diana dia amagana	notive stock
	Blennodia pterosperma	wild stock
	Brassica tournefortii*	wild turnin
	Sisymbrium erysimoides*	smooth mustard
PITTOSPORACEAE	Sisymonum er ysimolues	shooti mustaru
III IOSI OKACEAE	Pittosporum phylliraeoides var microcarpa	native apricot
LEGUMINOSAE	1 mosporum phymraeones var. meroeurpa	had ve upriest
	Acacia ligulata	umbrella bush
	Acacia murravana	colony wattle
	Acacia oswaldii	umbrella wattle
	Acacia salicina	willow wattle
	Acacia tetragonophylla	dead finish
	Acacia victoriae ssp.	elegant wattle
	Crotalaria eremaea ssp.	loose-flowered rattle-pod
	Cullen australasicum	tall scurf-pea
	Cullen discolor	prostrate scurf-pea
	Cullen graveolens	native lucerne
	Cullen pallidum	white scurf-pea
	Cullen patens	spreading scurf-pea
LEGUMINOSAE	Lotus cruentus	red-flower lotus
	Swainsona phacoides	dwarf swainson-pea
	Trigonella suavissima	sweet fenugreek

.

FAMILY	Species	Common Name
GERANIACEAE		
	Erodium cygnorum ssp.	blue heron's-bill
ZYGOPHYLLACEAE		
	Nitraria billardierei	nitre-bush
	Zygophyllum ammophilum	sand twinleaf
	Zygophyllum howittii	clasping twinleaf
	Zygophyllum prismatothecum	square-fruit twinleaf
FUDIODDIACEAE	Zygophyllum simile	white twinlear
EUPHORBIACEAE	Funhorbia drummondii	caustic weed
	Euphorbia arannonan Funhorbia tannensis ssp. eremonhila	desert spurge
	Phyllanthus lacunarius	lagoon spurge
SAPINDACEAE		ingoon spurge
	Dodonaea viscosa ssp.	sticky hop-bush
MALVACEAE		stienty hop cush
	Sida ammophila	sand sida
	Sida intricata	twiggy sida
THYMELAEACEAE		202
	Pimelea simplex ssp.	desert riceflower
CUCURBITACEAE		
	Citrullus colocynthis*	colocynth
	Cucumis melo	Ulcardo melon
	Cucumis myriocarpus*	paddy melon
MYRTACEAE		
	Eucalyptus coolabah ssp. arida	coolibah
HALORAGACEAE		
	Haloragis aspera	rough raspwort
UMBELLIFERAE		
	Daucus glochidiatus	native carrot
GENTIANACEAE		
	Centaurium spicatum*	spike centaury
ASCLEPIADACEAE		
	Cynanchum floribundum	desert cynanchum
CONVOLVULACEAE		
	Convolvulus erubescens	Australian bindweed
DODACINACEAE	Convolvulus remotus	grassy bindweed
DURAGINACEAE	Trichodosma zavlanicum	camel bush
SOLANACEAE	Thenouesmu ze yrunicum	canci bush
SOLANACEAE	Nicotiana excelsior	native tobacco
	Nicotiana glauca*	tree tobacco
	Nicotiana velutina	velvet tobacco
	Solanum esuriale	quena
	Solanum oligacanthum	desert nightshade
SCROPHULARIACEAE		C
	Stemodia florulenta	bluerod
	Stemodia glabella	smooth bluerod
OROBANCHACEAE	~	
	Orobanche cernua var. australiana SA:V	Australian broomrape
PLANTAGINACEAE		-
	Plantago drummondii	dark plantain
CAMPANULACEAE		-
	Wahlenbergia tumidifructa	swollen-fruit bluebell
GOODENIACEAE		
	Goodenia fascicularis	silky goodenia
	Goodenia triodiophila	
	Scaevola collaris	
COMPOSITAE		
	Calocephalus platycephalus	western beauty-heads
	Minuria denticulata	woolly minuria
	Othonna gregorii	fleshy groundsel
	Polycalymma stuartii	poached-egg daisy
COMPOSITAE	Pterocaulon sphacelatum	apple-bush

