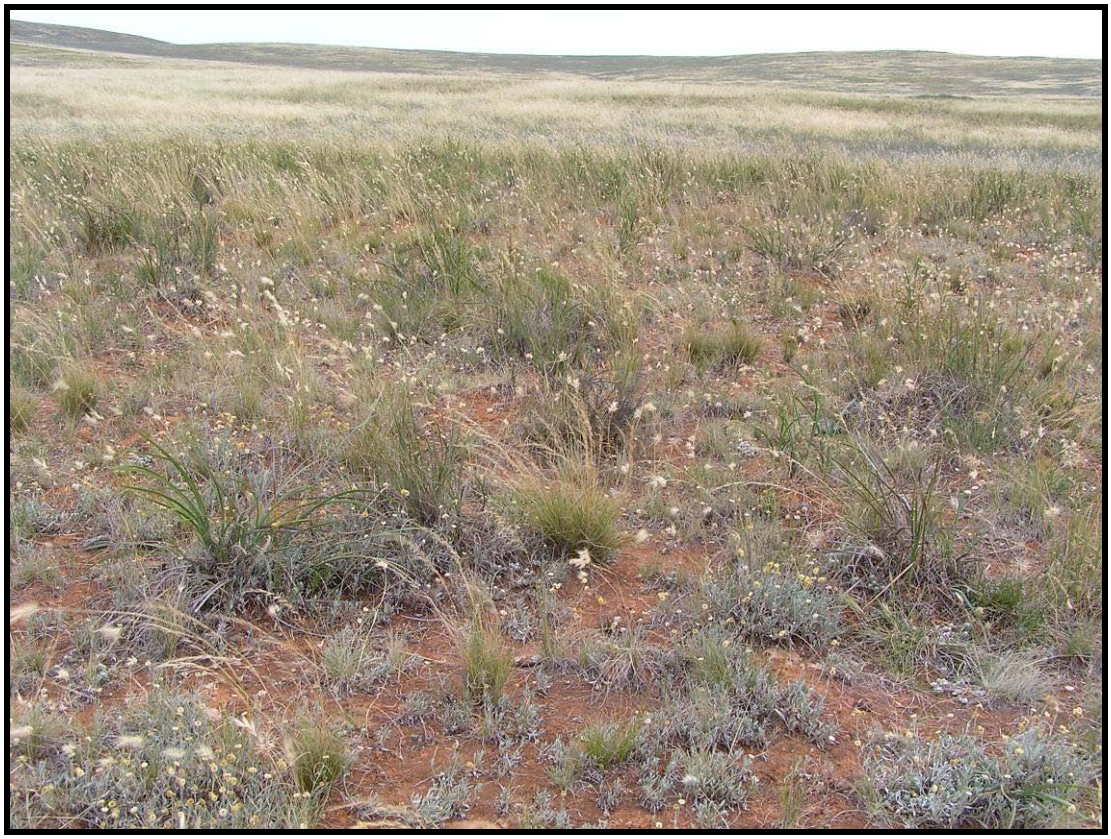
National Recovery Plan for the **Iron-grass Natural Temperate Grassland of South Australia** ecological community, 2012



Australian Government

Government of South Australia

Department of Environment and Natural Resources

This plan was prepared and published by the South Australian Department of Environment and Natural Resources as part of the Grassy Ecosystems Recovery Project.

ISBN 978-1-921800-01-6

This recovery plan sets out the actions necessary to stop the decline, and support the recovery, of the listed threatened species or ecological community. The Australian Government is committed to acting in accordance with the plan and to implementing the plan as it applies to Commonwealth areas.

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but the making or adoption of this plan does not necessarily indicate the commitment of individual stakeholders to undertaking any specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

Cite as:
Turner, J. (2012). *National Recovery Plan for the Iron-grass Natural Temperate Grassland of South Australia ecological community 2012*. Department of Environment and Natural Resources, South Australia.

Copies of this plan are available at:
www.environment.gov.au/biodiversity/threatened/recovery.html

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Cover photograph: Iron-grass Natural Temperate Grassland at Mokota Conservation Park, November 2007 (photograph by Jean Turner)

Acknowledgments

Many individuals, stakeholder groups and organisations have contributed to the development of this Recovery Plan. Their input and support is greatly appreciated and acknowledged.

Particular thanks to:

Members of the Recovery Planning Steering Committee, who generously shared their knowledge, ideas and time throughout the recovery planning process: Anne Brown (Greening Australia SA), Tim Jury (Threatened Plant Action Group), Bill New (Nature Conservation Society SA), Millie Nicholls (Grazier/Mid North Grasslands Working Group), Penny Paton (Ornithologist/Nature Conservation Society SA), Jodie Reseigh (Rural Solutions SA), Vicki-Jo Russell (formerly Conservation Council of SA and Threatened Species Network SA), Jo Spencer (Greening Australia SA), Sarah Lance (SA Murray Darling Basin NRM Board), Ann Prescott (Botanical Consultant; and formerly Department for Environment Heritage), Meg Robertson (Botanical Consultant; and Department of Environment and Natural Resources), and Angela Duffy, Peter Copley, Randall Johnson, Greg Guerin and Wendy Stubbs (all Department of Environment and Natural Resources).

Sonia Croft, Meg Robertson, Roman Urban and Steve Triplett (all Department of Environment and Natural Resources), who provided mapping and GIS support.

The following individuals who provided valuable comments on the draft plan: Ellen Bennett and Bob Myers (both Native Grass Resources Group), Alex Coombe (Trees for Life), Mick Durant (Greening Australia SA), Andrew Philpott (Light Regional Council), Andrew West (Adelaide and Mount Lofty Ranges NRM Board), Michael Wurst and Mary-Anne Young (both Rural Solutions SA), Nick Neagle (Department of Environment and Natural Resources), Kyle Flannery (Airservices Australia); Andrew Chalklen and other staff of the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

The Department of Sustainability, Environment, Water, Population and Communities, for funding support.

The Department of Environment and Natural Resources replaced the Department for Environment and Heritage on 1 July 2010.

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Abbreviations

AMLR	Adelaide and Mt Lofty Ranges (NRM Board/Region)
CITES	Convention on International Trade in Endangered Species
DEH	former Department for Environment and Heritage (South Australian Government)
DENR	Department of Environment and Natural Resources (South Australian Government) (formerly DEH)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Australian Government)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESP	Environmental Stewardship Program (Australian Government *Caring for our Country*)
GIS	Geographic Information System
INTG	Iron-grass Natural Temperate Grassland
IUCN	International Union for the Conservation of Nature and Natural Resources
NPW Act	*National Parks and Wildlife Act 1972*
N&Y	Northern and Yorke (NRM Board/Region)
NRM	Natural Resources Management
NRM Act	*Natural Resources Management Act 2004*
NV Act	*Native Vegetation Act 1991*
NVC	Native Vegetation Council
PBGW	Peppermint Box Grassy Woodland
PBT	Pygmy Bluetongue Lizard
SA MDB	South Australian Murray Darling Basin (NRM Board/Region)
SEB	Significant Environmental Benefit
WWF	World Wide Fund for Nature

Glossary

Annual	referring to plant species, a plant that completes its life cycle from germination to seeding in one year and then dies
Area of occupancy	the total area within its natural range actually occupied by the ecological community
Broad-leaved (plant)	referring to plant species in the dicotyledonous group of plants; i.e. plants which have a pair of seed leaves or cotyledons
Broad-leaved herbaceous species	an attribute used in Condition Class assessment of INTG remnants, referring to native plant species which are broad-leaved plants having a herbaceous growth form
Condition Class	a state of the INTG defined in the EPBC Act Listing Advice and based on native plant species diversity, composition and native perennial tussock density. Three Condition Class categories have been defined, representing high quality remnants (A), moderate quality remnants (B) and degraded remnants with potential for restoration (C)
Dominant species	species which make up a large proportion of biomass, or numbers of organisms, in a community; in vegetation, the most common and characteristic species in the uppermost stratum of the plant community, excluding emergent species
Ecological community	a naturally occurring assemblage of inter-dependent plant and animal species, characterised by a unique combination of species composition, structure and habitats, and determined by or associated with physical factors such as soil type, position in the landscape, climate and water availability
Emergent species	plants that rise up above the dominant upper stratum of the plant community, generally widely spaced and with total canopy cover less than 5%
Environmental offset	pertaining to the EPBC Act, an agreed action taken outside a development site, to compensate for direct, indirect or consequential impacts of the development on a matter or matters protected by the EPBC Act; can include direct on-ground actions and indirect actions to improve knowledge, understanding or management for conservation outcomes
Floristic	pertaining to the types, numbers and distribution of plant species in a particular area
Forb	a herbaceous (non-woody) plant other than grasses, sedges and rushes
Herb	a plant which does not develop a woody stem
Herbaceous	referring to the growth form of plant species; species which do not develop a woody stem
Integrity	(of the ecological community) the capacity of INTG remnants to support and maintain species composition, diversity and functional organisation similar to undisturbed examples of the ecological community

Long term	in relation to recovery of the ecological community, 50 years or more
Medium term	in relation to recovery of the ecological community, in the next 10 to 50 years
Perennial	referring to plant species, a plant that lives for more than two years before completing its life cycle from germination to seeding; may be short-lived, or long-lived with repeated annual cycles of flowering and seeding
Polygon	in GIS, an area bounded by a closed line, used to represent a feature on a map (e.g. an INTG remnant, or a continuous area of a floristic vegetation group) and linked to a data reference point inside the boundary
Priority remnants	INTG remnants and habitat areas that are significant and critical for the long-term persistence of the ecological community
Set stocking	referring to a stock grazing regime where the animals are placed on a fixed area and held at a consistent stock density without adjustment; also referred to as continuous grazing
Short term	in relation to recovery of the ecological community, over the next 10 years; the period of this recovery plan
Significant Environmental Benefit	pertaining to the NV Act, a negotiated activity to offset the loss of habitat, biodiversity and/or environmental values associated with native vegetation clearance approved under the NV Act; can include protection, active management or restoration of remnants, revegetation to recreate a functioning ecosystem, or payment into the Native Vegetation Fund for on-ground work elsewhere

Summary

This *National Recovery Plan for the Iron-grass Natural Temperate Grassland of South Australia* has been prepared in accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The intended life-span of this recovery plan is ten years. It will be reviewed after five years and further recovery goals and actions may be identified.

Conservation Status

The Iron-grass Natural Temperate Grassland of South Australia ecological community is listed as Critically Endangered under the EPBC Act.

The Ecological Community

The Iron-grass Natural Temperate Grassland of South Australia is an ecological community in which Iron-grasses (*Lomandra* species) are a characteristic and dominant part of the vegetation. In South Australia, Stiff Iron-grass (*Lomandra multiflora* subsp. *dura*) and Scented Iron-grass (*Lomandra effusa)* commonly occur in grassland communities, in association with perennial, tussock-forming native grasses. Tussock Grassland communities with Stiff Iron-grass and/or Scented Iron-grass as the dominant or co-dominant species are recognised as a unique type of natural temperate grassland (Carter *et al*. 2003).

Iron-grass Natural Temperate Grassland is considered endemic to South Australia. The main distribution is in the Flinders-Lofty Block Bioregion, with smaller occurrences in the Kanmantoo, Eyre-Yorke Block and Murray Darling Depression Bioregions. The ecological community occurs on loam to clay loam soils in areas of winter-dominant rainfall, generally on gentle to steep slopes of hills and rocky ridgelines.

Iron-grasses are members of the Lily family (Liliaceae) (Barker *et al*. 2005). They are grass-like in appearance and form persistent, long-lived tussocks. Iron-grass Natural Temperate Grassland has a characteristic structure, dominated by large and medium-sized perennial tussocks of Iron-grass and native grasses, with smaller herbs, low shrubs, mosses, lichens and bare ground in the inter-tussock spaces. Many plants and animals of the ecological community are regarded as grassy habitat specialists. The presence of mature Iron-grass tussocks generally indicates areas not previously disturbed by ploughing: such areas are important refuges for species sensitive to cultivation and fertilizers, such as orchids and soil-dwelling insects, spiders and reptiles.

Iron-grass Natural Temperate Grassland once extended over an estimated 750,000 to 1,000,000 hectares (Specht 1972; Hyde 1995). However, the ecological community has declined dramatically in area and integrity across its natural range, to the point where it is now considered critically endangered. Knowledge about the distribution, species composition and condition of remaining patches is incomplete. The area of Iron-grass Natural Temperate Grassland of South Australia which meets the EPBC Act condition criteria is unknown, but is likely to be less than 5,000 ha (Hyde, 1995; Threatened Species Scientific Committee 2007).

Land Uses

Most remaining areas of Iron-grass Natural Temperate Grassland are on agricultural land used for livestock production. Approximately 780 ha have been set aside for conservation, in Conservation Parks and private Heritage Agreements. Small areas also remain in various Crown Land reserves, including road and rail reserves and parcels managed by Local Governments.

Key Threats

The Iron-grass Natural Temperate Grassland ecological community is at risk from a range of threats. Key existing and potential threats include:

- changes in land use and management, such as altered grazing regimes, cultivation or fertiliser application;
- changes in land ownership and associated lack of knowledge on appropriate management;
- vegetation clearance associated with new developments such as urban and peri-urban expansion, wind farms, mining and other activities;
- ongoing degradation associated with weeds, fragmentation of remnants and small patch size;
- inappropriate or altered fire management regimes; and
- ecological, economic and social impacts of climate change.

Knowledge Gaps

Information about the location, size, condition and integrity of remaining areas is a key knowledge gap that needs to be addressed for recovery of the Iron-grass Natural Temperate Grassland ecological community. Other critical gaps include knowledge about fauna of the ecological community, their habitat requirements and species that are functionally important or depend on the community for their survival; community structure and dynamics; 'best practice' management strategies for conservation outcomes in different land uses; effective restoration techniques; the role and management of fire; and potential impacts of climate change.

Recovery Opportunities

Opportunities exist to improve the conservation status of the Iron-grass Natural Temperate Grassland ecological community. These centre on working in partnership with private land owners and managers to improve the condition and integrity of existing remnants, halt further decline in extent, and restore recoverable areas to meet the condition criteria for the listed ecological community. The *Environmental Stewardship Program* and other market-based incentive programs will enable greater participation of private land owners and managers in recovery of the ecological community, by providing incentives for long-term protection and management of Iron-grass Natural Temperate Grassland remnants. Surveys, condition assessments and monitoring undertaken by these programs could be an important part of the recovery process, potentially contributing knowledge on the extent, condition, management and restoration of the ecological community.

Recovery Objectives

The overall objective of this recovery plan is to ensure the survival of the Iron-grass Natural Temperate Grassland of South Australia and promote its recovery by maintaining or improving the area, condition and integrity of the ecological community.

Specific objectives to be achieved within the intended life of this recovery plan are:

1. To maintain or improve the condition of remnant Iron-grass Natural Temperate Grassland.
2. To increase the area of Iron-grass Natural Temperate Grassland secured and managed for conservation.
3. To increase the area of occupancy of Iron-grass Natural Temperate Grassland across its natural range.

The achievement of these objectives will be measured by the performance criteria that are listed for each strategy.

Recovery Strategies

The key strategies to achieve these objectives for recovery of Iron-grass Natural Temperate Grassland are to:

1. Increase awareness of INTG to ensure protection of the ecological community.
2. Improve baseline information on location, extent, condition and management of INTG remnants.
3. Increase the area of the EPBC listed INTG secured and managed for conservation.
4. Maintain or improve the condition and integrity of the EPBC listed INTG remnants using 'best practice' strategies.
5. Increase the area of occupancy of the EPBC listed INTG ecological community across its natural range.
6. Address critical knowledge gaps about the ecological community.
7. Actively manage the recovery process through an effective recovery team.

Twenty three recovery actions have been developed to implement these strategies and meet the recovery plan objectives over the next ten years. Performance criteria have been identified to assist with setting tasks and measuring their achievement.

Costs and Evaluation

The total funding required to implement this plan over the ten-year period is estimated at $5,941,000. This is likely to be an underestimate due to the difficulty of comprehensively costing many of the specific and ongoing activities and the in-kind contributions of partners. Funds to implement this plan will be sought from a range of sources, including South Australian and Australian Governments and the private sector. Progress towards achieving the recovery objectives will be reported against the performance criteria and as required by funding and management arrangements.

Part A Introduction

In South Australia, Stiff Iron-grass (*Lomandra multiflora* subsp. *dura*) and Scented Iron-grass (*Lomandra effusa)* commonly occur with perennial native grasses in Tussock Grassland communities. The Iron-grass Natural Temperate Grassland of South Australia is an ecological community in which Stiff Iron-grass and/or Scented Iron-grass form a characteristic and dominant component of the vegetation. These grasslands are recognised as a unique type of natural temperate grassland (Carter *et al*. 2003) endemic to South Australia.

Iron-grass Natural Temperate Grassland once extended over an estimated 750,000 to 1,000,000 hectares (Specht 1972; Hyde 1995). The ecological community has declined dramatically in area and integrity across its natural range, and is now considered threatened by extinction unless action is taken to conserve and manage it. Knowledge about the current distribution, species composition and condition of Iron-grass Natural Temperate Grassland is incomplete. The total area remaining, including modified and degraded remnants, has been estimated at less than 50,000 ha (Department of Transport, Urban Planning and the Arts 2000), while the area in good condition is thought to be less than 5,000 ha (Hyde, 1995).

Presence of mature Iron-grass tussocks generally indicates grasslands not previously disturbed by ploughing. Such areas are important refuges for species sensitive to cultivation and fertilizers, such as orchids, soil-dwelling insects, spiders and reptiles. The Iron-grass Natural Temperate Grassland ecological community includes many flora and fauna species regarded as grassy habitat specialists. Some of these species are considered threatened at national, state or regional levels.

Prior to this recovery plan there has been no formal, coordinated recovery program for the Iron-grass Natural Temperate Grassland ecological community. However, native grassland extension programs, management trials, stewardship funding and on-ground works programs over the past 12 years have helped some land owners and managers to adopt 'best practice' management of Iron-grass Natural Temperate Grassland remnants and contribute to conservation of the ecological community.

The National Recovery Plan

This *National Recovery Plan for the Iron-grass Natural Temperate Grassland of South Australia* has been prepared in accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The objects of the EPBC Act, as set out in Section 3 of that Act, have been considered in the development of this plan.

The recovery plan describes and documents current knowledge of Iron-grass Natural Temperate Grassland in South Australia. It identifies the major issues currently threatening and impacting on the ecological community, as well as emerging issues and potential threats which may impact in the near future. The long-term goal for the ecological community is to stabilise existing areas, prevent their decline and where possible, improve their condition and status through appropriate management.