FAMILY	Species	Common Name
	Pycnosorus pleiocephalus	soft billy-buttons
	Rhodanthe floribunda	white everlasting
	Rhodanthe moschata	musk daisy
	Senecio cunninghamii var.	shrubby groundsel
	Senecio cunninghamii var. serratus	inland shrubby groundsel
	Senecio georgianus var. georgianus AUS:X SA:E	George's groundsel
	Senecio glossanthus	annual groundsel
	Senecio magnificus	showy groundsel
	Sonchus oleraceus*	common sow-thistle
LILIACEAE		
	Bulbine alata	winged bulbine-lily
AMARYLLIDACEAE		0
	Crinum flaccidum	Murray lily
GRAMINEAE		2 2
	Astrebla lappacea	curly Mitchell-grass
	Enneapogon avenaceus	common bottle-washers
	Eragrostis setifolia	bristly love-grass
	Eragrostis xerophila	knotty-butt neverfail
	Panicum decompositum var. decompositum	native millet
	Paractaenum novae-hollandiae ssp. reversum	barbed-wire grass
	Schismus barbatus*	Arabian grass
	Sporobolus actinocladus	ray grass
	Triraphis mollis	purple plume grass
	Zygochloa paradoxa	sandhill cane-grass

10.3 Appendix C - List of Vertebrates

Site records for Strzelecki and Lake Frome Regional Reserves in the South Australian Biodiversity Database (May 2001). * designates an introduced species. National Conservation Status is from the Environment Protection and Biodiversity Conservation Act, 1999 (AUS) and South Australian status is from the National Parks and Wildlife Act, 1972 (SA).

Species	Common Name		
CLASS MAMMALIA Mammals			
ORDER : DASYUROMORPHIA			
FAMILY Subfamily : DASYURIDAE Sminthopsinae Dasyurids			
Sminthopsis macroura	Stripe-faced Dunnart		
Sminthopsis crassicaudata	Fat-tailed Dunnart		
ORDER : CARNIVORA			
FAMILY Subfamily : CANIDAE Dingo, H	Fox		
Canis lupus dingo	Dingo		
FAMILY Subfamily : FELIDAE Cat			
Felis catus*	Cat		
ORDER : RODENTIA			
FAMILY Subfamily : MURIDAE Hydromy	yinae Murids		
Notomys fuscus AUS:EN SA:V	Dusky Hopping-mouse		
FAMILY Subfamily : MURIDAE Murinae	Murids		
Mus musculus*	House Mouse		
ORDER : LAGOMORPHA			
FAMILY Subfamily : LEPORIDAE Rabbi	it, Hare		
Oryctolagus cuniculus*	Rabbit		
CLASS : AVES Birds			
ORDER : STRUTHIONIFORMES			
FAMILY Subfamily : CASUARIIDAE Ca	ssowaries and emus		
Dromaius novaehollandiae	Emu		
ORDER : GALLIFORMES			
FAMILY Subfamily : PHASIANIDAE Ph	easants, quails and allies		
Coturnix pectoralis	Stubble Quail		
ORDER : ANSERIFORMES			
FAMILY Subfamily : ANATIDAE Oxyuri	nae Geese, swans and ducks		
Biziura lobata SA:R	Musk Duck		
FAMILY Subfamily : ANATIDAE Anserin	nae Geese, swans and ducks		
Cygnus atratus	Black Swan		
FAMILY Subfamily : ANATIDAE Tadorn	inae Geese, swans and ducks		
Tadorna tadornoides	Australian Shelduck		
FAMILY Subfamily : ANATIDAE Anatina	ae Geese, swans and ducks		
Malacorhynchus membranaceus	Pink-eared Duck		
Chenonetta jubata	Australian Wood Duck, (Maned Duck)		
Aythya australis	Hardhead (White-eyed Duck)		
Anas superciliosa	Pacific Black Duck		
Anas rhynchotis SA:R	Australasian Shoveler		
Anas gracilis	Grey Teal		
Anas castanea	Chestnut Teal		
ORDER : PODICIPEDIFORMES			
FAMILY Subfamily : PODICIPEDIDAE	Grebes		
Tachybaptus novaehollandiae	Australasian Grebe, (Little Grebe)		
Poliocephalus poliocephalus	Hoary-headed Grebe		
ORDER : PELECANIFORMES	-		
FAMILY Subfamily : PHALACROCORA	CIDAE Cormorants		
Phalacrocorax melanoleucos	Little Pied Cormorant		
Phalacrocorax sulcirostris	Little Black Cormorant		
Phalacrocorax carbo	Great Cormorant		
FAMILY Subfamily : PELECANIDAE Pe	licans		