The plan sets strategies and actions to protect, manage and recover the Iron-grass Natural Temperate Grassland ecological community, including actions to address knowledge gaps and to engage stakeholders. Landholders are key partners in the recovery of the ecological community, and their active involvement through adoption of best practice management for conservation and production outcomes will be encouraged and supported.

This recovery plan is consistent with existing national recovery plans for threatened species within the ecological community and does not replace those plans. It takes a 'whole of community' approach to recovery, seeking to retain, re-establish and protect common species integral to the persistence and function of the ecological community, as well as rare and threatened species occurring within it. Maintenance and management of variations in the biological and physical environment of the ecological community underlie, and are integral to, the recovery actions identified in the plan.

It is also consistent with South Australian state plans and policies, including South Australia's Strategic Plan, the No Species Loss conservation strategy, the State Natural Resources Management (NRM) Plan, regional NRM plans and the Adelaide and Mount Lofty Ranges (AMLR) Regional Recovery Plan. Details of these plans are summarised in Appendix 3. The recovery plan for Iron-grass Natural Temperate Grassland of South Australia expands on targets in these plans and policies, identifying specific strategies and actions for restoration and conservation of the ecological community across its natural range. The recovery of the Iron-grass Natural Temperate Grassland will also link into other threatened species and ecological community recovery plans and programs.

This recovery plan will be reviewed periodically, and may be updated to include additional information from future surveys, research, adaptive management and monitoring, or other outcomes of recovery actions.

Affected Interests

The Iron-grass Natural Temperate Grassland of South Australia ecological community occurs on private and public lands, across a range of land tenures, land uses and management regimes.

The majority of Iron-grass grassland remnants are on land currently used for agricultural production, either in non-arable grazing areas, or non-arable patches within cropping land. Native pasture areas are an integral part of primary production on many properties.

Some remnants also occur on undeveloped house blocks in rural townships, 'lifestyle' properties in rural land subdivisions no longer used for conventional broad-acre agriculture, and in industrial infrastructure and development sites such as mines, transport hubs and wind farms. Some private landowners, non-government organisations, Local Governments and community groups have set aside Iron-grass grassland remnants as private reserves on free-hold land through Heritage Agreement covenants, gazetted Sanctuaries or as informal private conservation areas.

Iron-grass Natural Temperate Grassland also occurs on Crown lands, including Conservation Parks, reserves under the care and control of Local Governments, road and railway reserves, electricity and water infrastructure sites and various other sites managed by the State and Australian Governments.

Iron-grass Natural Temperate Grassland, as defined in the EPBC listing, is currently known to occur in three NRM regions; the Adelaide and Mt Lofty Ranges (AMLR), Northern and Yorke (N&Y), and SA Murray Darling Basin (SA MDB). This Recovery Plan links to programs, priorities and targets identified in these Boards' Regional NRM Plans.

Private land owners, public land management authorities and industry may be affected by implementation of this recovery plan, and a wide range of stakeholders will need to be engaged and involved in the recovery process. Voluntary participation by graziers and other private land owners and managers will be critical to achieving the overall objective of this plan. Strategies and recovery actions have been developed to raise awareness and knowledge of different stakeholder groups and to support their

participation in recovery actions. Representatives of the identified affected interests have been invited to comment on a draft of this plan prior to endorsement.

Role and Interests of Aboriginal People

The natural distribution of the Iron-grass Natural Temperate Grassland of South Australia ecological community extends through several Aboriginal Nations, including traditional lands of the Ngarrindjeri, Peramangk, Kaurna, Narrunga, Nukunu and Ngadjuri people. Extensive areas of Iron-grass grassland existed prior to European settlement, and these grasslands and the native plants and animals inhabiting them may have social, cultural and spiritual significance to the Aboriginal people.

This plan aims to ensure that the role and interests of Aboriginal people are considered in implementing recovery actions. To this end, the Aboriginal Partnerships Section of the Department of Environment and Natural Resources (DENR) consulted with the relevant Aboriginal nations and communities about their interests in the ecological community and their involvement in recovery planning and implementation. The standard process adopted by Aboriginal Partnerships is to contact each community, inform them of the plan and provide fact sheets with information on the relevant species or ecological community. Comments are requested by a set date and if no comment is forthcoming a personal follow-up reminder is made. For this recovery plan no comments had been received by the time of publication. However, as and when actions of this plan are implemented, relevant Aboriginal interests will be engaged with.

This recovery plan will be adopted and released subject to any Native Title rights and interests that may continue in relation to the land and/or waters. Nothing in the plan is intended to affect Native Title. The Commonwealth *Native Title Act 1993* should be considered before undertaking any future acts that might affect Native Title.

Social and Economic Benefits and Impacts

Implementation of this recovery plan is likely to provide a number of social and economic benefits, as well as having some impacts. Recommended recovery actions are compatible with continuation of existing land uses, with a focus on increased knowledge, adoption of 'best practice' adaptive management, and improved planning and development to minimise impacts to Iron-grass Natural Temperate Grassland.

Potential social and economic benefits include:

- Improved awareness, knowledge, skills and capacity of land owners and managers to manage Iron-grass Natural Temperate Grassland remnants for conservation and production;
- Increased productivity, economic benefits and sustainability of grazing enterprises through adoption of 'best practice' management (Bishop 2009);
- Local peer support networks developed and maintained for land owners and managers;
- Opportunities for coordinated brokering of livestock grazing services to land owners without stock;
- Greater general knowledge, awareness and understanding of the ecological community and its management;
- Increased community skills and capacity to participate in management of biodiversity and natural resource assets;
- Improved development assessment and planning processes for sites with Iron-grass Natural Temperate Grassland remnants;

- Targeting of available funding resources to high priority activities and sites;
- Improved access to funding for individual land owners and managers, community groups and Local Government, for conservation and management of Iron-grass Natural Temperate Grassland;
- Research effort focussed on addressing knowledge gaps for the ecological community;
- Increased aesthetic and tourism values associated with improved condition and native species diversity of Iron-grass Natural Temperate Grassland remnants (as found in other natural grasslands, e.g. Lindemann-Matthies *et al*. 2010); and
- Natural resource protection resulting from adoption of 'best practice' management, including reduced surface water run-off, reduced water-table recharge and reduced soil compaction and erosion associated with inappropriate grazing.

Potential social and economic impacts may include:

- Additional infrastructure costs associated with changes to 'best practice' grazing management (Bishop 2009);
- Time and effort to learn about new management techniques (Bishop 2009);
- Management costs for Iron-grass Natural Temperate Grassland remnants currently not actively managed;
- Limitations or conditions placed on urban and peri-urban developments, new infrastructure developments and mineral exploration or extraction;
- Additional costs associated with improved site management and protection of Iron-grass Natural Temperate Grassland remnants at industrial, infrastructure and development sites; and
- Costs of implementing 'best practice' restoration of degraded sites.

Recovery actions in this plan provide a framework to help minimise significant adverse social and economic impacts. These include provision of targeted training and support to land owners and managers, planners, developers and other stakeholders; development of improved 'best practice' adaptive management and restoration techniques for different land uses; and targeted funding, peer support and advice to assist adoption of 'best practice' adaptive management and restoration techniques at Iron-grass Natural Temperate Grassland sites.

Benefits to Species and other Ecological Communities

Individual native plant and animal species of the Iron-grass Natural Temperate Grassland ecological community will also benefit from implementation of this recovery plan. Some of the benefits to species and the environment are outlined below.

Increased knowledge about the location, native species composition and condition of Iron-grass Natural Temperate Grassland remnants will enhance:

- Conservation, management and protection of rare and threatened species, particularly species listed under the EPBC Act or the South Australian *National Parks and Wildlife Act 1972* (Table 3);
- Protection and management of habitat for a range of grassy habitat specialist species;
- Targeted threat abatement and site restoration work in priority areas; and
- Land use planning and assessment of development proposals in or near Iron-grass Natural Temperate Grassland remnants, to ensure impacts on the ecological community are avoided or minimised; and

Increased adoption of 'best practice' adaptive grazing management will help:

- Shift the biomass balance from exotic annual plants to perennial native plants;
- Reduce grazing pressure on palatable native herbs and forbs, such as native legumes, lilies and daisies;
- Provide habitat for grassland invertebrates such as butterflies and spiders;
- Reinstate and maintain the protective soil surface layer of mosses and lichens; and
- Reduce surface water run-off, water-table recharge, soil erosion and compaction, and their associated impacts on native species.

Conservation outcomes will be enhanced by aligning with relevant State and regional planning documents, including;

- No Species Loss, A Nature Conservation Strategy for South Australia 2007-2017 (Department for Environment and Heritage, undated)
- Cape Borda to Barossa Naturelink (Department of Environment and Natural Resources, undated)
- Regional recovery plan for threatened species and ecological communities of Adelaide and the Mount Lofty Ranges, South Australia – 2009-2014 (Wilson & Bignall 2009)
- Natural Resource Management Plans for the Northern and Yorke, SA Murray-Darling Basin and Adelaide and Mount Lofty Ranges NRM regions
- Recovery Plan for the Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) 2012 (Duffy *et al*. 2012)
- Draft National Recovery Plan for the Peppermint Box (*Eucalyptus* odorata) Grassy Woodland of South Australia 2012 (Turner 2012)
- Recovery Plan for Twelve Threatened Orchids in the Lofty Block Region of South Australia (Quarmby 2010)
- Draft National Recovery Plan for the Coloured Spider-Orchid *Caladenia colorata* 2011 (Department of Environment and Natural Resources 2011)
- National recovery Plan for the Trailing Hop-bush *Dodonaea procumbens* (Carter 2010)
- Draft Recovery Plan for *Acanthocladium dockeri* (Spiny Daisy) (Clark *et al*. 2012)

Adjoining areas of other ecological communities may also benefit from recovery actions in Iron-grass Natural Temperate Grassland remnants. For example improved site management and protection measures in Iron-grass grasslands may provide important seasonal feeding or breeding habitat for native fauna species, enhancing their ability to maintain viable populations, provide ecosystem services or move through the landscape between different ecological communities.

Threatened species in Iron-grass Natural Temperate Grassland remnants may need specific management which disadvantages or impacts on other more common species at those sites. For example, grazing management to maintain ideal habitat for a population of Pygmy Bluetongue Lizards (*Tiliqua adelaidensis*) (Schofield 2006) or Plains Wanderers (*Pedionomus torquatus*) (NPWS 2002) may reduce vegetative growth, flowering, seed production or population size of palatable native plants at the site. However, the overall diversity of native species and the needs of different species within the ecological community can be balanced and addressed at the broader district and regional landscape scales by maintaining a mix of different management goals and strategies across the distribution range.

International Obligations

International conventions and agreements relevant to this plan include the Convention on International Trade in Endangered Species (CITES) and the Convention on Biological Diversity. Natural temperate grassland ecological communities are considered threatened world-wide but are not specifically the subject of international agreements. However, they may include species and habitat that are subject to these agreements. Recovery actions identified in this plan are consistent with Australia's obligations under these conventions and agreements, and recovery actions for the ecological community also aim to enhance the conservation of threatened species, including species subject to international agreements.

Part B Description and Status of the Ecological Community

Definition of the Listed Community

The Iron-grass Natural Temperate Grassland of South Australia ecological community is listed nationally as Critically Endangered under the EPBC Act. The EPBC Listing Advice defines the ecological community by characteristic features of its vegetation structure and composition, distribution range, climate, soil type and position in the landscape (Threatened Species Scientific Committee 2007). Key features of the ecological community are as follows:

- The Iron-grass Natural Temperate Grassland of South Australia is a type of natural temperate grassland. Trees and tall shrubs are absent to sparse (cover less than 10%) and tussock-forming perennial grasses and Iron-grasses (*Lomandra effusa* and/or *L. multiflora* subsp. *dura*) dominate the ground layer. A range of herbaceous plant species occur in the inter-tussock spaces.
- Iron-grasses are a characteristic feature of this ecological community, and may cover up to 70% of the ground area. *Lomandra* species may be absent in small areas (less than 1 ha) of the listed ecological community, if these patches sit within the context of areas that contain *Lomandra*.
- Remaining patches of Iron-grass Natural Temperate Grassland are generally on the slopes of low hills, at altitudes above 380 metres. The soils on which this ecological community occurs are predominantly loams to clay loams. Surface pebbles are common at some sites and some rock outcropping may also occur. The mean annual rainfall ranges from 280-600 mm/year across the distribution range.
- The ecological community is considered endemic to South Australia, and occurs primarily in the Flinders-Lofty Block Bioregion, with a major part of the distribution between Clare and Burra, north to Jamestown, Peterborough and to west of Carrieton. The ecological community also extends into the Kanmantoo, Eyre-Yorke Block and Murray-Darling Depression Bioregions (Figure 1).
- The nationally listed ecological community comprises two closely related but floristically distinct tussock grassland communities, one dominated by Stiff Iron-grass (*Lomandra multiflora* subsp. d*ura*) and the other dominated by Scented Iron-grass (*Lomandra effusa*) (Hyde 1995; Robertson 1998). Examples of Iron-grass Natural Temperate Grassland are shown in Figures 2 and 3.

Figure 1: Areas where Iron-grass Natural Temperate Grassland of South Australia may occur.

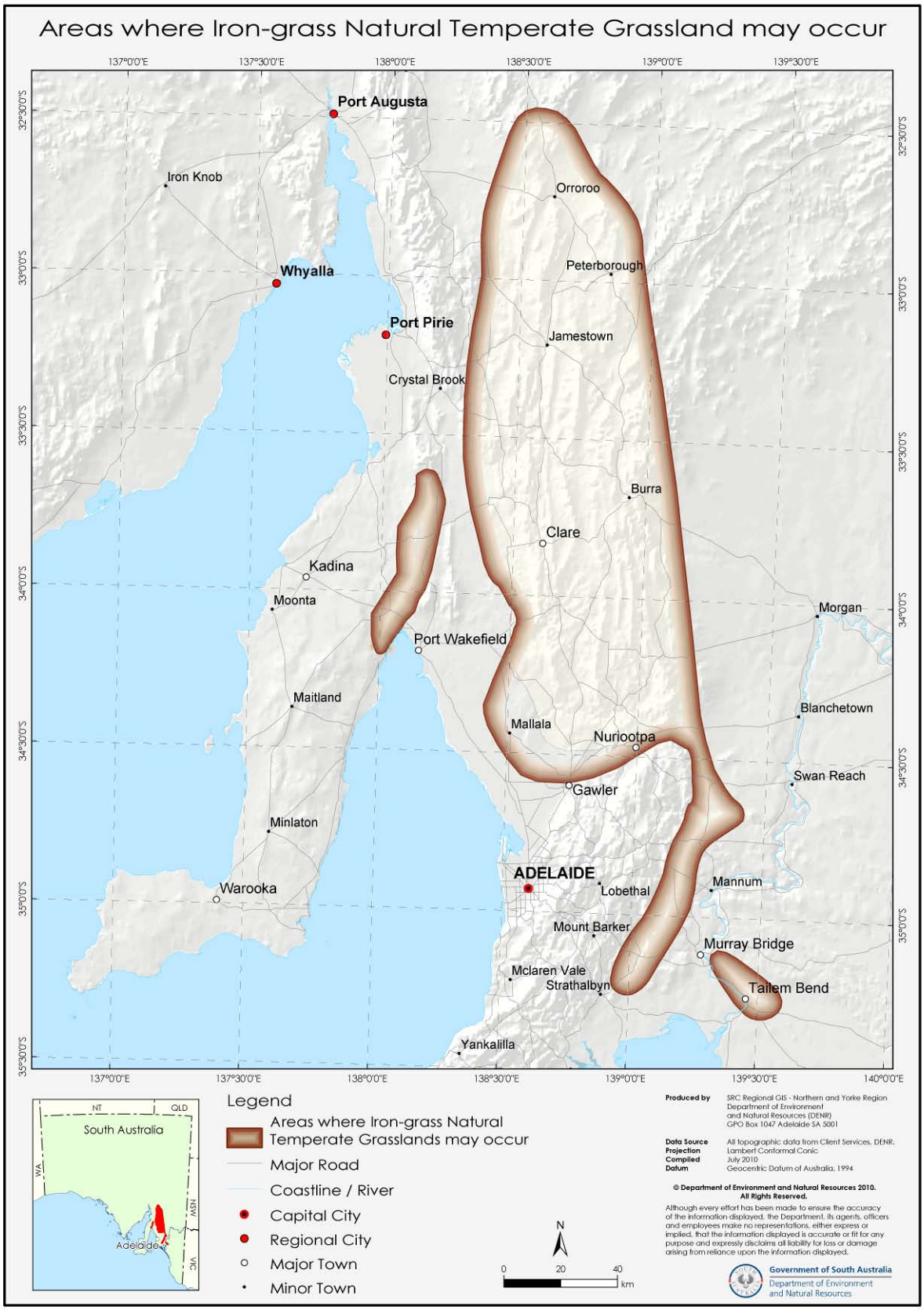

Figure 2: *Lomandra multiflora* subsp. *dura* Tussock Grassland, Mokota Conservation Park, November 2003. (Photo: J Turner)

Figure 3: *Lomandra effusa* Tussock Grassland, eastern Mount Lofty Ranges near Cambrai, August 2008. (Photo: J Turner)

Condition Classes and Assessment

The EPBC Listing Advice distinguishes better quality remnants of Iron-grass Natural Temperate Grassland that are protected by the listing, from the remnants with low native species diversity that are not considered part of the listed ecological community and are not protected under the EPBC Act (Threatened Species Scientific Committee 2007). Three different condition classes are defined on the basis of patch size, native species diversity and composition, and tussock density (Table 1).

Condition Classes A and B make up the listed ecological community, with Condition Class A representing the areas in best condition. Condition Class C represents Iron-grass Natural Temperate Grassland remnants that are considered too degraded to be part of the listed community, but with sufficient biodiversity value to target for restoration.

Table 1: Condition Classes defined under the EPBC Act listing for Iron-grass Natural Temperate Grassland of South Australia.

Condition Class	Minimum Patch Size (hectares)	Native Species Diversity[1]	No. of Broad-leaved Herbaceous Species[1] (excluding disturbance resistant species[2])	No of Perennial Grass species[1]	Average Tussock Count[3]
Listed ecological community					
A	0.1 ha	> 30	≥ 10	≥ 5	1/m
B	0.25 ha	> 15	≥ 3	≥ 4	1/m
Degraded patches amenable to rehabilitation					
C	No minimum	> 5	No minimum	≥ 1	No minimum

Notes

[1] As measured in a 50m x 50m quadrat, (or equivalent to make 2,500m^2 if patch is narrower – e.g. roadside corridor).

[2] Disturbance resistant species: *Ptilotus spathulatus*; *Sida corrugata*; *Oxalis perennans*; *Convolvulus erubescens*[4]; *Euphorbia drummondii*, *Maireana enchylaenoides.*

[3] Average count as measured along a 50m transect, including all native perennial tussock species i.e. true grasses, as well as species of *Lomandra*, *Dianella*, *Gahnia*, *Lepidosperma* and other perennial sedges and rushes.

[4]NB *Convolvulus erubescens* is no longer considered to occur in South Australia (Barker *et al*. 2005) and specimens previously named as this species are now ascribed to eight other taxa in the genus with *C. angustissimus* subsp. *angustissimus, C. angustissimus* subsp. *peninsularum* and *C. remotus* possibly occurring in the INTG ecological community.

Reference sites have been established for different Condition Classes of Iron-grass Natural Temperate Grassland. These will be used for long-term monitoring and for training in site assessment. Locations of ten Condition Class reference sites on public land are provided in Appendix 4.

While Condition Class assessments could, in theory, be done at any time of the year, accurate rating relies on determining the total native plant species diversity, the number of herbaceous perennial species, the number of perennial native grass species and the density of perennial native tussocks. This may only be possible at certain times of the year or at certain phases of management (e.g. after rest and re-growth following grazing).

Some commonly occurring native forbs of the ecological community are only detected in winter and spring. These species either are annuals, or behave like annuals, drying off and dying back in late spring/early summer and germinating or re-sprouting after rain in

autumn/winter. They are most easily identified during flowering and seed formation, but can be difficult to identify, or even detect, at other times of the year. Many of the characteristic native grass species, particularly Wallaby Grasses (*Austrodanthonia* species) and Spear-grasses (*Austrostipa* species) also are difficult to identify in vegetative growth and can only be positively determined by their flowers or mature seeds, generally in late spring to early summer. In grazed areas, palatable species may be maintained in vegetative growth and need to regrow and flower before they can be identified.

Condition Class ratings help inform decisions about the likelihood of significant impact on the listed Iron-grass Natural Temperate Grassland ecological community. However, ratings for a site can vary according to the season the assessment is done; climatic conditions such as drought; time elapsed since grazing or other disturbances; presence of weed biomass obscuring small native plants; whether the 50m x 50m survey quadrat and 50m tussock count transect represent best, average, or low diversity or tussock density in that remnant; and interpretation of which native plant species to include in the 'broad-leaved herbaceous' category.

Potential site assessors require more specific guidance in Condition Class assessment of remnants. It is recommended that this be addressed in the short-term through field testing and clarification of survey methods, followed up with information and training for site assessors.

Thresholds for Condition Classes of the EPBC Act listed ecological community may be reviewed by the Australian Government from time to time. Any change in thresholds will need to be incorporated into site assessor training and the GIS database and mapping of the ecological community updated.

Ideally site surveys for Condition Class ratings should be:

- undertaken in mid to late spring, and if necessary over multiple visits, to ensure accurate plant identification;
- assessed in good seasonal conditions or within two months of effective rain;
- done at least two months after a disturbance (e.g. fire, grazing, slashing);
- located in the most intact (least modified) vegetation in the remnant;
- based on multiple quadrats and transect lines.

If site surveys are undertaken in poor seasonal conditions, during or soon after stock grazing or other disturbances, or at a sub-optimal time for plant identification, the precautionary principle should be applied to Condition Class ratings, especially if a remnant fails to meet any of the criteria for Condition Class A or B by a small margin.

Distribution of the Ecological Community

Current Distribution

The Iron-grass Natural Temperate Grassland of South Australia ecological community occurs only in South Australia. Tussock Grasslands dominated by *Lomandra multiflora* subsp. *dura* and/or *L. effusa* occur mainly in the Flinders-Lofty Block Bioregion (Neagle 2008), with smaller occurrences in the Kanmantoo, Eyre-Yorke Block and Murray Darling Depression Bioregions (Department for Environment and Heritage 2005). The distribution of Iron-grass Natural Temperate Grassland is a sub-set of the South Australian distributions of *L. multiflora* subsp. *dura* and *L. effusa*, which also occur in a range of other native vegetation communities including forest, woodland, mallee and coastal cliff-top grasslands.

The climate in which this ecological community occurs is typically 'Mediterranean', with hot, dry summers and cool, wet winters. The winter-dominant rainfall averages 280-600

mm/year across this distribution range. Frosts are common in some areas and occasional light snow falls occur at the highest altitudes. Remaining patches are generally on the slopes of low hills, at altitudes above 380 metres, on loam to clay loam soils with estimated clay content of 30-35%. Surface pebbles are common and some rock outcropping may also occur.

The area of Iron-grass Natural Temperate Grassland at the time of European settlement has been estimated at between 750,000 to 1,000,000 hectares (Specht 1972; Hyde 1995). At the time of listing under the EPBC Act in 2007, the remaining area of Iron-grass Natural Temperate Grassland of any condition, including highly degraded remnants, was thought to be less than 50,000 ha (Department for Transport, Urban Planning and the Arts 2000). The area meeting the criteria for the listed ecological community is likely to be substantially less and may be less than 5,000 ha (Hyde 1995; Threatened Species Scientific Committee 2007).

Knowledge of the location, area and condition of Iron-grass Natural Temperate Grassland remnants is still incomplete. A large proportion of the potential area of remnant temperate native grassland in South Australia is yet to be surveyed, assessed and mapped. Many of the areas already floristically mapped require ground-truthing to confirm the presence and extent of the ecological community. Field surveys have recorded Iron-grass Natural Temperate Grassland in various positions in the landscape, including the crests, slopes and foot slopes of hills, on plains and flats, in gullies and on ridges (Robertson 1998; Neagle 2008a).

The general area in which the Iron-grass Natural Temperate Grassland of South Australia is likely to occur, based on current interpretations of the EPBC listing, is shown in Figure 1. A desktop assessment of mapped grasslands, using existing survey data and floristic vegetation mapping, has identified 869 polygons within the general distribution with potential to contain Iron-grass Natural Temperate Grassland (BDBSA 2010). Approximately 27,340 ha of currently mapped grassland areas are either known or considered likely to include the ecological community.

A total of 19,288 ha (71%) of the assessed polygons are considered highly likely to include Iron-grass Natural Temperate Grassland of varying condition. Survey sites in these remnants have *Lomandra multiflora* subsp. *dura* or *L. effusa* as overstorey dominants, contain a high percentage of 'grassy habitat' species and are in the area of existing or pre-European mapping of native grassland. However, the proportion of this area which fits the definition of the ecological community or meets the criteria for the EPBC listed community is uncertain. Condition Class ratings for some sites can be deduced from the survey data, but most sites and mapped polygons require field assessment to determine their Condition Class ratings and extent.

A further 4,725 ha of mapped grassland are rated as medium confidence of being the Iron-grass Natural Temperate Grassland ecological community. These have *Lomandra* species as understorey dominants, with tree and shrub cover likely to be less than 10%. The remaining 3,325 ha have *Lomandra* species as understorey dominants but tree and shrub cover is likely to be more than 10% and hence these are rated as low confidence of being Iron-grass Natural Temperate Grassland.

The distribution of mapped Iron-grass Natural Temperate Grassland remnants across different land tenures is summarized in Table 2. More than 95% of the identified area of potential Iron-grass Natural Temperate Grassland is on privately owned and privately managed land.

Table 2: Estimated areas of Iron-grass Natural Temperate Grassland under different land tenure and protection[1].

Confidence Level[2]	Protected Areas		Areas not Formally Protected	
	Public Land[3]	Private Land[4]	Public Land[5]	Private Land[6]
High	567 ha	43 ha	457 ha	18,222 ha
Medium		95 ha	17 ha	4,613 ha
Low	0.2 ha	73 ha	128 ha	3,124 ha

Notes
1 Based on the desk-top assessment of existing survey sites and floristic vegetation mapping polygons. Includes native grassland remnants rated as High, Medium or Low confidence of fitting the definition for the EPBC listed ecological community, within the general distribution area for the ecological community.
2 Confidence that the vegetation at a survey site or in a floristic vegetation mapping polygon meets the general definition for Iron-grass Natural Temperate Grassland as in EPBC Act Policy Statement 3.7 (Australian Government 2007), irrespective of current Condition Class. The confidence categories are defined in Appendix 6.
3 Protected as a park or reserve under the NPW Act.
4 Protected in perpetuity by a Heritage Agreement covenant under the NV Act.
5 Includes Crown Land assigned to various State or Australian Government Departments, Corporations, and Local Governments, not protected under the NPW Act or by a Heritage Agreement covenant under the NV Act.
6 Private freehold and leasehold land, including private Sanctuaries declared under the NPW Act but not formally protected by a Heritage Agreement covenant under the NV Act.

Furthering Knowledge of Distribution and Condition

Iron-grass Natural Temperate Grassland is under-represented in current vegetation surveys and mapping. Increased survey effort is needed to improve knowledge of its current distribution and condition.

Native grasslands are difficult to distinguish from sown and naturalised exotic pastures in the 1 to 40,000 scale colour aerial photographs used for survey site selection and vegetation mapping. Interpretation of aerial photographs is confounded by the high component of exotic annual grasses in most native grassland remnants; the dry condition of most herbaceous vegetation when the photographs are taken (late summer); and the lack of structural detail discernable from the altitude the photographs are taken. Ground checking with 'drive-by' surveys is limited by the lack of public road access to most areas with native grassland remnants.

Remote sensing techniques have been suggested as an alternative tool for mapping grassland communities (Playfair and Heard 1995). A feasibility study of options for mapping Iron-grass Natural Temperate Grassland found that multi-spectral analysis of satellite imagery is unlikely to be effective and that hyper-spectral imagery analysis may be useful, but is cost-prohibitive to trial (A. Duffy, pers. comm.).

Predictive vegetation mapping can be used to model the natural occurrence of Iron-grass Natural Temperate Grassland, helping to inform selection of survey sites and target future survey effort. DENR has developed a predictive vegetation model for the N&Y and AMLR NRM regions, based on floristic associations and physical parameters (Rogers in prep.). Field surveys are needed to test, verify and further develop the model.

In the short term (i.e. the next ten years), improved knowledge on the location, area and condition of Iron-grass Natural Temperate Grassland remnants will continue to rely mainly on site-based surveys and other information from a range of sources, including targeted surveys, land owners and managers, local grassland experts, and site assessments for development proposals, environmental stewardship programs and NRM

on-ground works activities. Targeted surveys should prioritise and focus on areas at risk of development and land use change.

To make best use of future survey effort, new information and existing data, it is vital that:

- site assessors use a consistent, agreed survey methodology;
- data are recorded in a form compatible with the GIS database already developed by DENR for Iron-grass Natural Temperate Grassland;
- adequate resources are available to maintain and regularly update the GIS database;
- polygons requiring ground-truthing are targeted for field assessment;
- site surveys are used to ground-truth the predictive model;
- updated information on the distribution and condition of Iron-grass Natural Temperate Grassland remnants is provided back to land owners and managers, site assessors and other stakeholders; and
- updated mapping information is provided to the Australian Government for environmental reporting, assessment and compliance.

Past Distribution

Specht (1972) mapped the natural distribution of vegetation communities in South Australia, based on geology and soil maps and historical records of explorers, land surveyors and botanists. He identified *Lomandra* species tussock grassland as occurring in the higher altitude areas of the Mid North, from Clare north to Burra, Terowie, Jamestown and further north beyond Orroroo. Specht (1972) noted that the community extended into the broad valleys between the hills, where density of *Lomandra* species declined and native grasses were more prominent.

More detailed pre-European vegetation mapping of the Mid North of South Australia by Croft (2008) shows additional areas of *L. multiflora* subsp. *dura* +/- *L. effusa* Open Tussock Grassland further south to near Mallala, Freeling, and Eudunda and along the Hummocks and Nantawarra ranges. Croft notes that in the southern areas of the Mid North *L. effusa* Open Tussock Grassland tended to occur on the higher hill slopes onto the hill crests, while *L. multiflora* subsp. *dura* +/- *L. effusa* Open Tussock Grassland tended to occur on the lower slopes. The *L. multiflora* subsp. *dura* +/- *L. effusa* Open Tussock Grassland community extended further north, but with some zonation of the two *Lomandra* species in this community: *L. effusa* was more common on the higher hill slopes onto the hill crests and *L. multiflora* subsp. *dura* more prominent on the lower slopes. While the community occurred predominantly on stonier ground, it also extended onto the deeper soils of the broad valley floors, where it graded into tussock grasslands dominated by perennial grass species (Croft 2008). Pre-European vegetation mapping for other areas of the distribution range is under way but has not been completed.

Hyde (1998) reported that extensive grasslands with emergent trees originally occurred in the Strathalbyn district of the Fleurieu Peninsula, with grasslands dominated by *L. effusa* and *Lepidosperma viscidum* on the hill slopes. Some areas along the eastern flanks of the Mt. Lofty Ranges which Specht (1972) mapped as *Allocasuarina verticillata* woodland were probably *L. effusa* dominated tussock grassland with emergent trees (Hyde 1995). Hyde (1995) also described a *Lomandra multiflora*/Tussock Grass Complex which extended beyond Specht's distribution for *Lomandra* spp. tussock grassland. Hyde reported that the *Lomandra multiflora*/Tussock Grass Complex also occurred on the western foot slopes of the Mount Lofty Ranges onto the Adelaide Plains and speculated it may have been present in the Cleve and Koppio Hills of Eyre Peninsula and the Lower South East. However, these additional locations are difficult to interpret, as Hyde's *Lomandra multiflora*/Tussock Grass Complex included some woodland

communities with a *L. multiflora* subsp. *dura* dominated understorey, and some grasslands without *L. multiflora* subsp. *dura* present.

Historical Factors Influencing Current Distribution

Many Iron-grass Natural Temperate Grassland remnants have been used for sheep grazing since the early days of European settlement and their botanical composition has been substantially altered, with perennial native grasses and forbs largely replaced by introduced annual grasses and other weeds (Specht 1972; Playfair and Heard 1995). Fertiliser application to promote pasture growth favoured introduced annual species, further changing the species composition in some areas. The tendency in traditional 'set stocking' grazing regimes for sheep to congregate and camp on the high areas of paddocks means that many of the highest areas in paddocks no longer support Iron-grass Natural Temperate Grassland.

While livestock grazing has impacted mainly on the condition of Iron-grass Natural Temperate Grassland, the progressive development of land for cropping has substantially reduced the area of the ecological community. Ploughing of Iron-grass Natural Temperate Grassland on the arable lower slopes and plains cleared the ecological community from the deeper soils and less rocky areas. Once cleared, these areas have generally been maintained for cropping and sown pastures, and Iron-grasses have been prevented from regenerating.

Hence, while Iron-grass Natural Temperate Grassland was once widespread in the landscape, it is now confined mainly to steeper slopes, rocky ridges and rocky areas in arable paddocks. Remnants in the Lofty Block Bioregion generally follow the north-south pattern of alignment of the hills and ranges. Remnant patches vary in size from less than 1 ha to large blocks of 100 ha or more, but the condition and ecological integrity within remnants can vary considerably. Remnants are generally fragmented and isolated from each other by areas of arable cropping land or pasture dominated by introduced species.

Structure and Species Composition

Iron-grass Natural Temperate Grassland of South Australia is the only recognised natural temperate grassland community dominated by tussock-forming species that are not true grasses (Carter *et al.* 2003). Although various *Lomandra* species occur in native grasslands of temperate Australia, South Australia is the only State or Territory where they occur at sufficient density to form a dominant stratum. Stiff Iron-grass (*Lomandra multiflora* subsp. *dura*) is endemic to South Australia, while Scented Iron-grass (*Lomandra effusa)* occurs throughout the southern temperate zone from Western Australia through South Australia to western New South Wales and Victoria.

Iron-grasses (*Lomandra* species) are members of the Lily family (Liliaceae) (Barker *et al*. 2005), sometimes classified separately with Grass-trees (Xanthorrhoeaceae) (Threatened Species Scientific Committee 2007; Ross and Walsh 2003) or in their own family (Lomandraceae) (Harden 1993). However, the community has strong ecological, structural and floristic affinities with other natural temperate grassland communities (Carter *et al.* 2003). Native perennial tussock grasses (Poaceae) generally occur with the Iron-grasses and may be co-dominant. Many of the other native herbaceous species of Iron-grass Natural Temperate Grassland are common to and characteristic of other natural temperate grassland communities in South Australia and elsewhere in south-eastern Australia (Eddy *et al*. 1998; Lunt *et al*. 1998; Robertson 1998; Carter *et al*. 2003). Some of these herbaceous species occur predominantly or exclusively in grassy ecosystems and are regarded as 'grassland specialists' (Specht 1972; Davies 1997; Robertson 1998).

More detailed information on the structure and floristic composition of Iron-grass Natural Temperate Grassland is presented in Appendix 5.

The native plants most commonly recorded in Biological Surveys of Iron-grass Natural Temperate Grassland (BDBSA 2010) are listed in Appendix 6.

Characteristic Flora

The native plant species composition of Iron-grass Natural Temperate Grassland is very similar to other grassy communities throughout the Lofty Block bioregion (Robertson 1998). Characteristic species of different grassland and grassy woodland communities may have become rare or locally extinct (Robertson 1998) due to selective grazing, trampling or suppressed regeneration, so these species are not readily identified in floristic analyses. The most characteristic vegetative feature of the ecological community is the dominance of *L. multiflora* subsp. *dura* and *L. effusa.*

Fauna

Native fauna are an integral component of the Iron-grass Natural Temperate Grassland ecological community. Mammals, birds, reptiles, insects, spiders and other invertebrates drive or influence essential ecological processes of the grassland, including biomass reduction, nutrient recycling, soil structure, water infiltration and run-off, pollination, plant dispersal, flora and fauna species composition, habitat availability and distribution of species within and between remnants. Some native fauna of the ecological community, including kangaroos, emus and grasshoppers, occasionally become over-abundant and may have an impact either on Iron-grass Natural Temperate Grassland remnants or in adjoining areas. Few fauna surveys have been done in Iron-grass Natural Temperate Grassland, and some fauna groups, such as the invertebrates, are difficult to observe, sample and identify. Further work is needed to identify characteristic and functionally important fauna species of the ecological community.