Species	Common Name
Pelecanus conspicillatus	Australian Pelican
ORDER : CICONIIFORMES	
FAMILY Subfamily : ARDEIDAE Heror	as and bitterns
Ardea pacifica	White-necked Heron
Egretta novaehollandiae	White-faced Heron
FAMILY Subfamily : THRESKIORNITH	IDAE Ibises and Spoonbills
Platalea flavipes	Yellow-billed Spoonbill
Plegadis falcinellus SA:R	Glossy Ibis
Platalea regia	Royal Spoonbill
ORDER : FALCONIIFORMES	
FAMILY Subfamily : ACCIPITRIDAE A	ccipitrinae Osprey, Hawks, Eagles and allies
Haliastur sphenurus	Whistling Kite
Elanus scriptus	Letter-winged Kite
Accipiter cirrhocephalus	Collared Sparrowhawk
Aquila audax	Wedge-tailed Eagle
Circus approximans	Swamp Harrier
Circus assimilis	Spotted Harrier
Elanus axillaris	Black-shouldered Kite
Milvus migrans	Black Kite
Hamirostra melanosternon SA:R	Black-breasted Buzzard
FAMILY Subfamily : FALCONIDAE Fa	lcons
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel
Falco subniger	Black Falcon
Falco hypoleucos SA:R	Grey Falcon
ORDER : GRUIFORMES	
FAMILY Subfamily : GRUIDAE Cranes	
Grus rubicunda SA:V	Brolga
FAMILY SUDIAMILY : RALLIDAE Rails,	Crakes and Allies
Funca atra	Eurasian Coot
Porzana fluminea	Australian Spotted Crake
Gallinula ventralis	Black-tailed Native-nen
FAMILY Subtamily : OTIDIDAE Bustar	as Accetor lien Decetor d
Araeons australis SA: V	Australian Bustard
UKDER : CHARADRIIFURMES	Trinsings Conduiners and allies
FAMILY Sublamily : SCOLOPACIDAE	Marsh Sandpipers and alles
Tringa stagnattis	Common Greenshenk
EAMILY Subfamily - SCOLODACIDAE	A reporting a Sondringer and allies
Anonania internes	Puddy Turnstone
Arenaria interpres	Calidrings Sandningra and allies
FAMILY Sublamily : SCOLOPACIDAE	Dad page of Stint
Calidris formainea	Curley Sandningr
Calidris germinata	Sharp tailed Sandpiper
EAMILY Subfamily · DECUDVIDOSTDI	DAE Avocate and stills
Cladorhynchus laucocanhalus	Banded Stilt
Himantonus himantonus	Black winged Stilt
Recurvirostra novaehollandiae	Red pecked Avocet
FAMILY Subfamily · CHARADRIDAE	Ployers and dotterels
Vanallus milas	Masked Lanwing
vanenas nues Charadrius australis	Inland Dotterel
Vanellus tricolor	Banded Lanwing
Frythogonys cinctus	Red-kneed Dotterel
El ymogonys cincus Flsevornis melanons	Black-fronted Dotterel
Charadrius ruficanillus	Red-canned Plover
FAMILY Subfamily : GLARFOLIDAE	Pratincoles and Coursers