Detailed information on mammals, birds, reptiles and macro-invertebrates of Iron-grass Natural Temperate Grassland, based on biological surveys of *Lomandra multiflora* subsp. *dura* Open Tussock Grassland and *Lomandra effusa* Open Tussock Grassland in the Mid North (Brandle 2008a and 2008b; Hyde 2000; Neagle 2008a and 2008b; Queale and Neagle 2008) is summarised in Appendix 7.

Threatened Species

Threatened Flora

Seventeen plant species recorded in Iron-grass Natural Temperate Grassland have conservation ratings at the National or State levels (Table 3). Spiny Everlasting (*Acanthocladium dockeri*), Coloured Spider-orchid (*Caladenia colorata*) and Trailing Hop-bush (*Dodonaea procumbens*) are the only EPBC Act listed plant species currently recorded in the ecological community.

Threatened Fauna

The Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) and Flinders Worm Lizard (*Aprasia pseudopulchella*) are the only EPBC Act listed fauna species currently recorded in the ecological community. The EPBC Act listed Plains-wanderer (*Pedionomus torquatus*) is considered likely to occur in the ecological community, but there are no confirmed records to date. The state vulnerable Australian Bustard (*Ardeotis australis*) and White-spot Skipper (*Trapezites luteus*) have also been recorded in Iron-grass Natural Temperate Grassland. *Trapezites luteus* is considered vulnerable in South Australia (Grund 2002 & 2009) although there is no formal listing process for state threatened invertebrates. Further information on these species is contained in Table 3 and Appendix 7.

Regionally Threatened Species

For information on the status, trends and prioritisation of flora and fauna species at the regional scale, see Gillam and Urban (2008 & 2010); Gillam (2009a & 2009b); and Willson and Bignall (2009).

Other Communities Resembling the Listed Ecological Community

Derived Grasslands

Iron-grass-dominated grasslands thought to be derived from degraded grassy woodlands also occur in the general distribution range of Iron-grass Natural Temperate Grassland (T. Croft pers. comm.). These derived grasslands can be difficult to distinguish from natural Iron-grass grasslands. Woodlands previously dominated by *Allocasuarina verticillata*, *Eucalyptus leucoxylon* subsp. *pruinosa*, *E. odorata* or *E. porosa* can resemble *Lomandra* tussock grasslands if the trees have been removed or declined and failed to regenerate, and *Lomandra* has become the dominant stratum. Given the close floristic similarities between grassy ecosystems in the Lofty Block bioregion (Robertson 1998) it would be difficult to separate these derived grasslands from the Iron-grass Natural Temperate Grassland ecological community without evidence such as tree stumps or fallen dead trees at woodland densities. Unless there is strong evidence of being a degraded woodland, derived Iron-grass grasslands in the general distribution range of the listed ecological community that meet the criteria for the EPBC Act listed ecological community should be considered part of the listed community and protected under the EPBC Act.

Other Ecological Communities

There are other floristic vegetation communities in South Australia that resemble Iron-grass Natural Temperate Grassland ecological community. The following floristic vegetation groups do not meet the criteria for the Iron-grass Natural Temperate Grassland of South Australia ecological community, because either the *Lomandra* species are not a dominant component of the perennial tussock stratum; the grassland is dominated by *Triodia* species; the vegetation is part of a degraded woodland community outside the currently accepted range of Iron-grass Natural Temperate Grassland; the environment is a coastal area with saline influences; or the grassland is not in the temperate climate zone:

- Tussock Grassland where *Lomandra multiflora* subsp. *dura* and/or *Lomandra effusa* are present but not a dominant or characteristic component of the perennial tussock stratum;
- Hummock Grassland with *Lomandra multiflora* subsp. dura and/or *Lomandra effusa* present;
- *Lomandra effusa* tussock grassland derived from degraded woodland communities outside the natural distribution range of Iron-grass Natural Temperate Grassland;
- *Lomandra effusa* Tussock Grassland in coastal areas where the floristic composition is influenced by coastal processes (e.g. salt spray and saline soils); and
- *Lomandra effusa* Tussock Grassland in the arid climate zone in which the floristic composition has arid affinities.

Table 3: Threatened species occurring in, or associated with, Iron-grass Natural Temperate Grassland of South Australia.

Species	Common Name	EPBC Act	SA NPW Act	Existing Recovery Plan
Flora				
Acanthocladium dockeri	Spiny Everlasting	CE	E	Draft & EPBC Act conservation advice
Austrodanthonia tenuior	Short-awn Wallaby-grass		R	
Austrostipa gibbosa			R	
Austrostipa pilata	Prickly Spear-grass		V	
Caladenia colorata	Coloured Spider-orchid	E	E	Draft in preparation
Cryptandra campanulata (syn. *C.* sp. 'Long hypanthium' (C.R. Alcock 10626))	Long-flower Cryptandra		R	
Cullen parvum	Small Scurf-pea	De-listed	V	Part range only (AMLR[1])
Dianella longifolia var. *grandis*	Pale Flax-lily		R	Part range only (AMLR[1])
Dodonaea procumbens	Trailing Hop-bush	V	V	Yes
Eryngium ovinum (syn. *E. rostratum*)	Blue Devil		V	
Maireana excavate	Bottle Fissure-plant		V	
Maireana rohrlachii	Rohrlach's Bluebush		R	
Ptilotus erubescens	Hairy-tails		R	
Rumex dumosa	Wiry Dock		R	
Swainsona behriana	Behr's Swainson-pea		V	
Swainsona fuscoviridis			R	
Thysanotus tenellus	Grassy Fringe-lily		R	
Fauna				
Aprasia pseudopulchella	Flinders Ranges Worm-lizard	V	De-listed	Part range only (AMLR[1]); EPBC Act conservation advice
Ardeotis australis	Australian Bustard		V	
Pedionomus torquatus	Plains-wanderer	V	E	Draft in preparation
Tiliqua adelaidensis	Pygmy Bluetongue Lizard	E	E	Yes

Notes

Includes species listed under the Commonwealth EPBC Act and the South Australian NPW Act.
1 AMLR refers to the Adelaide and Mount Lofty Ranges Regional Recovery Plan (Willson and Bignall 2009); the AMLR plan only addresses the recovery of species within the AMLR region as defined in that plan.

CE = Critically Endangered, E = Endangered, V = Vulnerable, R = Rare, (in descending order of threat status).

Part C Conservation Status, Protection, and Recovery Opportunities

Conservation Status

National Conservation Status:

The Iron-grass Natural Temperate Grassland of South Australia ecological community is listed nationally as Critically Endangered, under the EPBC Act. The listing encompasses two closely related natural temperate grassland communities which occur only in South Australia, the *Lomandra multiflora* subsp. *dura*, +/- *Lomandra effusa* Tussock Grassland; and *Lomandra effusa* Tussock Grassland.

South Australian Conservation Status:

South Australian legislation has no provision for officially rating and listing threatened ecological communities. However, the *Lomandra multiflora* subsp. *dura* Tussock Grassland and *Lomandra effusa* Tussock Grassland ecosystems are recognised as Endangered in a provisional list of threatened ecosystems of South Australia (Department for Environment and Heritage 2005), and are protected under provisions of the *Native Vegetation Act 1991* and associated Regulations.

Legislative Protection

Australian Government Legislation:

Under the provisions of the EPBC Act, any action likely to have a significant impact on the nationally listed ecological community, or a nationally listed plant or animal species occurring in the ecological community, must be referred to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, for assessment and approval before the proposed action is taken.

South Australian Government Legislation:

South Australian Acts of Parliament most relevant to the protection and management of Iron-grass Natural Temperate Grassland of South Australia are the *Native Vegetation Act* 1991 and the *National Parks and Wildlife Act 1972*.

The ***Native Vegetation Act 1991*** (NV Act) regulates the removal of native vegetation and prohibits broad-scale clearance. It also provides for 'in perpetuity' protection of native vegetation and associated wildlife, through conservation covenants called Heritage Agreements.

Activities permitted by the *Native Vegetation Regulations 2003* under the NV Act could impact on remnants of the Iron-grass Natural Temperate Grassland ecological community, and therefore should still be assessed under the provisions of the EPBC Act. Conversely, areas of Iron-grass grassland that do not meet the criteria for the nationally listed ecological community may still be protected from clearance under the NV Act.

The ***National Parks and Wildlife Act 1972*** (NPW Act) provides for protection and management of natural habitats and wildlife species, through establishment of parks and reserves, development of plans for their management, protection of native plant and animal species within protected areas, and the listing of State threatened species. Areas of Iron-grass Natural Temperate Grassland within NPW Act parks and reserves are protected under the NPW Act. Some plant and animal species which occur within Iron-grass Grassland are listed as threatened species under this Act.

Further information on South Australian legislation relevant to the conservation, management and protection of Iron-grass Natural Temperate Grassland of South Australia is provided in Appendix 1.

Nationally and State listed threatened species associated with Iron-grass Natural Temperate Grassland of South Australia are listed in Table 3.

Protected Areas

Conservation Parks

Three Conservation Parks protect areas of the Iron-grass Natural Temperate Grassland of South Australia.

Mokota Conservation Park is a 455 ha reserve 15 km north east of Burra and was dedicated in October 2000 to conserve temperate native grasslands (Department for Environment and Heritage 2003). Approximately 334 ha of the Park have been mapped as *Lomandra multiflora* subsp. *dura* Tussock Grassland of varying condition (Hyde 2000; BDBSA 2010). Several survey, monitoring and reference sites in the Park meet the criteria for Condition Class A or B, but the overall proportion of grassland in Mokota Conservation Park that meets the criteria for the EPBC Act listed Iron-grass Natural Temperate Grassland ecological community has not been assessed.

Poonthie Ruwe-Riverdale Conservation Park is a 240.9 ha reserve 5 km south east of Tailem Bend, proclaimed in January 2003 to protect temperate native grasslands (Department for Environment and Heritage 2007). The park contains 227 ha of *Lomandra effusa* Tussock Grassland, including patches that meet the Condition Class criteria for the nationally listed ecological community. Grassland areas in the Park may be derived from *Callitris gracilis* woodlands logged early after European settlement (Department for Environment and Heritage 2003; Hyde 1995) but this has not been verified and documented. The proportion of *Lomandra effusa* Tussock Grassland in Poonthie Ruwe-Riverdale Conservation Park that meets the criteria for the EPBC Act listed Iron-grass Natural Temperate Grassland has not been assessed.

Caroona Creek Conservation Park is a 4,536 ha reserve 30 km north east of Burra yet to be formally proclaimed. The Park covers an extensive landscape area spanning semi-arid and temperate woodlands, shrublands and grasslands. The Paradise Block of the Park includes at least 4.5 ha of *Lomandra* Tussock Grassland. This area has not been assessed for Condition Class. The Tooralie Gorge Block may also include Iron-grass Natural Temperate Grassland remnants but is yet to be surveyed and mapped in detail.

A desk-top assessment of survey and mapping data identified two other Conservation Parks that may contain remnants of Iron-grass Natural Temperate Grassland: **Red Banks Conservation Park** 12 km east of Burra, and **Black Rock Conservation Park** 19 km east-north-east of Orroroo. However, due to the lack of documented survey sites and floristic mapping in these areas, field surveys are required to determine the composition, extent and condition of native grasslands in these Parks.

Heritage Agreements

Iron-grass Natural Temperate Grassland remnants on private properties and Crown lands can be protected voluntarily with Heritage Agreements. A Heritage Agreement formally protects the indigenous plants and animals within an area of vegetation defined and registered on the land title or parcel details.

Fourteen private Heritage Agreements contain and protect remnants of *Lomandra multiflora* subsp. *dura* Tussock Grassland or *Lomandra effusa* Tussock Grassland. The total area of Iron-grass Natural Temperate Grassland identified in these Heritage Agreements is 210.4 ha, with patch sizes varying from 0.2 ha to 41 ha (average patch size 15 ha). The proportion of these Iron-grass Natural Temperate Grassland remnants that meets the criteria for the EPBC Act listed ecological community has not been assessed.

Callington Hill Native Grassland Flora Reserve is an 11 ha Council-owned reserve 2.5 km east of Callington, established in 2002 to protect *Lomandra effusa* Tussock Grassland vegetation. The Rural City of Murray Bridge and the Bremer-Barker Catchment Group formed a partnership to acquire the land. The reserve is managed by a local Landcare group and an application is underway to formally protect the vegetation and associated wildlife with a Heritage Agreement.

A further three applications are underway for Heritage Agreements to protect areas of *Lomandra multiflora* subsp. *dura* Tussock Grassland. Two remnants are on private land and one is in a portion of a Crown Land reserve. There may be other applications in process for land parcels that include Iron-grass Natural Temperate Grassland remnants.

Sanctuaries

Iron-grass Natural Temperate Grassland remnants outside of NPW Act reserves can also be voluntarily protected under the NPW Act, through declaration as a Sanctuary for conservation of natural habitat and protection of native animals and plants. Sanctuaries are not binding 'in perpetuity' agreements and are not part of the Protected Areas network.

Recovery Opportunities

The Iron-grass Natural Temperate Grassland ecological community is currently listed as Critically Endangered, based on the following criteria:

- The ecological community has suffered a likely decline in extent of greater than 95%, based on estimates of the pre-European extent and current extent;
- The ecological community has a restricted distribution and is subject to ongoing threats, the impact of which may eliminate it in the medium-term future; and
- Without active intervention, the degree of reduction in community integrity of remaining examples makes regeneration unlikely in the medium-term future.

Given the modified agricultural landscape in which the Iron-grass Natural Temperate Grassland now occurs, the small size of many remnant patches, and the high level of past clearance and fragmentation, it is unlikely that the severe decline in extent of the ecological community could be substantially reversed through recovery actions. To change the national threat rating from Critically Endangered to Endangered (i.e. to more than 5% of the original area) would require more than a seven-fold increase (i.e. more than 32,000 ha) in the current estimated area of the ecological community in Condition Classes A and B.

Broad-scale re-establishment of the ecological community where it once occurred is not feasible or practical, due to changed conditions at cleared sites, including altered soil structure, nutrients and chemistry, depletion of native plant species from soil seed banks, and loss of soil-dwelling native fauna, fungi and micro-organisms. However, opportunities exist to improve the long-term viability of the Iron-grass Natural Temperate Grassland ecological community. Priorities focus on improving the condition and integrity of existing areas; halting further decline in extent and integrity; and where possible, restoring recoverable degraded areas so they meet the condition criteria for the listed ecological community. Opportunities also exist to increase conservation outcomes for Iron-grass Natural Temporal Grassland ecological community by linking with other threatened species and ecological community recovery plans and programs including Cape Borda to Barossa NatureLinks and the recovery programs for the Peppermint Box Grassy Woodland, Pygmy Bluetongue Lizard, Coloured Spider-orchid, Trailing Hop-bush and the Spiny Daisy.

Most remaining areas of Iron-grass Natural Temperate Grassland are on private agricultural land used for livestock grazing. These areas are often highly modified and

many are likely to fit within Condition Class C of the ecological community (A. Brown and J. Reseigh, pers. comm.). Condition Class C remnants offer the best opportunity to increase the area of occupancy of the ecological community but are not formally protected by the EPBC Act. Recovery of the Iron-grass Natural Temperate Grassland of South Australia will depend on ensuring that Condition Class C areas are retained, and that interested and willing land owners and managers are supported in adopting grazing management and other practices that protect and restore these areas.

Habitat Critical to Survival

Current knowledge indicates that less than 5% of the Iron-grass Natural Temperate Grassland that existed at the time of European settlement remains. These remnants are highly fragmented and isolated across the natural distribution range; many remnants are degraded and in lower condition states. It is likely that less than 1% of the original area remains in a moderate to high level of ecological integrity.

Iron-grass Natural Temperate Grassland of South Australia is rated nationally as Critically Endangered. Given the small area remaining, all sites that meet the criteria for the listed community should be considered habitat critical to the survival of the ecological community.

From an ecological perspective, remnants of lower condition (Condition Class C) may also be habitat critical to survival of the ecological community, if they adjoin, buffer or connect high integrity remnants, provide habitat critical for functionally important or threatened species, expand the potential habitat available to some species, or have good potential for restoration.

Actions under Strategies 2, 3, 4 and 5 of this recovery plan (Table 5) provide the basis for surveying and assessing the condition of Iron-grass Natural Temperate Grassland remnants and ranking sites for their value and priority for conservation or restoration.

In addition to the criteria defining condition classes under the EPBC Act listing, the following attributes should be considered when assessing the significance of remnants and assigning priorities for their protection. They will be useful in evaluating habitat critical to survival of the Iron-grass Natural Temperate Grassland ecological community, including Condition Class C remnants.

- moderate to high native plant species diversity in the remnant as a whole;
- presence of different age cohorts of *Lomandra multiflora* subsp. *dura* and/or *L. effusa*, including on-going regeneration and recruitment;
- presence of different vegetation strata within the grassland;
- native fauna species diversity;
- presence of grassland fauna habitats;
- presence and condition of the microphytic crust;
- variations in grassland structure, including open spaces and bare patches;
- presence of one or more listed threatened species;
- presence of grazing-sensitive species;
- remnant size and shape;
- connectivity with other remnants of the ecological community and/or remnants of other ecological communities;
- low weed density, species diversity and/or limited distribution in remnants; and
- potential for restoration.

Specific benchmarks for these attributes are yet to be determined for the ecological community.

Part D Land Use History and Management

Current Land Use and Management

Most remaining areas of Iron-grass grassland in South Australia are on private land managed for agricultural production. Historical clearance for agricultural development significantly reduced the original extent of Iron-grass Natural Temperate Grassland in South Australia, particularly on arable lower slopes and flats. Uncleared remnants are generally confined to steep or rocky areas unsuitable for cultivation, or are on properties such as sheep or cattle studs, where grazing has been the main long-term enterprise. These remnants have usually had a long history of regular stock grazing dating back to pastoral and agricultural settlement in the 1850s to 1870s. Species composition and condition of these remnants has been modified to varying degrees, depending on stock types and grazing regimes, introduction of alien pasture species, and whether fertilizers, particularly phosphate, have been applied.

Continuation of appropriate livestock grazing is one of the main tools available for long-term management, maintenance and protection of the ecological community. Studies in native grasslands in the Mid North of South Australia indicate that management practices such as low intensity grazing and time-managed rotational grazing can help maintain or improve the condition, structure and habitat values of grassland remnants whilst also benefiting agricultural production (Earl and Kahn 2003). Complete exclusion of stock after a long history of grazing can be detrimental to native grasslands and depending on the grassland species composition and condition, can lead to dominance by introduced annual grasses and other weeds.

Natural grassland communities are adapted to regular disturbance by herbivore grazing and fire (Curry 1994). Introduced livestock have largely replaced native herbivores in the landscape, especially small mammals and invertebrates. Stock grazing in Iron-grass grasslands could be actively managed to provide some of the essential ecosystem functions previously controlled by the native herbivores, including timely reduction of dry biomass from native tussocks, nutrient recycling and redistribution, seed dispersal and maintenance of structural complexity such as inter-tussock spaces, patchiness of species distribution and different growth stages of plants in the grassland. Stock can also be managed to reduce the impacts of introduced pasture species and some weeds, by controlling biomass and reducing seed production.

However, as Iron-grass Natural Temperate Grassland occurs predominantly on agricultural land, incompatible agricultural uses or inappropriate management practices also have potential for significant impact on the survival and persistence of the ecological community. The main management practices or changes in agricultural land use likely to have a detrimental impact in Iron-grass grasslands include high intensity set-stocked grazing regimes; cultivation for cropping; aerial seeding of introduced pasture species; soil disturbance for weed or vertebrate pest control; application of fertilizers, soil ameliorants and agricultural chemicals; incompatible new agricultural industries; and other intensified activities (Table 4).

Tussock grasslands, including Iron-grass Natural Temperate Grassland, are natural habitat of the Australian plague locust and other native grasshopper species that sometimes reach plague numbers (Department of Agriculture, Fisheries and Forestry 2009a). In favourable seasons populations of these species can cause significant damage and economic loss to agricultural and horticultural crops (Department of Agriculture, Fisheries and Forestry 2009b) and require management to minimise their economic impact. However, some control methods for the Australian plague locust and grasshoppers have potential for adverse impact on native fauna, either through direct contact with pesticides, or indirectly via the food chain (e.g. Fildes 2008). Off-target impacts on fauna of the Iron-grass Natural Temperate Grassland ecological

community should be considered and addressed in control programs for locust and grasshopper plagues.

Best Practice Management

Active, adaptive management will be a key strategy for long-term persistence and conservation of the Iron-grass Natural Temperate Grassland ecological community, regardless of land tenure, land uses or protection mechanisms in place at individual sites. Existing 'best practice' guidelines for temperate native grasslands in south-eastern Australia provide general information relevant to conservation and management of Iron-grass Natural Temperate Grassland remnants (e.g. Ross 1999; Eddy 2002; Sharp *et al*. 2005; Dorrough *et al*. 2008), but site-based research, trials and monitoring are needed to develop specific strategies for recovering the ecological community.

Management tools such as livestock grazing, slashing, fire and herbicides all influence, and can be used to manage, native and exotic plant biomass, vegetation structure, habitat features and diversity of native plants and animals in Iron-grass grasslands.

Livestock grazing has been identified as a vital tool for restoration of degraded grazed grasslands (Papanastasis, 2009). Field trials have found that different grazing strategies can be used to manipulate the perennial native grass component of native pastures (Earl and Kahn 2003; Bowman *et al.* 2009), and variations in grazing regimes, such as rest periods, can benefit native invertebrate diversity and soil processes (Dorrough *et al*. 2004). Cessation of long-term grazing in a large Iron-grass grassland remnant produced little change in native and exotic plant species diversity and grassland structure up to 10 years after livestock were removed, although abundance of some native species declined slightly (Robertson 2009). Adaptive management trials comparing grazing with burning in the same Iron-grass grassland found that either treatment had a short term (1-2 years) influence on vegetation composition and biomass, but these changes were not sustained over the medium term (6 years) (Reseigh and Foster undated). Over short time-frames seasonal and climatic variations may have a greater influence than management on species composition and structure of native grasslands (M. Robertson, pers. comm.).

Fire in previously grazed grasslands can, in some cases, result in rapid invasion by exotic plant species (Lunt and Morgan, 1999). However, a combination of fire and livestock grazing may be more effective than grazing alone, in reducing weed cover and enhancing native plant cover (Dorrough *et al*. 2004), and restoring natural disturbance patterns, structural heterogeneity and species diversity in grasslands (Fuhlendorf *et al*. 2008). Grass-specific herbicides show potential in broadacre control of exotic annual grasses in native grasslands (Davies 1997) and carefully timed slashing can significantly reduce the cover of exotic annual grasses and some exotic perennial forbs (Davies 1997), but the value of these approaches in Iron-grass grasslands needs testing.

Use of all of these management tools, separately or in combination, in Iron-grass Natural Temperate Grassland needs further investigation. Management requirements at the site level will vary depending on current land use, management history, species composition, site condition, disturbances and threats, management goals, climate and the physical environment. Strategies for maintaining and improving condition and integrity of Iron-grass Natural Temperate Grassland remnants need to be tested and monitored against suitable benchmarks for the ecological community.

Development of 'best practice' management guidelines for the ecological community should be based on research and monitoring across a range of Iron-grass grassland sites with different land uses, site histories and management regimes. In addition, this research and monitoring needs to:

- be funded and run over longer time-frames (10+ years) so that long-term trends and changes due to management can be detected;
- be undertaken in close collaboration with private and public land owners and managers and utilise their local knowledge and experience as well as their land and time resources;
- include partnerships between researchers, NRM Boards, funding bodies, agricultural production advisers, communications and extension specialists;
- fund changes in infrastructure and management which impact on the production and economic outcomes of participating land owners and managers;
- identify indicators and long-term monitoring strategies for the ecological community which land owners/managers and others can use; and
- link with and have input into GIS databases for site surveys, Condition Class assessments and mapping of the ecological community.

Recovery Action to Date

Prior to this recovery plan there has been no formal, coordinated recovery program for the Iron-grass Natural Temperate Grassland ecological community.

An initial workshop of stakeholder group representatives held in November 2007 identified known threats to the ecological community, potential recovery actions, mapping needs and communication and engagement issues. A workshop of field experts in 2009 identified important ecological attributes and habitat features of the ecological community, and areas at risk of land-use change and development. Ideas and information from both workshops have been incorporated into this recovery plan.

Since the listing of this ecological community under the EPBC Act in 2007, the following recovery actions have been implemented:

- awareness raising with land owners, land managers and the general public;
- training and information kits for extension advisors, native vegetation assessors and consultants in recognising the ecological community, understanding the EPBC Act implications and assessing the Condition Class of remnants;
- Condition Class reference sites established for training, bench-marking and long-term monitoring;
- Development of the *State and transition model for the Iron-grass (Lomandra effusa) natural temperate grassland community* (Prescott et al. 2010); and
- GIS survey database and mapping layers developed for Iron-grass Natural Temperate Grassland; distribution maps revised; data collection sheets developed for surveys and site assessments of the ecological community; and field surveys to help fill knowledge gaps on the distribution and condition of Iron-grass Natural Temperate Grassland.

Over the past 12 years, native grasslands extension programs, on-ground works and environmental stewardship funding have provided general support for recovery of Iron-grass Natural Temperate Grassland, through a range of activities including:

- awareness raising with land owners and managers and the general public;
- development and distribution of extension materials;
- training in grassland plant identification and 'best practice' grazing management;
- research and farmer trials of grazing management systems;
- financial support for adoption of rotational grazing and other conservation management strategies; and

- protection of high quality native grassland remnants through management agreements.

In 2011, Greening Australia commenced a series of Conservation Action Planning (CAP) workshops for the Mid-North of South Australia, in consultation with interested organisations and agencies. The assets within, and threats to, Iron-grass Natural Temperate Grassland and other ecosystems within the region are being discussed, and strategies for integrated conservation are being devised.

Organisations and groups involved in these earlier and current activities include DENR, World Wide Fund for Nature, the former Threatened Species Network, Mid North Grasslands Working Group, Native Grass Resources Group, Nature Conservation Society of SA, Eastern Hills and Murray Plains Catchment Group, Greening Australia SA, Rural Solutions SA, the Upper North Farming Systems Group, the Northern and Yorke, SA Murray Darling Basin and Adelaide-Mt Lofty Ranges NRM Boards and their precursor Integrated NRM Committees, and local landholders.

In line with Davies (1982) recommendations, two large land parcels were acquired by the South Australian Government in the past decade and dedicated as reserves for the conservation of *Lomandra multiflora* subsp. *dura* Tussock Grassland (Mokota Conservation Park) and *Lomandra effusa* Tussock Grassland (Poonthie Ruwe-Riverdale Conservation Park).

While the above activities have increased general awareness, knowledge and protection of Iron-grass Natural Temperate Grassland and supported management change in some remnants, it is not yet possible to tell how much they have contributed to recovery of the ecological community.

Environmental Stewardship Program

The Environmental Stewardship Program (ESP), part of the Australian Government's Caring for our Country initiative, aims to "maintain and improve the condition and extent of targeted high public value environmental assets on private land" (Australian Government 2008). Iron-grass Natural Temperate Grassland of South Australia is one of two nationally threatened South Australian endemic ecological communities targeted by the ESP's *Multiple Ecological Communities Project* in South Australia. Implementation of the project commenced in 2010 – 2011 and continued through 2011 – 2012, and provides market-based incentives for individuals and organisations that own or manage private land to undertake long-term protection and improvement of eligible Iron-grass Natural Temperate Grassland remnants. The ESP is working with SA-based delivery agents and land managers to implement management changes for long-term protection and recovery of the ecological community. Tender bids are assessed on the basis of conservation value and value for money. Funding contracts of up to 15 years duration provide the opportunity for longer term management to be undertaken.

The ESP is a major source of funding for implementing many of the on-ground recovery actions identified in this plan for private land. It will also contribute more broadly to the long-term recovery of the ecological community by improving knowledge of the location, size, condition and management of remnants. Monitoring the management changes and their outcomes at funded sites will help inform the development of 'best practice' adaptive management guidelines for Iron-grass Natural Temperate Grassland. It is recommended there be two-way sharing of survey, mapping and monitoring data between DENR, the ESP and other organisations involved in the delivery and implementation of recovery actions, to avoid duplication of effort and make best use of available resources.

Part E Known and Potential Threats

A wide range of factors currently threaten or have potential to impact on the Iron-grass Natural Temperate Grassland ecological community. The main threatening processes and their risks to the ecological community are summarized in Table 4.

Sources of threats with potential for major impact on the Iron-grass Natural Temperate Grassland of South Australia in the short to medium term are outlined below.

General lack of awareness and recognition of native grasslands as native vegetation:

- Lack of specific knowledge about the Iron-grass Natural Temperate Grassland ecological community, its appearance, significance and ecological values;
- Lack of awareness/knowledge of appropriate Iron-grass Natural Temperate Grassland management;
- View of native grasslands as low productivity, low value agricultural land requiring 'improvement'.

Changes in land use:

- Change of livestock species/breeds and stocking rates resulting in inappropriate grazing levels and disturbance;
- Intensification of activities (cropping in new areas, pasture improvement, hand-feeding or establishment of feed-lots, new water supply/dams for irrigation);
- New industries displacing the ecological community (horticulture, agroforestry, apiary, carbon sequestration programs, revegetation);
- Inappropriate chemical application (herbicides, fertilizers, soil ameliorants).

Weed invasion:

- Competition for resources (space, nutrient, water);
- Increased dominance of existing weeds species;
- Introduction of new weed species;
- Incompatible weed control techniques (cultivation, chemical, off-target damage);
- Inappropriate choice of species composition and density for revegetation.

Exotic animals and overabundant native species:

- Overgrazing of grassland flora by exotic and native herbivores;
- Predation of grassland fauna by exotic carnivores (foxes, cats);
- Spread of exotic weeds by animal vectors (foxes, starling);
- Soil disturbance and poisoning of native fauna from inappropriate exotic animal control (rabbit warren destruction, spraying of locust/grassland plague).

New infrastructures and developments:

- Land sub-division and development;
- Infrastructures for energy and water supplies (buildings, wind generator networks, transmission line poles, underground power cables, pipelines, dams, bores);
- Mineral exploration and extraction;
- New roads or upgrading of existing roads (widening, re-surfacing);
- Infrastructure development in non-arable areas (sheds, roads, storage facilities).

Fire

- Inappropriate or altered fire regimes;
- Lack of investigation/knowledge about grassland species response to fire;

- Inappropriate biomass management for fire prevention (slashing too frequently or too low to maintain and protect biodiversity assets);
- Damage to vegetation and soils from fire suppression activities (grading of fire breaks, vehicle access through remnants, application of chemical foam).

Ongoing ecological stresses due to past clearance, fragmentation and management changes:

- Incremental clearance and decline in condition of remnants;
- Isolation of remnant populations (barriers to dispersal, inbreeding, edge effects);
- Increased competition in remnant population (resources, mortality, loss of pollinators, loss of host plants or animals, disruption of critical life stages, vulnerability to stochastic events);
- Competition with new and existing weeds (see Appendix 8);
- Over-harvesting of native seeds from grassland remnants due to increased demands.

Climate change:

- Potential reduction in biomass production;
- Possible escalation of species stresses associated with a drying climate (increased competition for water and other resources, increased mortality, disruption to critical life stages, loss of pollinators, loss of host plants or animals);
- Social impacts on agricultural enterprises in lower rainfall areas (reduced management effort in INTG remnants to cut costs);
- Increased grazing intensity from failure to adapt 'best practice' grazing management strategy.

Key Areas Affected by Threats

Most of the threats identified above are not limited to specific locations or areas where the ecological community occurs, and have potential to impact on Iron-grass Natural Temperate Grassland remnants throughout the distribution range. The main areas in which Iron-grass Natural Temperate Grassland may occur are shown in Figure 1.

The impacts of climate change on the ecological community are likely to be more pronounced in the lower rainfall areas of the distribution range. Climate change is also more likely to impact on agricultural production, economics and options for land owners/managers in these areas. However, the effects of climate change on the ecological community are poorly known and strategies to minimise the potential impacts need to be investigated across the distribution range.

Wind farms, urban developments and other new infrastructure developments have more localised impacts. The ridgelines and higher slopes of hills and ranges in the Lofty Block Bioregion are target areas for wind energy generation. Several wind farms have already been developed in the Mid North Region, and further wind farms may be in the planning phases. Urban and peri-urban developments are most likely to occur and affect the ecological community in identified population growth areas such as smaller towns and adjoining areas in the Murray Bridge and Barossa Valley districts.

Table 4: Summary of threatening processes, associated issues and activities, risk to the ecological community and threat abatement options.

Threatening process	Associated issues and activities	Risk to ecological community	Threat abatement options
1. Agricultural land use	• Incompatible grazing levels and disturbance by stock • Change of livestock species or breed (to species/breeds with different grazing behaviours from historical use) • Intensification of activities (cropping in new areas, increased stocking rates, hand-feeding or establishment of feed-lots, new water supply systems/dams for irrigation, new paddock sub-division fencing) • Soil disturbance – cultivation (pasture renovation, cultivation for cropping), pest control (warren ripping) • New industries displacing the ecological community (horticulture, agroforestry) • Inappropriate chemical applications – herbicides, fertilizer, and soil ameliorants	• Defoliation, reduced capacity of plants to re-sprout, gradual decline leading to death of plants • Loss or damage to native perennial plant root systems • Trampling of small herbaceous plants and seedlings • Selective removal of palatable species and replacement by unpalatable species • Reduced flowering, seed set and regeneration • Depletion of the soil seed bank • Destruction of the soil surface crust • Vegetation clearance or incremental clearance • Decline in condition of remnants • Loss of native fauna habitat • Indirect effects on the soil - compaction, erosion, reduced water infiltration or pugging, and nutrient enrichment favouring introduced annual species	• Promote 'best practice' adaptive grazing management strategies • Use fencing for land class/land use, to manage INTG remnants with low intensity or rotational grazing • Increase awareness about the potential occurrence and significance of INTG amongst new land owners/managers, and people entering new agricultural industries (Addressed in Strategy 1, 3, 4, 5 & 7)
2. Weed invasion and management	• Dominance by annual grasses & herbs • Perennial grass weeds • Perennial herbaceous weeds • Woody weeds • Mechanical or chemical weed control techniques, including inappropriate cultivation, off-target herbicide damage or broad-scale over-spraying • Weed invasion exacerbated by soil	• Decline in available inter-tussock spaces • Smothering of native plants due to increased weed biomass • Decline in condition of remnants • Increased competition for nutrients and water • Shading, introduction of perch sites and alteration of ecological processes associated with invasion and increase of	• Prepare and implement site-specific action plans for weed control and management • Provide information on native plant and weed identification and weed control methods, including 'minimum disturbance' techniques for high quality/high priority sites • Provide information and training for NRM Officers and other advisors on

Threatening process	Associated issues and activities	Risk to ecological community	Threat abatement options
	disturbance, inappropriate grazing regimes, nutrient enrichment, inappropriate and altered fire regimes, or altered drainage and surface flows	woody weeds • Change or loss of floristic structure due to competition and exclusion of native plants • Physical damage to native grassland plants (cultivation, machinery, off-target herbicide damage) • Impacts on native fauna e.g. loss of inter-tussock spaces used by ground-foraging species	appropriate weed control methods • Develop 'best practice' guidelines to manage annual and perennial grass weeds in the ecological community • Provide information, training and resources to assist adoption of best practice weed management in INTG remnants (Addressed in Strategy 1, 3, 4, 5, 6 & 7)
3. Pest animals, including exotic species and overabundant native herbivores	• Feral herbivores – rabbits, hares, goats, deer, agricultural pest snails • Feral carnivores – foxes, cats • Weed vectors (e.g. foxes; starlings, if perches available) • Rabbit warren destruction – ripping or explosives • Native herbivores – kangaroos in high numbers • Australian plague locusts or other grasshopper species in plague numbers – short-term grazing; and control programs	• Physical damage to native grassland plants and interference with reproduction and regeneration of native species due to high grazing pressure • Underestimating total grazing pressure by ignoring contribution of feral and native herbivores • Plant stresses leading to decline in plant vigour and condition • Physical damage to grassland plants, fauna and fauna habitat by mechanical ripping of rabbit warrens • Physical damage by pest control vehicle traffic • Weed vectors spreading dry seeds with spines/awns on fur; and woody weeds with soft fruits, e.g. boxthorn and olives, in droppings • Reduced availability of suitable tussock habitat for native fauna (birds, reptiles, invertebrates) • Off-target impact of pesticides (e.g. plague locust spraying) on native fauna, including birds, reptiles, invertebrates and their natural predators in the ecological	• Undertake planned and coordinated local action for pest control • Provide information and training for NRM Officers and other advisors on appropriate 'minimum disturbance' pest control and management in INTG • Improve availability of information to land managers on control and management of pest species • Provide training and resources to assist adoption of best practice pest management in INTG (Addressed in Strategy 1, 2, 4, 5, 6 & 7)