Species	Common Name
Stiltia isabella	Australian Pratincole
FAMILY Subfamily : LARIDAE Larinae	Gulls, skuas and allies
Larus dominicanus	Kelp Gull
Larus novaehollandiae	Silver Gull
FAMILY Subfamily : LARIDAE Sternina	e Gulls, skuas and allies
Sterna nilotica	Gull-billed Tern
Chlidonias hybridus	Whiskered Tern
Sterna caspia	Caspian Tern
ORDER : COLUMBIFORMES	1
FAMILY Subfamily : COLUMBIDAE Pi	geons and Doves
Geopelia cuneata	Diamond Dove
Ocyphaps lophotes	Crested Pigeon
Phaps chalcoptera	Common Bronzewing
ORDER : PSITTACIFORMES	6
FAMILY Subfamily : CACATUIDAE Co	ockatoos
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
FAMILY Subfamily : PSITTACIDAE Pa	rrots and Allies
Melopsittacus undulatus	Budgerigar
Neophema chrysostoma SA:V	Blue-winged Parrot
Psephotus haematonotus	Red-rumped Parrot
ORDER : CUCULIFORMES	•
FAMILY Subfamily : CUCULIDAE Cuch	koos
Cuculus pallidus	Pallid Cuckoo
Chrysococcyx basalis	Horsfield's Bronze-cuckoo
ORDER : STRIGIFORMES	
FAMILY Subfamily : TYTONIDAE Bar	n Owls
Tyto alba	Barn Owl
ORDER : CORACIIFORMES	
FAMILY Subfamily : ALCEDINIDAE Ha	alcyoninae River Kingfishers
Todiramphus pyrrhopygia	Red-backed Kingfisher
Todiramphus sancta	Sacred Kingfisher
FAMILY Subfamily : MEROPIDAE Bee	-eaters
Merops ornatus	Rainbow Bee-eater
ORDER : PASSERIFORMES	
FAMILY Subfamily : MALURIDAE Male	urinae Fairy-wrens, emu-wrens and grasswrens
Malurus lamberti	Variegated Fairy-wren
Malurus leucopterus	White-winged Fairy-wren
FAMILY Subfamily : MALURIDAE Amy	tornithinae Fairy-wrens, emu-wrens and
Amytornis goyderi	Eyrean Grasswren
FAMILY Subfamily : PARDALOTIDAE	Pardalotes
Pardalotus striatus	Striated Pardalote
FAMILY Subfamily : ACANTHIZIDAE	Acanthizinae Bristlebirds, thornbills, scrubwrens
Aphelocephala nigricincta	Banded Whiteface
Calamanthus campestris	Rufous Fieldwren
Calamanthus fuliginosus	Striated Fieldwren
Pyrrholaemus brunneus SA:R	Redthroat
FAMILY Subfamily : MELIPHAGIDAE	Honeyeaters and Australian Chats
Lichenostomus penicillatus	White-plumed Honeyeater
Lichenostomus virescens	Singing Honeyeater
Manorina flavigula	Yellow-throated Miner
Certhionyx niger	Black Honeyeater
FAMILY Subfamily : MELIPHAGIDAE	Epthianurinae Honeyeaters and Australian Chats
Epthianura aurifrons	Orange Chat
Epthianura tricolor	Crimson Chat
FAMILY Subfamily : EUPETIDAE Whit	bbirds, quail-thrushes and allies

Species	Common Name
Cinclosoma cinnamomeum	Cinnamon Quail-thrush
FAMILY Subfamily : DICRURIDAE	Monarchs, Drongos, Magpie-larks and allies
Grallina cyanoleuca	Magpie-lark
Rhipidura leucophrys	Willie Wagtail
FAMILY Subfamily : ARTAMIDAE	Woodswallows, butcherbirds and allies
Artamus personatus	Masked Woodswallow
Artamus cinereus	Black-faced Woodswallow
Artamus leucorhynchus	White-breasted Woodswallow
Gymnorhina tibicen	Australian Magpie
FAMILY Subfamily : CAMPEPHAG	IDAE Cuckoo-shrikes and Allies
Coracina maxima	Ground Cuckoo-shrike
Coracina novaehollandiae	Black-faced Cuckoo-shrike
FAMILY Subfamily : CORVIDAE C	rows
Corvus bennetti	Little Crow
Corvus coronoides	Australian Raven
Corvus mellori	Little Raven
FAMILY Subfamily : STURNIDAE	Starlings
Sturnus vulgaris*	Common Starling
FAMILY Subfamily : HIRUNDINIDA	AE Swallows and Martins
Petrochelidon nigricans	Tree Martin
Cheramoeca leucosternus	White-backed Swallow
Hirundo neoxena	Welcome Swallow
Petrochelidon ariel	Fairy Martin
FAMILY Subfamily : SYLVIIDAE M	legalurinae Warblers
Cincloramphus mathewsi	Rufous Songlark
Megalurus gramineus	Little Grassbird
Cincloramphus cruralis	Brown Songlark
FAMILY Subfamily : ALAUDIDAE	Larks
Mirafra javanica	Horsfield's Bushlark
FAMILY Subfamily : DICAEIDAE F	Flowerpeckers
Dicaeum hirundinaceum	Mistletoebird
FAMILY Subfamily : MOTACILLID	AE Wagtails and Pipits
Anthus novaeseelandiae	Richard's Pipit
FAMILY Subfamily : ESTRILDIDAE	E Grass-Finches(waxbills)
Taeniopygia guttata	Zebra Finch