Threatening process	Associated issues and activities	Risk to ecological community	Threat abatement options
		community • Predation by foxes and cats	
4. Revegetation	• Inappropriate plantings of native trees and shrubs for amenity/aesthetics, landscape restoration and carbon sequestration programs (including local & non-local native species and exotic species)	• Physical damage to native grassland plants and fauna habitat • Competition for water and soil nutrients • Introduction of potential woody weeds • Increased density and shading by woody plants leading to changes in floristic composition structure (tussocks and inter-tussock spaces), ecological processes • Increased availability of habitat for perching birds, leading to changes in bird species composition and associated ecological processes	• Increase awareness, knowledge and recognition of native grasslands by land owners/managers and community groups • Improve spatial definition of INTG remnants to inform revegetation works • Provide information and training for NRM Officers and other advisors on appropriate species and strategies for restoration of INTG remnants • Develop stricter guidelines for carbon plantings in areas of remnant vegetation (Addressed in Strategy 1, 2, 5, 6 & 7)
5. Infrastructure and developments including industrial and urban development, mining & energy infrastructures	• Development of existing surveyed allotments for housing • Re-zoning and subdivision of land in urban fringe areas for housing, commercial and industrial developments • Other inappropriately sited new buildings (sheds, schools) & industrial developments • New roads/upgrading of existing roads (widening, sealing, bituminising) • New water supplies (dams, pipelines, bores etc) • Energy supplies (infrastructure buildings, wind generator networks, transmission line poles, underground power cables, access roads)	• Clearance of INTG remnants for approved house and infrastructure development • Loss of remnant patches due to clearance permitted for fire risk management around houses and other infrastructure • Encroachment of upgraded roads into INTG remnants on roadsides • Clearance of INTG remnants for approved mining activity and associated infrastructure development • Introduction of weeds on machinery associated with infrastructure construction and operational phases • Smothering of INTG remnants by road aggregate, earthmoving and over-burden stock-piles	• Improve spatial definition of INTG remnants to inform development assessments and applications to clear native vegetation • Increase awareness of planning authorities, project developers and development assessors about INTG and its significance • Train native vegetation officers, environmental consultants and local government planning staff in recognition and condition assessment of INTG remnants • Adopt and enforce weed hygiene strategies during construction and operation phases of mining and infrastructure developments

Threatening process	Associated issues and activities	Risk to ecological community	Threat abatement options
	• Mining exploration and extraction • Wind farm developments • New transmission lines • Road development and borrow pits • Installation of underground pipes/cables • Compaction by vehicles	• Decline in condition of remnants	• Promote suitable site management practices for development sites (Addressed in Strategy 1, 2 & 7)
6. Fire management	• Inappropriate fire regimes (too frequent, too infrequent, wrong season for native fauna/flora or biodiversity outcome) • Lack of investigation/knowledge about fire response at different sites (timing/conditions favouring native vs. weed species) • Inappropriate biomass management for fire prevention (e.g. slashing too frequently or too low to maintain and protect biodiversity assets) • Fire suppression activities (grading, slashing, clearing fire breaks, vehicles access through remnant)	• Loss of fire sensitive species due to frequent burning • Decline in soil seed bank and recruitment of fire-dependent and fire-stimulated species due to infrequent burning • Increase in fire stimulated species altering floristic structure and grassland functions of (e.g. transitions to *Acacia* shrubland) • Increased susceptibility to weed invasion and growth • Loss of grassland structure and habitat • Suppression of native grass recruitment due to excessive biomass of annual weeds and grass thatch	• Undertake research on the fire ecology of INTG and trial appropriate fire regimes for INTG remnants of varying species composition and condition states • Develop 'best practice' guidelines for managing fuel loads in INTG remnants (slashing, grazing, burning) for ecological benefits and asset protection • Actively manage INTG remnants to promote plant diversity (restoration and infill plantings) (Addressed in Strategy 4, 5 & 6)
7. Ecological stresses	• Fragmentation & isolation of patches • Small population sizes of some component species • Reduction and loss of habitat areas for component species • Negative impacts from surrounding land use – pesticide/herbicide/nutrient drift or residues • Decline in native pollinator species (native wasps and bees etc)	• Altered patterns of genetic diversity and gene flow • Inbreeding leading to reduced vigour and resilience of species populations • Loss of key species and species diversity generally • Incremental loss of habitat • Decline in condition of remnants • Loss of ecological functions such as pollination and recruitment	• Identify and monitor indicators of ecological stress in INTG • Develop restoration strategies to help reverse the impacts of ecological stresses • Identify and monitor functionally important species of the ecological community • Identify important habitat features and indicators of ecological integrity (Addressed in Strategy 3, 4, 5 & 6)

Threatening process	Associated issues and activities	Risk to ecological community	Threat abatement options
8. Climatic factors	• Water stress and drought effects • Increased incidence of frosts & frost damage to plants, associated with spring drying trends • Climate change impacting on species survival and timing of ecological functions • Social changes in land use and management resulting from climate change	• Increased grazing pressure on plants in INTG remnants, including grazing of less preferred plants ('prey shifting') • Loss of individual plants and species from remnants or areas within the distribution range, due to varying levels of susceptibility to climate change impacts • Reduced plant resource availability for fauna – e.g. poor seed-set and quality of native grass seeds for seed-eating grassland birds	• Investigate the potential impacts of climate change on the ecological community • Trial management strategies to minimise climate change impacts (Addressed in Strategy 6)
9. Land Use Changes	• Reduced or altered land management • Intensified activities (economic pressures, new industries) • Inappropriate management by new owners (e.g. "Tree Change") • Re-zoning for different land uses • Exclusion of grazing or biomass management	• Increased grazing pressure in response to poor economic or seasonal conditions • Degradation to floristic structure and composition resulting from lack of awareness by new landholders about the ecological community and its management needs (e.g. "Tree Change")	• Provide key information through local advisors to reach new landholders • Provide training for land owners and managers in 'best practice' adaptive management for INTG (Addressed in Strategy 1, 4, 5 & 7)
10. Use of biological and other resources	• Apiary industry (bees taking nectar & pollen) • Illegal hunting or collection of plants/animals • Over-harvesting of native seeds (permitted uses with inappropriate limits) • Rock collection for landscaping (especially in the eastern Mount Lofty Ranges area)	• Competition with native insects for nectar and pollen from native herbs and forbs • Reduced capacity for regeneration of native plants from seed • Loss of seeds as a food resource for grassland-dependent fauna (e.g. birds, invertebrates) • Loss of protective rock habitat for highly palatable plants and species requiring moist and sheltered micro-habitats • Loss of habitat for fauna, particularly reptiles and some invertebrates • Changes to surface water flow and infiltration (from removal of rocks)	• Raise awareness about the component species of INTG and their habitat needs • Monitor impacts of harvesting on functionally important species • Restrict and manage rock harvesting in INTG remnants (Addressed in Strategy 1, 4, 5, 6 & 7)

Part F Planning for Recovery

Recovery Objectives

The overall objective of this recovery plan is to ensure the survival of the Iron-grass Natural Temperate Grassland of South Australia and promote its recovery, by maintaining or improving the area, condition and integrity of the ecological community.

Specific objectives to be achieved within the intended life of this recovery plan are:

1. To maintain or improve the condition of remnant Iron-grass Natural Temperate Grassland.
2. To increase the area of Iron-grass Natural Temperate Grassland secured and managed for conservation.
3. To increase the area of occupancy of Iron-grass Natural Temperate Grassland across its natural range.

The achievement of these objectives will be measured by the performance criteria that are listed for each strategy.

Recovery Strategies

Seven broad strategies and associated recovery actions critical to achieving the recovery plan objectives are outlined in Table 5, with performance criteria to measure their success. Specific responsibility for recovery actions has not been assigned, due to the wide geographic spread of the ecological community, the large number of land owners and managers, the variety of land tenures and the number of other stakeholders and partner organisations that need to be involved.

The recovery plan objectives will only be met by working in close collaboration with key stakeholders, particularly private land owners and managers, throughout the natural range of the Iron-grass Natural Temperate Grassland. Awareness raising and training activities, realistic incentives, local peer support and access to technical advice are essential to encourage land owners and managers to participate and adopt management changes on the scale required to benefit the ecological community.

Successful implementation of recovery actions will rely on active participation and coordination of the various stakeholder groups. An adequately resourced, representative team is needed to facilitate and coordinate the recovery program. This will provide a central reference point for the recovery program, helping to avoid duplication of effort and ensure that priority actions are implemented, monitored and reviewed. It will also establish a mechanism for communication and partnership building between stakeholders on issues such as funding, priorities and responsibility for recovery actions.

While this plan aims to build on actions already underway and use knowledge from existing grassy ecosystems research, restoration and extension programs in South Australia and elsewhere, some critical knowledge gaps must be addressed for the recovery plan objectives to be achieved. These include knowledge about the location, extent, condition and current management of Iron-grass Natural Temperate Grassland remnants; native species composition, ecological functions and essential habitat requirements, especially of native fauna; 'best practice' adaptive management strategies for different land uses; and the most effective strategies to restore degraded remnants. Further field surveys, mapping, research and monitoring programs are essential to overcome these knowledge gaps.

Table 5: Recovery actions and performance criteria to meet the recovery plan objectives.

Strategy 1: Increase awareness of INTG to ensure protection of the ecological community *Run targeted awareness campaigns and training activities for different stakeholder groups, to promote wider recognition and protection of INTG, their conservation significance, management and connections with primary production.*			
Action	**Description**	**Performance Criteria**	**Priority**
1.1	Develop a recovery plan communication strategy identifying how key stakeholder groups will be engaged, informed and communicated with and produce extension materials on recognition of INTG, 'best practice' adaptive management guidelines and Condition Class assessment.	• Recovery plan communication strategy developed and implementation commenced by Year 1. • Fact sheet to assist recognition of INTG updated if required and distributed by Year 1. • Existing 'best practice' guidelines for temperate native grasslands (e.g. Ross 1999; Eddy 2002; Sharp *et al*. 2005; Dorrough *et al*. 2008) distributed initially, with an aim to develop a 'Best practice' adaptive management guidelines for INTG at a later date (Action 4.3). • Site-based Condition Class assessment guidelines distributed by Year 1 and updated as new information are gathered. • Existing networks are engaged to support communication and information sharing including establishing a network of local mentors and champions - ongoing.	**High**
1.2	Run coordinated, local training and extension programs for stakeholders and interest groups on the recognition, protection and management of INTG and understanding of the implications of EPBC listing.	• At least 2 training activities conducted per year for stakeholders and other industry providers about INTG. • At least 2 field day events per year attended to provide information and talk about INTG to the wider communities. • Organise at least 1 information session with each of the 6 identified Aboriginal Nation to identify their interests in INTG, incorporate their knowledge and facilitate their involvement (if requested) by Year 5. • At least 10% of known landowners with INTG targeted and engaged with and provided with information, training, advice or incentives to protect and manage the grassland annually. • At least 20% of targeted landowners engaged with (from above), becomes involved in some form, with protecting the INTG on their property annually.	**Medium to High**
1.3	Collaborate with landowners, planning authorities and developers to identify, protect and implement appropriate management strategy for INTG remnants.	• GIS layers on INTG distribution/conditions updated annually and provided to relevant landholders, planning agencies and authorities - ongoing. • Landholders, planning authorities and developers provided with advice on appropriate management of INTG remnants - ongoing. • No avoidable decline in condition of INTG remnants due to lack of awareness	**High**

		of locations or of inappropriate management practices known or observed to occur.	
1.4	Opportunities for interested community volunteers to become involved in on-ground recovery activities.	• Opportunities for interested volunteers to participate in on-ground recovery activities identified and promoted through networks including links with other threatened species activities such as Pygmy Bluetongue, Spiny Daisy and Mount Lofty orchid recovery - ongoing. • Involve Aboriginal people in recovery planning and activities where appropriate – ongoing.	**Medium**
Strategy 2: Improve baseline information on location, extent, condition and management of INTG remnants. *Survey and map the location, extent and condition of INTG remnants to support monitoring, management, planning and recovery activities.*			
Action	**Description**	**Performance Criteria**	**Priority**
2.1	Identify and undertake targeted surveys to fill gaps in our knowledge on location, extent, management and condition of INTG remnants. *(Desktop assessment using existing survey data and floristic vegetation mapping identified approx. 27,340ha likely to contain INTG with 19, 288ha of high confidence, 4,725ha medium confidence and 3,325ha low confidence. The EPBC Act listed community could be as low as 5,000ha.)*	• Desktop Assessment of mapped grassland used to identify gaps in survey effort, Condition Class assessment and ground-truthing of remnant INTG sites determined and prioritised by Year 2. • 50 person days of surveys conducted at priority sites to gather information on extent, baseline condition data, current management and threats completed annually. • Survey data lodged with DENR and reported to Recovery Team annually.	**High**
2.2	Review and update the guidelines for assessing the Condition Class rating, based on research and field surveys of INTG remnants in varying seasons, climatic conditions, land uses and management across the distribution range.	• Condition Class criteria and assessment methods (from Recovery Plan) evaluated in at least 20 representative INTG sites by Year 2. • Condition Class criteria assessed by field based (site assessment) experts, and updated guidelines Condition Class assessment developed by Year 2. • Updated guidelines distributed to site assessors – ongoing.	**High**
2.3	Maintain and update the GIS database with survey data and Condition Class assessments, to reflect new information.	• GIS database maintained and updated, with survey data collated and entered annually including from consultants, Stewardship Agreements, Heritage Agreements and other private conservation area. • Land owners and managers, the Australian Government and other stakeholders provided with updated information from surveys, mapping and data analysis - ongoing.	**High**

Strategy 3: Increase the area of the EPBC listed INTG secured and managed for conservation *Develop a network of INTG conservation areas, with a variety of conservation management and protection mechanisms suited to different land owners, land managers and land use, including land management and stewardship agreements, covenants, planning mechanisms and land acquisition for reserves.*			
Action	**Description**	**Performance Criteria**	**Priority**
3.1	Identify priority INTG sites (Class A & B) to target for formal and informal conservation management agreements ensuring representation of distinct INTG types and connectivity across the geographic and ecological range of the community. (As little as 5,000ha of the EPBC Act listed community may be available for formal or informal protection)	• Criteria developed and used to select and prioritised INTG sites (identified from Action 2.1) to increase the area of INTG secured and managed for conservation by Year 2. • Appropriate conservation mechanisms (e.g. Stewardship Agreement, Heritage Agreement, public and private reserve system) determined for the top 50 sites by Year 2. • Prioritised INTG sites to secure mapped, with maps and associated conservation mechanism provided to NRM Boards and coordinators of environmental stewardship programs and management incentives schemes by Year 2.	**High**
3.2	Increase the area of INTG secured and managed for conservation using a variety of protection mechanisms.	• Total area of INTG secured and management for conservation increased from 3,310 ha (2011) to at least 4,300 ha by Year 10 based on priority sites identified in Action 3.1 and consisting of; • Management agreements (eg. Stewardship Agreement) where landholders enter into new, secure land agreement increased from 2,535 ha to at least 3,200 ha by Year 10. • SA Heritage Agreements entered into for INTG remnants increased from 210 ha (14 Heritage Agreements in 2011) to at least 400 ha by Year 10. • Public & private protected area reserves established for INTG increased from 565 ha (2011) to at least 700 ha by Year 10.	**High**
Strategy 4: Maintain or improve the condition and integrity* of the EPBC listed INTG remnants using 'best practices' strategies *Encourage and support private and public land owners and managers to manage INTG remnants to maintain or improve the integrity and Condition Class rating.* (* Integrity refers to the capacity of INTG remnants to support and maintain native species composition, diversity, functional organisation and natural ecological processes similar to undisturbed examples of the ecological community)			
Action	**Description**	**Performance Criteria**	**Priority**
4.1	Identify and prioritise known INTG remnants (Class A & B) to maintain or improve the condition and integrity* ensuring representation of distinct INTG types and connectivity across the geographic and ecological range of the community. *(As little as 5,000ha of the EPBC Act listed*	• Criteria developed and used to select and prioritise INTG sites (identified from Action 2.1) to maintain or improve the condition and integrity of INTG remnants by Year 2. • Prioritised INTG sites to maintain or improve mapped, with maps and associated management requirements provided to NRM Boards and field coordinators by Year 2.	**High**

	community may be available to maintain or improve the condition and integrity)		
4.2	Support landowners and land managers to maintain or improve the condition and integrity* of INTG remnants and establish a process for monitoring condition over time.	• Total area with active management increased by 1,000 ha by Year 10 with 100% maintained at pre-management condition (Class A or Class B) and at least 20% of areas with improved condition (Class B to Class A). • Baseline condition collected and management plans using 'best practice' adaptive management guidelines developed and being implemented for 100 ha of priority INTG remnants (identified from Action 4.1) annually. • Long-term condition monitoring established at all sites with active management and monitored biannually to evaluate the effectiveness of management activities to maintain or improve the condition of INTG. • Monitoring data on the effectiveness of management activities used to improve the management at that site and of other INTG sites – ongoing. • Survey data (baseline and monitoring) lodged with DENR and reported to Recovery Team annually. • Report on management practices, cost-benefits and condition, published and used to inform future management practices by Year 10.	**High**
4.3	Develop a 'best practice' adaptive management guideline for INTG from gathered information to better maintain & improve the integrity* of INTG remnants.	• 'Best practice' adaptive management guideline for INTG developed by Year 5 and updated as new information is gathered by Year 10. • 'Best practice' adaptive management guideline for INTG distributed to relevant people – ongoing.	**Medium**
Strategy 5: Increase the area of occupancy of the EPBC listed INTG ecological community across its natural range *Identify, map and promote the best locations for restoration (Class C patches rather than broad-acre planting of iron-grass) to increase the area and integrity of INTG remnants; and ensure this information is available to support planning processes at the national, state, regional and local levels.* (** Key areas and sites for restoration may include buffer zones around significant small remnants, connectivity between priority remnants, large recoverable INTG remnants of Condition Class C, or important habitat areas for key species of the INTG ecological community.)			
Action	**Description**	**Performance Criteria**	**Priority**
5.1	Identify priority INTG sites (Class C) for restoration** throughout the geographic ranges that will contribute to the increase in area of occupancy and to the long-term recovery and viability of the EPBC listed ecological community. (*Based on desk-top assessment of mapped grassland, of the 19,288ha with high confidence of being INTG, minus 5,000ha of possible EPBC Act listed community, there*	• Criteria developed and used to select and prioritise INTG sites (identified from Action 2.1) for potential restoration to increase the area of INTG by Year 2. • Prioritised INTG restoration sites mapped, with maps and associated information provided to NRM Boards, on-ground work coordinators, and coordinators of environmental stewardship programs and management incentives schemes by Year 2.	**High**