Species	Common Name
CLASS : REPTILIA Reptiles	
ORDER : SQUAMATA	
FAMILY Subfamily : AGAMIDAE Dra	gon Lizards
Ctenophorus pictus	Painted Dragon
Diporiphora winneckei	Canegrass Dragon
Pogona vitticeps	Central Bearded Dragon
FAMILY Subfamily : GEKKONIDAE D	iplodactylinae Geckos and Legless Lizards
Diplodactylus tessellatus	Tessellated Gecko
Nephrurus levis	Smooth Knob-tailed Gecko
Diplodactylus damaeus	Beaded Gecko
FAMILY Subfamily : GEKKONIDAE G	ekkoninae Geckos and Legless Lizards
Heteronotia binoei	Bynoe's Gecko
FAMILY Subfamily : SCINCIDAE Skir	iks
Ctenotus brooksi	Sandhill Ctenotus
Ctenotus leae	Centralian Coppertail
Ctenotus regius	Eastern Desert Ctenotus
Egernia inornata	Desert Skink
Eremiascincus fasciolatus	Narrow-banded Sandswimmer
Eremiascincus richardsonii	Broad-banded Sandswimmer
Lerista labialis	Eastern Two-toed Slider
Menetia greyii	Dwarf Skink
Morethia adelaidensis	Adelaide Snake-eye
FAMILY Subfamily : VARANIDAE Go	pannas
Varanus gouldii	Sand Goanna
FAMILY Subfamily : ELAPIDAE Elapi	d Snakes
Suta suta	Curl Snake
Pseudonaja nuchalis	Western Brown Snake
CLASS : AMPHIBIA Frogs	
ORDER : ANURA	
FAMILY Subfamily : LEPTODACTYLI	DAE Southern Frogs
Neobatrachus centralis	Trilling Frog

10.4 Appendix D - Assessment of environmental objectives - Goal attainment scaling for seismic survey lines

Taken from:

Petroleum Group, 2001 South Australia, Department of Primary Industries and Resources. Earth Resources Information Sheet 8. Compiled by A.C. Crimes

The Petroleum Group of the Office of Minerals and Energy Resources has a regulatory responsibility regarding seismic operations conducted in South Australia's petroleum provinces. Petroleum exploration and development activities in South Australia are undertaken pursuant to the . Activities conducted must be accompanied by an approved statement of environmental objectives (SEO) before they are undertaken. The statement defines the environmental objectives which need to be achieved and a methodology of how the levels of achievement will be assessed.

Goal attainment scaling

Goal attainment scaling is a process in which stakeholders are required to participate in evaluating and seeking consensus on the most important aspects of the goals to be achieved within a particular time frame and the range of expected outcomes of the activities undertaken. Each outcome is allocated a score from +2 to -2. Expected outcomes are documented as:

- +2 much more than expected excellent
- +1 more than expected good
- 0 expected satisfactory
- -1 less than expected unsatisfactory
- -2 much less than expected very unsatisfactory

Due to the diversity of land systems across the State, the goal attainment scaling criteria have been developed to apply to different petroleum provinces throughout South Australia.

The examples provided here are divided into **land system specific** and **non-land system specific** criteria. Land system specific criteria detail all the land systems recognised in the Cooper and Eromanga Basins. Non-land system specific criteria look at potential operational, pollution, visual and infrastructure impacts that can be caused by seismic survey related operations. These guidelines use descriptive outcome criteria supported by colour photographs. The photographs illustrate the criteria marked in bold text and are provided as an example only and do not represent an absolute situation. Where multiple outcomes are applicable to a particular site, the final score will be the lowest, reflecting the lesser expected outcome. In order to achieve a 0, +1 and +2 score, all relevant criteria for that goal must be satisfied.

PIRSA stress that the goal attainment scaling criteria relate to survey specific field acquisition activities and are only applicable to recently recorded seismic lines.

The statement of environmental objectives for seismic operations in the Cooper and Eromanga Basins in South Australia contains goal attainment scaling criteria for both recently recorded seismic lines and for the assessment and continual monitoring of rehabilitation of vintage seismic lines. The latter set of criteria use elements, like the relationship between time and degree of restoration, that differ from those contained in this field guide. They are also designed to take account of external factors that can accelerate the rate of restoration of seismic lines, such as rainfall events.

The goal attainment scaling method of assessment facilitates an equitable assessment of the level of environmental compliance, by having clearly defined criteria that minimises subjective interpretation. This tends to 'normalise' the assessment scoring for the wide range of potential stakeholders who may be involved and provides a consistent and objective measure of achievement level.

Non- land system specific						
Measure	+2	+1	0	-1	-2	
Impact on infrastructure	No impact to any pastoral, tourist or production infrastructure	No observable repair or damage to infrastructure	Any impact to infrastructure has been reported and reinstated or repaired	Repair to damaged infrastructure is incomplete or inappropriate. Damage has not been reported	Damage to any infrastructure has been left unrepaired and not reported	
Visual impact	No evidence of seismic operations	Only wheel tracks are evident Line weaves Line of sight is unimpaired	Established roads and tracks have been reshouldered Doglegs have been placed at established roads and tracks in vegetated areas Dozer or grader has been walked 40 m either side of established road or track Line weaves through vegetated areas Line of sight is impaired	No doglegs at established roads or tracks in vegetated areas No weaving through vegetated areas Line of sight is unimpaired	Line is clearly evident and dominates the landscape	
Uphole site restoration	No evidence of upholes	No evidence of cuttings Some evidence of operations	Cuttings are evident but dispersed around hole Subsidence is not evident	Hole is plugged Cuttings form mound <0.5 m high Subsidence is evident	Hole is open Cuttings form mound >0.5 m high	
Pollution or litter	No pollution or litter	No evidence of water or pollution Maximum of 1 pin flag/ km No other litter	Waste water and vehicle oil spills have been managed appropriately Maximum of 2 pin flags/ km Maximum of 1 item of other litter/ km	Waste water forms ponds or extensive boggy ground Vehicle oil spills have not been remedied Maximum of 3– 4 pin flags/ km Maximum of 1– 4 items of other litter/ km	Extensive waste water ponding Oil spills of more than 20 L have not been remedied 5 or more pin flags/ km 5 or more items of other litter/ km	

Summary of goal attainment scaling criteria for assessing seismic lines shortly after completion of a seismic survey in the Cooper and Eromanga Basins, South Australia
Land system specific

Measure	+2	+1	0	-1	-2
Dunefield impact on vegetation	No removal of vegetation	No removal of Priority 3 shrubs >1m high	No removal of Priority 1 and 2 vegetation No removal of Priority 3 shrubs >2 m high Less than 30% of tree branches have been removed	Priority 1 or 2 vegetation <2 m high have been removed, including rootstock Priority 3 shrubs >2 m high have been removed, including rootstock	Priority 1 or 2 vegetation >2 m high have been removed, including rootstock
Dunefield disturbance to land surface	No dune cuts No windrows	Dune cuts are <0.5 m deep Windrows in swale are <0.1 m high	Dune crest cuts are 0.5–2 m deep Side cuts are 1.5 m deep Sand is stacked along side of cut Windrows in swale are <0.3 m high Clay- rich dune cuts are <1 m deep	Dune crest cuts are 2–4 m deep Side cuts are 1.5–3 m deep Minor ramping of sand on swale Windrows in swale 0.3–0.5 m high Clay- rich dune cuts are >1 m deep but rehabilitated Off line trafficking is evident	Dune crest cuts are >4 m deep Extensive ramping of sand onto swale Side cuts are >3 m deep Claypans have been cut Windrows in swale are >0.5 m high
Floodplains and wetlands impact on vegetation	No removal of vegetation	No removal of Priority 3 shrubs 1– 2 m high	No removal of Priority 1 and 2 vegetation No removal of Priority 3 shrubs >2 m high Less than 30% of tree branches have been removed Rootstock is intact	Priority 1 and 2 vegetation <2 m high has been removed Priority 3 shrubs >2 m high have been removed Rootstock is intact	Trees and/ or shrubs >2 m high have been removed Rootstock has been removed
Floodplains and wetlands disturbance to land surface	No windrows No interference with drainage channels	Windrows are <0.1 m high for <50% of line Only creek banks <0.5 m high have been cut	Windrows are <0.1 m high Creek banks 0.5–1 m high have been cut Creeks are not blocked Wheel tracks are <0.1 m deep	Windrows are <0.3 m high Creek banks 1– 2 m high have been cut and not restored Creeks are blocked by material <1 m deep	Windrows are >0.3 m high Creek banks >2 m high have been cut Wheel tracks >0.2 m deep Soil compaction is evident
Salt lake disturbance to land surface	No evidence of seismic line	No evidence of shotholes Little evidence of foot trafficking	Only footprints are evident No significant evidence of shotholes	Wheel tracks are <0.2 m deep Minor evidence of shotholes	Wheel tracks are >0.2 m deep Bog holes are evident Dominant evidence of shotholes (e. g. cratering, blowout, discolouration)

10.5 Appendix E STRZELECKI AND LAKE FROME REGIONAL RESERVES ECONOMIC ASSESSMENT