	maybe 14,200 ha of Class C remnant for possible restoration)		
5.2	Support landowners and land managers to increase the area of occupancy of the INTG through active restoration**. Link restoration activities with other threatened species recovery project including NatureLink, PBT, PBGW and Lofty Block orchids.	• 5% (approx. 700ha) of the total area of Class C improved to Class B by Year 10. • Baseline data collected and management plans using current 'best practice' restoration guidelines developed and being implemented for at least 70ha of priority INTG remnants (identified from Action 5.1) annually. • Long-term condition monitoring established at all INTG sites with active restoration and monitored biannually to evaluate the effectiveness of restoration activities to restore and improve the condition of INTG. • Monitoring data on the effectiveness of restoration activities used to improve current and future restoration of other INTG sites – ongoing. • Survey data (baseline and monitoring) lodged with DENR and reported to Recovery Team annually. • Report on effectiveness of restoration and cost-benefits published and used to inform future restoration practices by Year 10.	**High**
5.3	Develop a 'best practice' restoration guideline for INTG from consultation with land managers and expert groups and analysis of existing knowledge, experience and research.	• 'Best practice' restoration guideline for INTG developed by Year 5 & updated as new information are gather by Year 10. • 'Best practice' restoration guideline for INTG distributed to relevant people – ongoing.	**Medium**
Strategy 6: Address critical knowledge gaps about the ecological community *Identify and facilitate projects, collaborative partnerships and funding to address key knowledge gaps influencing or impacting on conservation, management and restoration of INTG.*			
Action	**Description**	**Performance Criteria**	**Priority**
6.1	Identify, assess and monitor the status of species in INTG that are functionally important, threatened, or dependent on the ecosystem for their persistence.	• Functionally important, threatened, and ecosystem-dependent species of INTG identified, their status assessed and included in monitoring of key sites by Year 5.	**High**
6.2	Identify ecological attributes and habitat features which are indicators of condition and ecological integrity of INTG remnants and ensure these are incorporated into survey, research and monitoring programs.	• Indicators of condition and ecological integrity in INTG remnants identified and included in survey, research and monitoring programs by Year 3. • Information gathered used to update the Condition Classes Assessment guideline.	**High**
6.3	Identify indicators for measuring detrimental changes in the INTG ecological community and ensure these indicators are	• Indicators of detrimental changes in INTG identified and included in survey, research and monitoring programs by Year 5.	**High**

	incorporated into survey, research and monitoring programs.		
6.4	Investigate the potential impacts of, and management strategies for, significant threatening processes on the INTG ecological community including impacts of ecological barriers (small patch size, fragmentation & isolation of remnants), fire and climate change.	• Impacts of, and management strategies for, significant threatening processes investigated and incorporated into 'best practice' adaptive management and restoration guidelines by Year 10. • Strategies to overcome ecological barriers (small patch size, fragmentation and isolation of remnants) investigated and 'best practice' restoration guidelines revised to include these strategies by Year 10. • Research on role and management of fire in INTG remnants undertaken, by Year 7. Results incorporated into 'best practice' adaptive management and 'best practice' restoration guidelines, by Year 9. • Likely climate change impacts on INTG identified and trials of management strategies to minimise these impacts set up at 4 representative sites across its range by Year 10.	**Medium**
6.5	Foster partnerships with public and private institutions to conduct research to improve management and restoration practices in INTG.	• Key stakeholders involved in partnerships to develop and conduct research into knowledge gaps by Year 2. • Potential funding sources for research projects identified by Year 2. • Link with other research projects for PBT, PBGW and Lofty Block Orchids.	**Medium**
Strategy 7: Actively manage the recovery process through an effective recovery team. *Manage and review the recovery process through a Recovery Team*			
Action	**Description**	**Performance Criteria**	**Priority**
7.1	Establish a representative state Recovery Team to coordinate key recovery actions and monitor, evaluate, review and report on implementation of the recovery plan.	• A state Recovery Team for INTG established by Year 1. • Membership of the state INTG Recovery Team representative of key stakeholder and community groups (from Table 7). • Recovery Team membership, relevance, effectiveness reviewed annually.	**High**
7.2	Engage a Recovery Team Coordinator and Project Officer to manage day-to-day business of Recovery Team (liaise with stakeholders, help coordinate & implement recovery plan). Coordinator to have part-time role for INTG, PBGW, PBT and Lofty Block Orchids recovery programs.	• Recovery Team Coordinator role funded and appointed by Year 2. • Full time Project Officer for INTG & PBGW funded and appointed by Year 2.	**High**
7.3	Actively monitor the status of the ecological community, evaluate and review the effectiveness of recovery actions, and identify and prioritise future actions for	• Status and recovery of the ecological community reviewed every 3 years and summary reports submitted to the State and Australian governments with review of the Recovery Plan at the end of Year 5 and Year 10. • Future actions necessary for the recovery of INTG identified and prioritised, by	**Medium**

	ongoing recovery of INTG.	Year 10 based on new information gathered from recovery actions.	

Costs and Duration of Recovery

The intended life-span of this recovery plan is ten years. It will be reviewed after five years and further recovery goals and actions may be identified. Estimated indicative costs and timing of the recovery actions outlined in Table 5 are summarized in Table 6.

Table 6: Estimated costs of implementing the recovery plan over 10 years.

Action	Summary Description	Priority	[1]Timeframe	[2]Cost Estimate ($K)										
				1	2	3	4	5	6	7	8	9	10	Total
1.1	Develop communication strategy & extension material	High	Short - Ongoing	40	10	10	10	10	10	10	10	10	10	**130**
1.2	Run local training & extension programs	Medium - High	Short - Ongoing	30	30	30	30	30	25	25	25	25	25	**275**
1.3	Identify, protect & implement management strategy for INTG remnants	High	Ongoing	10	10	10	10	10	10	10	10	10	10	**100**
1.4	Identify opportunities to involve volunteers in on ground activities.	Medium	Ongoing	2	2	2	2	2	2	2	2	2	2	**20**
2.1	Identify & undertake targeted survey of gaps on location, extent, condition	High	Short - Ongoing	50	40	40	40	40	40	40	40	40	40	**410**
2.2	Review & update Condition Class assessment guideline	High	Short	10	10									**20**
2.3	Maintain & update GIS Database	High	Short - Ongoing	15	15	15	15	15	15	15	15	15	15	**150**
3.1	Identify priority INTG sites for formal & informal conservation	High	Short		10									**10**
3.2	Increase the area of INTG secured using a variety of mechanisms	High	Short - Ongoing	190	190	190	190	190	190	190	190	190	190	**1,900**
4.1	Identify & prioritise known INTG remnants to maintain or improve condition	High	Short		10									**10**
4.2	Maintain/mprove the condition & integrity of INTG remnants	High	Short - Ongoing	60	60	60	60	60	60	60	60	60	60	**600**
4.3	Develop 'best practice' adaptive management guidelines	High	Medium - Long					10					10	**20**
5.1	Identify priority INTG sites for restoration	High	Short		10									**10**
5.2	Support landowners/managers to	High	Short -	60	60	60	60	60	60	60	60	60	60	**600**

Action	Summary Description	Priority	[1]Timeframe	[2]Cost Estimate ($K)										
				1	2	3	4	5	6	7	8	9	10	Total
	increase area of occupancy		Ongoing											
5.3	Develop a 'best practice' restoration guidelines	Medium	Medium - Long					10					10	**20**
6.1 - 6.5	Foster partnerships, research projects	Medium - High	Short - Ongoing		100	100	100	100	100	100	100	100	100	**900**
7.1	Establish a representative Recovery Team	High	Short - Ongoing	3	3	3	5	3	3	3	3	5	3	**34**
7.2	Engage a Recovery Team Coordinator and Project Officer	High	Short - Ongoing		80	80	80	80	80	80	80	80	80	**720**
7.3	Evaluate & review recovery actions	Medium	Medium - Long			2			4				6	**12**
TOTAL				**470**	**640**	**602**	**602**	**620**	**599**	**595**	**595**	**597**	**621**	**5,941**

Notes
1 For the implementation time frame: Short term = 1 to 2 years; Medium term = 3 to 5 years; Long term = 5 to 10 years; Ongoing = recurrent from year of commencement to the end of recovery plan period
2 Costs calculated at present (2012) rates.

Evaluation

Performance criteria have been identified to evaluate the effectiveness of each recovery action. A key strategy for the recovery plan is to establish a recovery team to facilitate and coordinate recovery plan implementation, evaluate the effectiveness of recovery actions and report on progress with recovering the ecological community. Representation on this recovery team is yet to be determined but should include key stakeholder groups and organisations.

The Grassy Ecosystems Recovery Project Steering Committee is an advisory group established to support development of this recovery plan. The committee is not a representative group for key stakeholders, but may be able to take an interim role until the recovery team is established. Organisations and stakeholders represented on this steering committee include:

- Department of Environment and Natural Resources
- Mid North Grasslands Working Group
- Rural Solutions SA
- Greening Australia SA
- Threatened Plant Action Group
- Nature Conservation Society of SA
- Conservation Council of SA
- Northern & York NRM Board
- SA Murray-Darling Basin NRM Board
- Community members, including graziers
- Upper North Farming Systems Group
- Eastern Hills and Murray Plains Catchment Group

The outcomes of the plan and future directions for recovery will be reviewed after five years and at the end of the ten-year period. In addition, the Recovery Team will review and report on the status and recovery of the ecological community every three years. However it is recognised that many of the desired ecological outcomes for the Iron-grass Natural Temperate Grassland community will need to be measured over a much longer time-frame than the intended duration of this plan.

Part G Communication and Participation

A communication strategy is being developed to support the recovery program (Action 1.1). The strategy will identify options for engaging with key stakeholder groups and strategies for implementing recovery actions related to awareness raising, knowledge and skills development and capacity building of those stakeholders. It will also identify opportunities for engaging partner organisations and gaining their support and involvement in recovery actions.

Private land owners and managers are key stakeholders in the recovery of the Iron-grass Natural Temperate Grassland of South Australia, as they currently own, manage and have influence over most of the remaining area of the ecological community. The greatest gains for the ecological community will be achieved by working in partnership with private land owners and managers, to raise their interest in and awareness of native grasslands, develop their knowledge and skills to manage these areas, and build their capacity to implement 'best practice' adaptive management for conservation and production outcomes.

Other sectors including community and industry groups, non-government organisations, local government, NRM Boards, other statutory organisations, research institutions, government agencies and indigenous groups and organisations will be significant and essential partners in the recovery program.

Effective communication and liaison will be needed between these various stakeholders and partners, to ensure a common understanding of the recovery aims, objectives and priorities, to help establish and maintain partnerships and to avoid duplication and make best use of resources in implementing recovery actions. The proposed recovery team (Action 7.1), supported by a project officer (Action 7.2) will facilitate and coordinate stakeholder involvement in implementing this recovery plan.

Current and potential stakeholders in the management and recovery of the Iron-grass Natural Temperate Grassland of South Australia are listed in Table 7.

Table 7: Current and potential stakeholders in the management and recovery of Iron-grass Natural Temperate Grassland of South Australia.

National Stakeholders:
Department of Sustainability, Environment, Water, Population and Communities
National non-government organisations (e.g. WWF Australia)
National Farmers' Federation
General public
State Stakeholders:
Department of Environment and Natural Resources
Primary Industries and Resources SA
Rural Solutions SA
Department for Planning, Transport and Infrastructure
Department of Planning and Local Government
Native Vegetation Council
Natural Resources Management Council
Advisory Board of Agriculture
South Australian Farmers Federation
Greening Australia SA
Conservation Council of South Australia
Nature Conservation Society of SA
Threatened Plant Action Group
Trees for Life
Specialist non-government organisations and groups (e.g. Birds SA; SA Herpetology Group; Butterfly Conservation SA)
Mining and wind energy industries
Flinders University of South Australia
University of Adelaide
University of South Australia
General public
Regional Stakeholders:
Land owners and managers, including private landholders, local councils and Airservices Australia
Northern and Yorke NRM Board
SA Murray-Darling Basin NRM Board
Adelaide and Mount Lofty Ranges NRM Board
Agricultural Bureau Branches (Men's and Women's)
Mid North Grasslands Working Group
Native Grass Resources Group
Northern and Yorke Grassy Habitats Recovery Team
Local governments:- Alexandrina Council, The Barossa Council, District Council of Barunga West, Clare and Gilbert Valleys Council, Coorong District Council, Goyder Regional Council, Light Regional Council, District Council of Mallala, Mid Murray Council, District Council of Mount Remarkable, The Rural City of Murray Bridge, Northern Areas Council, District Council of Orroroo-Carrieton, District Council of Peterborough, Wakefield Regional Council
Central Local Government Region of SA
Threatened species recovery teams (Spiny Daisy, Pygmy Bluetongue Lizard)
Friends of Burra Parks
Eastern Hills and Murray Plains Catchment Group

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Appendix 1: South Australian Government legislation relevant to the conservation, protection and management of Iron-grass Natural Temperate Grassland of South Australia

Native Vegetation Act 1991

An Act to provide incentives and assistance to landowners in relation to the preservation and enhancement of native vegetation; to control the clearance of native vegetation; and for other purposes.

The *Native Vegetation Act 1991* (NV Act) regulates the removal of native vegetation and prohibits broad-scale clearance. It also provides for 'in perpetuity' protection of native vegetation and associated wildlife, through conservation covenants called Heritage Agreements.

'Clearance' as defined under the NV Act includes ploughing, establishment of exotic pastures in native vegetation, changes in livestock species, or increased grazing intensity, as well as deliberate direct removal of native plants (e.g. by cutting, digging or burning). Native vegetation may only be cleared with approval of the Native Vegetation Council (NVC), or in accordance with activities defined in the *Native Vegetation Regulations 2003* under the Act (see Native Vegetation Council 2009). Clearance applications are assessed against a set of Principles defined in Schedule 1 of the NV Act (Appendix 2). These Principles take into account the conservation status and remnancy of the vegetation community, the presence of threatened species and the habitat values and condition of the remnant and can be used to protect areas of Iron-grass Natural Temperate Grassland from clearance.

National Parks and Wildlife Act 1972

An Act to provide 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.

For more details refer to *Conservation Status and Protection* section of the plan.

Development Act 1993

An Act to provide for planning and regulate development in the State; to regulate the use and management of land and buildings, and the design and construction of buildings; to make provision for the maintenance and conservation of land and buildings where appropriate; and for other purposes.

Under the *Development Act 1993*, local Councils and the state Development Assessment Commission (DAC) seek advice from the NVC regarding applications for land sub-division and where development may impact on native vegetation. Decisions made by local Councils and the DAC may go against the advice of the NVC. An approved development within an area of intact native vegetation is subject to the Regulations of the NV Act.

Natural Resources Management Act 2004

An Act to promote sustainable and integrated management of the State's natural resources; to make provision for the protection of the State's natural resources; to repeal the Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986*, the* Soil Conservation and Land Care Act 1989 *and the* Water Resources Act 1997*; and for other purposes.*

Under the *Natural Resources Management Act 2004* (NRM Act) the state NRM Council and regional NRM Boards identify the range and condition of natural resources, including biodiversity assets, throughout the state; plan and set targets for the protection and management of natural resources; and encourage landholders to adopt appropriate conservation and management practices. NRM Boards run programs targeting high priority pest plants and animals impacting on natural resources. Boards may also fund on-ground works and environmental stewardship

programs for management and protection of natural resource assets, including threatened ecological communities.

Crown lands Act 1929
An Act relating to Crown lands.

The *Crown Lands Act 1929* (CL Act) regulates the use of Crown land under the care of Local Government, such as cemetery reserves, water reserves, stone reserves and parklands. Crown land under the care of Local Government can be proclaimed as Conservation Reserves under the CL Act and managed for biodiversity purposes.

Forestry Act 1950
An Act to provide for the creation and management of State forests and other related matters,

The *Forestry Act 1950* (FA Act) regulates the use of land gazetted for the purpose of Forestry. Forestry SA manages areas of native vegetation including land with Iron-grass Natural Temperate Grassland remnants. Native Forest Reserves can be proclaimed under the FA Act for purposes relating to the conservation and management of land supporting native flora and fauna.

Native Title Act 1994
An Act relating to native title in South Australia.

The Native Title Act 1994 recognises the rights and interests of communities, groups and individual Aboriginal peoples in relation to land (and waters), where rights are possessed by traditional laws and traditional customs are observed. Native title rights may exist in some areas of Iron-grass Natural Temperate Grassland where native title has not been extinguished, allowing people to hunt and gather and carry out other traditional practices on the land.

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Appendix 2: Principles under Schedule 1 of the *Native Vegetation Act 1991* that protect Iron-grass Natural Temperate Grassland remnants in South Australia

Native Vegetation Act 1991: Schedule 1—Principles of native vegetation clearance

Native vegetation should not be cleared if, in the opinion of the (Native Vegetation) Council —

(a) it comprises a high level of diversity of plant species; or

(b) it has significance as a habitat for wildlife; or

(c) it includes plants of a rare, vulnerable or endangered species or

(d) the vegetation comprises the whole, or a part, of a plant community that is rare, vulnerable or endangered; or

(e) it is significant as a remnant of vegetation in an area which has been extensively cleared; or

(g) it contributes significantly to the amenity of the area in which it is growing or is situated; or

(h) the clearance of the vegetation is likely to contribute to soil erosion or salinity in an area in which appreciable erosion or salinisation has already occurred or, where such erosion o salinisation has not yet occurred, the clearance of the vegetation is likely to cause appreciable soil erosion or salinity; or

(i) the clearance of the vegetation is likely to cause deterioration in the quality of surface or underground water; or

(j) the clearance o the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding; or

(k) (i) after clearance the land will be used for a particular purpose; and

(ii) the regional NRM board for the NRM region where the land is situated has as part of its NRM plan under the Natural Resources Management Act 2004, assessed —

(A) the capability and preferred uses of the land; and

(B) the condition of the land; and

(iii) according to that assessment the use of the land for that purpose cannot be sustained;

Additional Principles of native vegetation clearance not relevant to protection of Iron-grass Natural Temperate Grassland —

(f) it is growing in, or in association with, a wetland environment; or

(l) the clearance of the vegetation would cause significant harm to the River Murray within the meaning of the *River Murray Act 2003*; or

(m) the clearance of vegetation would cause significant harm to the Adelaide Dolphin Sanctuary.

Interpretation

In this Schedule, unless the contrary intention appears—

endangered species means a species of plant for the time being appearing in Part 2 of Schedule 7 of the *National Parks and Wildlife Act 1972*;

plant community means plants of a species indigenous to South Australia growing in association with one another and forming a group that is distinct from other plant communities;

rare species means a species of plant for the time being appearing in Part 2 of Schedule 9 of the *National Parks and Wildlife Act 1972*;

vulnerable species means a species of plant for the time being appearing in Part 2 of Schedule 8 of the *National Parks and Wildlife Act 1972*;

wildlife has the same meaning as in the *National Parks and Wildlife Act 1972*.

Appendix 3: State and Regional Plans relevant to the recovery of the Iron-grass Natural Temperate Grassland of South Australia ecological community

Several current South Australian planning strategies address biodiversity decline and are relevant to the recovery of the Iron-grass Natural Temperate Grassland of South Australia ecological community. These include:

South Australia's Strategic Plan

South Australia's Strategic Plan 2007 (Government of South Australia undated) includes sustainability targets to 'lose no native species as a result of human impacts' (Target 69) and to 'increase participation in nature conservation activities by 25% by 2015' (Target 72). These targets became the benchmark for establishment of the *No Species Loss* conservation strategy.

SA No Species Loss – A Nature Conservation Strategy for South Australia 2007 – 2017

The vision of the *No Species Loss* conservation strategy (Department for Environment and Heritage undated) is for *the people of South Australia actively supporting their native plants, animals and ecosystems to survive, evolve and adapt to environmental change*. With this view, the aim of *No Species Loss* is to halt and where possible reverse the decline in the State's terrestrial, aquatic and marine biodiversity over the next 10 years. The Strategy forms a framework with timelines for achievement. This recovery plan addresses objectives and targets under the five main goals of the *No Species Loss* conservation strategy.

NatureLinks

NatureLinks is part of the *No Species Loss* conservation strategy, relating specifically to establishment of five landscape scale biodiversity corridors in South Australia (Department of Environment and Natural Resources undated). The purpose of these corridors is to manage and restore large areas of native species habitat, enabling native wildlife to survive and adapt to environmental change. The Iron-grass Natural Temperate Grassland ecological community may be a component of landscape restoration activities in the Cape Borda to Barossa Naturelink. The Cape Borda to Barossa NatureLink aims to increase landscape connectivity to build resilience in ecosystems, particularly in the face of climate change.

State NRM Plan

The *State Natural Resources Management Plan* (Department of Water, Land and Biodiversity Conservation 2006) provides a framework for sustainable, long-term use of natural resources in South Australia. It promotes a landscape scale approach to managing and maintaining natural ecosystems and dealing with critical risks to biodiversity. Biodiversity conservation strategies identified in the Plan include protection, maintenance and expansion of native vegetation and natural habitats, increased functional connectivity, threat abatement and recovery of threatened species and ecological communities. The State's eight Regional NRM Boards support and deliver natural resources management in the regions. Their NRM Plans identify targets and strategies for biodiversity conservation.

Regional NRM Plans

The Northern and Yorke, SA Murray-Darling Basin and Adelaide and Mount Lofty Ranges NRM Boards have Regional NRM Plans which include targets to retain native species and ecological communities, improve native vegetation cover and maintain or improve the viability and conservation status of threatened species and ecological communities. All three NRM Plans identify Iron-grass Natural Temperate Grassland as a significant threatened ecological community in their region.

AMLR Regional Recovery Plan (2009 – 2014)

The *Regional Recovery Plan for Threatened Species and Ecological Communities of Adelaide and the Mount Lofty Ranges, South Australia* (Willson and Bignall 2009)

identifies and prioritises the native species and ecological communities most at risk in the region. The plan highlights the Iron-grass Natural Temperate Grassland of South Australia as a very high priority for recovery. The ecological community occurs in the Eastern Hills district of the AMLR region. A threat analysis for the AMLR region rated native grasslands as being at very high threat of weed invasion; high threat of grazing and disturbance by stock and/or inappropriate fire regimes; and medium threat from drought, climate change, severe weather; incompatible site management; grazing and disturbance by kangaroos; firewood and rock removal; and/or pollution and poisoning (chemical and solid waste).

Regional Biodiversity Plans

Regional Biodiversity Plans describe the biodiversity assets of a region, including major plant community groups, and the ecology, distribution, threats and management of threatened plant communities. They also describe selected threatened native flora and fauna and special habitats in the region.

Biodiversity Plans were published in 2001 for the Northern Agricultural Districts (Graham *et al*. 2001) and the SA Murray-Darling Basin (Kahrimanis *et al*. 2001). While these plans pre-date the EPBC Act listing of Iron-grass Natural Temperate Grassland of South Australia, they did identify *Lomandra multiflora* subsp. *dura* +/- *L. effusa* Tussock grasslands as a threatened plant community and a high priority for conservation. They also outlined the issues impacting on these grasslands, management requirements and priorities for conservation.

A Biodiversity Strategy has been drafted for Adelaide and the Mount Lofty Ranges region.

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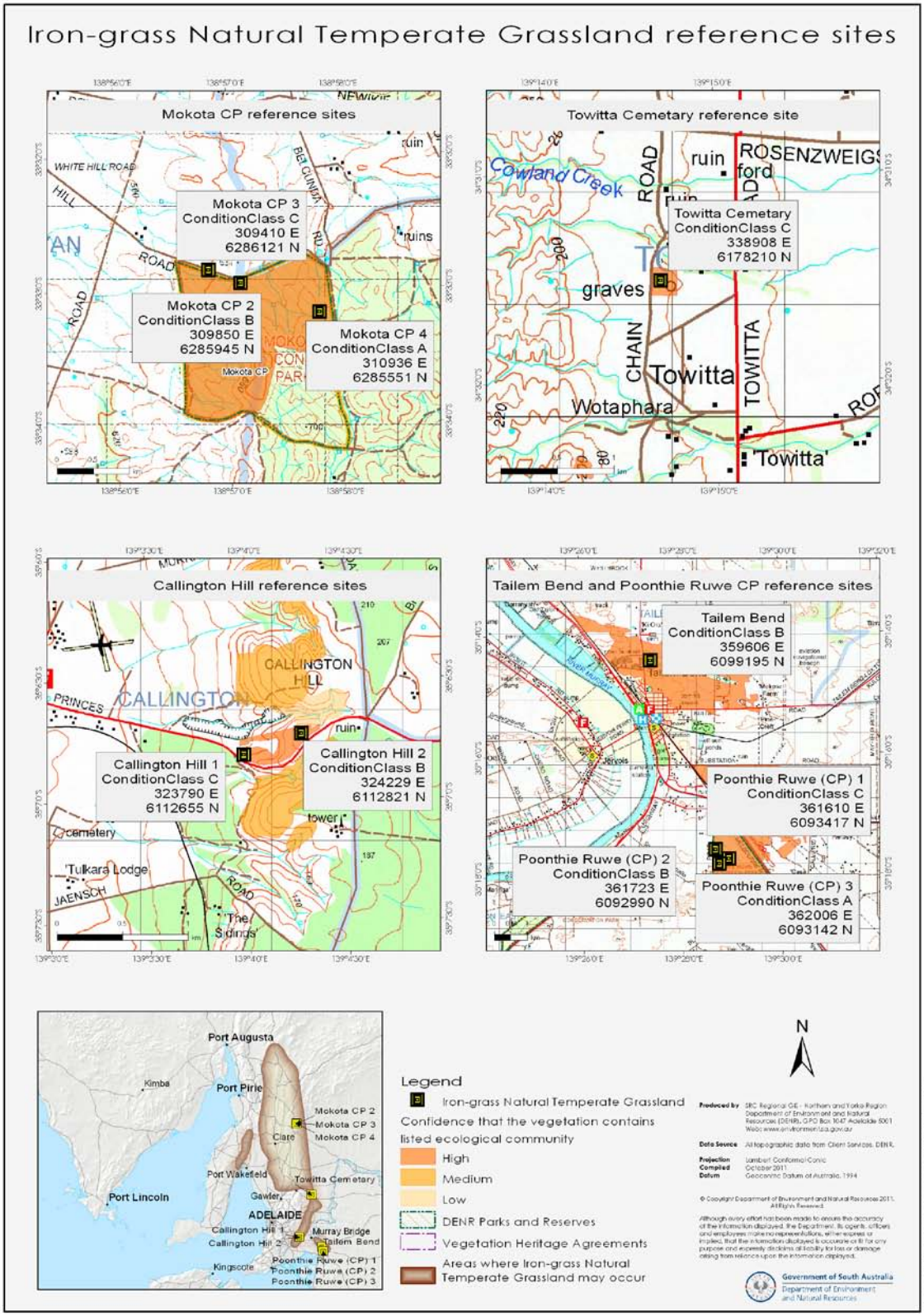
Appendix 4: Locations of Condition Class reference sites for Iron-grass Natural Temperate Grassland on public land.



Appendix 5: Grassland structure and floristic composition of Iron-grass Natural Temperate Grassland

Grassland Structure

The vegetation structure of Iron-grass Natural Temperate Grassland has commonly been classified as Open Tussock Grassland (Robertson 1998; Croft 2008; Neagle 2008a), Tussock Grassland (Robertson 1998) and Low Open Tussock Grassland (Hyde 2000).

Stiff Iron-grass (*Lomandra multiflora* subsp. d*ura*) and Scented Iron-grass (*Lomandra effusa*) form persistent, long-lived (Royal Botanic Gardens Sydney 2009) tussocks, giving the ecological community its characteristic structure. Perennial native tussock grasses of similar size often occur with the *Lomandra*, but are less persistent. The perennial tussock stratum is generally mid-high (up to 0.5 m), with tussock spacing from very sparse to dense and canopy cover varying from 5% up to 70% or more. Mature tussocks of both *Lomandra* species can grow 0.5 m or more high and greater than 0.5 m wide (Jessop and Toelken 1986; Cunningham *et al*. 1992), but are often smaller. Co-dominant grasses such as *Austrostipa* species and *Themeda triandra* form vegetative tussock growth of similar size to the Iron-grasses, but their culms (flower stalks) are often taller (Jessop *et al.* 2006). Projective foliage cover of *Lomandra* at some of the best remaining sites in the Lofty Block varies from sparse (10-30%) in *Lomandra multiflora* subsp. d*ura* Tussock Grasslands, to mid-dense (30-70%) in *Lomandra effusa* Tussock Grasslands (Robertson 1998), but can be less than 10% at many sites (Robertson, pers. comm.).

A lower stratum of shorter perennial grass tussocks and perennial and annual forbs occurs between the Iron-grass tussocks, with a discontinuous ground-cover layer of dwarf forbs, mosses, lichens and occasional prostrate shrubs, interspersed with patches of bare soil (e.g. Robertson 1998; Hyde, 2000; Neagle 2008a). Embedded rocks and loose surface rocks commonly occur, providing additional structure and micro-habitats for animals and plants.

Lomandra species have tough, fibrous foliage thought to be of lower palatability and digestibility than grasses, but they often show signs of grazing in poor seasons, at sustained high stocking rates, or at younger stages of growth. Scented Iron-grass (*L. effusa*) has sharp spines on the leaf tips and is probably less attractive to large herbivores. Grazing pressure from large native herbivores (kangaroos), most stock species (cattle, most sheep breeds, horses) or feral animals (rabbits, hares) generally has more impact and influence on the native grasses and forbs in the inter-tussock spaces than on the dominant Iron-grass structure.

Floristic Composition

The floristic composition of Iron-grass Natural Temperate Grassland has been described in recent surveys (Hyde 1995 and 2000; Robertson 1998; Neagle 2008a). The nationally listed Iron-grass Natural Temperate Grassland of South Australia ecological community comprises two main floristic groups, *Lomandra multiflora* subsp. *dura* Tussock Grassland and *Lomandra effusa* Tussock Grassland. Neagle (2008a) distinguished a third floristic group, *Lomandra multiflora* subsp. *dura* and/or *L. effusa* Tussock Grassland, in the Mid North. All three floristic groups co-occur in the northern and central areas of the distribution range, while only the *Lomandra effusa* Tussock Grassland floristic group is found in the southern areas. The main features distinguishing these three floristic groups are summarized below.

<u>*Lomandra multiflora* subsp. *dura* Tussock Grassland group</u>

Stiff Iron-grass (*L. multiflora* subsp. *dura*) is the dominant native species and Brush Wire-grass (*Aristida behriana*) is the most frequently occurring perennial grass. Other sub-dominant tussock grasses include Common Wallaby-grass (*Austrodanthonia caespitosa*), Crested Spear-grass (*Austrostipa blackii*) and Corkscrew Spear-grass (*A. setacea*). Scented Iron-grass (*L. effusa*) may occur in lower numbers at some sites.

Frequently occurring perennial and annual forbs include Common Everlasting (*Chrysocephalum apiculatum*), Australian Bindweed (*Convolvulus* sp. syn. *C. erubescens*), Caustic Weed (*Euphorbia drummondii*), Woolly New Holland Daisy (*Vittadinia gracilis*) and Yellow-wash Bluebell (*Wahlenbergia luteola*). The low shrub, Long-flower Cryptandra (*Cryptandra campanulata*) is the most frequently encountered woody species. Surveys in 30m x 30m quadrats have recorded up to 41 native plant species, but diversity at a site may be higher due to the patchy distribution of species. This group is associated with loams and clays on hill slopes and plains in the northern range of the ecological community, particularly the Burra Hills.

<u>*Lomandra effusa* Tussock Grassland group</u>

Scented Iron-grass (*L. effusa*) is the dominant species. A perennial forb, Pussy-tails (*Ptilotus spathulatus*) is the most frequently associated species. Sub-dominant tussock grasses are Common Wallaby-grass (*Austrodanthonia caespitosa*), Rusty Spear-grass (*Austrostipa eremophila*) and Balcarra Spear-grass (*A. nitida*). Stiff Iron-grass (*L. multiflora* subsp. *dura*) occurs at some sites, but in lower numbers. Other frequently occurring forbs include Australian Bindweed (*Convolvulus* sp. syn. *C. erubescens*), Native Sorrel (*Oxalis perennans*), Fuzzy New Holland Daisy (*Vittadinia cuneata* var. *cuneata*), Woolly New Holland Daisy (*V. gracilis*) and Yellow-wash Bluebell (*Wahlenbergia luteola*). Sweet Bursaria (*Bursaria spinosa* subsp. *spinosa*) is the most frequently occurring woody species. Surveys in 30m x 30m quadrats have recorded up to 45 native plant species, but diversity at a site may be higher due to the patchy distribution of species. This group is associated with loam soils with surface stone (calcrete and shale) on hill slopes, particularly along the eastern Lofty Block from Orroroo and Peterborough, south to near Strathalbyn and east to Tailem Bend.

<u>*Lomandra multiflora* subsp. *dura* and/or *Lomandra effusa* Tussock Grassland</u>

Either *L. multiflora* subsp. *dura* or *L. effusa* is the dominant species, or occasionally the two may be co-dominant (Neagle 2008a). *Vittadinia gracilis* is a characteristic species of this group, occurring at all sites. Other frequently occurring species are *Austrodanthonia caespitosa*, *Austrostipa nitida* and *Ptilotus spathulatus*. Although only recorded at a few sites, the most frequent woody species are chenopods, Short-leaf Bluebush (*Maireana brevifolia*) and Ruby Saltbush (*Enchylaena tomentosa* var. *tomentosa*). Surveys found up to 25 perennial native plant species and up to 11 annual native plant species in 30m x 30m quadrats, although diversity at a site may be higher. This floristic group occurs on loam soils of hill slopes and plains along the eastern hills, from Eudunda to Mt Bryan (Neagle 2008a).

Apart from the variations in species dominance, frequency of occurrence of co-dominant species and characteristic species (above), these floristic groups have many species in common and intergrade with each other at some sites.

Many annual and perennial native forbs occur in the ecological community, and can constitute 60% or more of the native plant species diversity at a site (e.g. Hyde 2000). Commonly represented plant families include:-

daisies - e.g. Scaly Buttons (*Leptorhynchos squamatus* subsp. *squamatus*), New Holland Daisies (*Vittadinia* spp.), Minnie Daisy (*Minuria leptophylla*), Small Yellow-heads (*Triptilodiscus pygmaeus*), Lemon Beauty-heads (*Calocephalus citreus*), Sunrays (*Hyalosperma* spp.) and Everlastings (*Rhodanthe* spp.);

lilies - e.g. Common Vanilla Lily (*Arthropodium strictum*), Nodding Vanilla-lily (*A. fimbriatum*), Bulbine-lily (*Bulbine bulbosa*), Flax-lilies (*Dianella* spp.), Fringe-lilies (*Thysanotus* spp.), and Early Nancy (*Wurmbea dioica* subsp. *dioica*);

chenopods - e.g. Wingless fissure-plant (*Maireana enchylaenoides)*, Bottle Fissure-plant (*M. excavata*), Climbing Saltbush (*Einadia nutans* subsp. *nutans*), Berry Saltbush (*Atriplex semibaccata*) and Frosted Goosefoot (*Chenopodium desertorum* subsp. *desertorum*);

native primroses - e.g. Cut-leaf Goodenia (*Goodenia pinnatifida*), Small-flower Goodenia (*G. pusilliflora*) and Spur Velleia (*Velleia paradoxa*); and

peas – e.g. Twining Glycine (*Glycine rubiginosa*), Behr's Swainson-pea (*Swainsona behriana*), and Scurf-peas (*Cullen* spp.).

The native plants most commonly recorded in Biological Surveys of Iron-grass Natural Temperate Grassland (BDBSA 2010) are listed in Appendix 6.

Trees and tall shrubs are either absent in the ecological community, or occur as scattered individuals with canopy cover totalling less than 10%. Low shrubs occur more frequently but their cover is still low. The most common tree species is Drooping She-oak (*Allocasuarina verticillata*). Golden Wattle (*Acacia pycnantha*) also occurs either as a small tree, or shrub. *Eucalyptus* species occur rarely and are likely to be associated with adjoining woodlands, but may include Inland South Australian Blue Gum (*E. leucoxylon* subsp. *pruinosa*), Peppermint Box (*E. odorata*), and Mallee Box (*E. porosa*) (BDBSA 2010).

The most frequently recorded shrubs in Iron-grass Natural Temperate Grassland remnants include Sweet Bursaria (*Bursaria spinosa* subsp. *spinosa*), Long-flower Cryptandra (*Cryptandra campanulata*), Ruby Saltbush (*Enchylaena tomentosa* var. *tomentosa*), Common Eutaxia (*Eutaxia microphylla*), Short-leaf Bluebush (*Maireana brevifolia*) and Silky Riceflower (*Pimelea micrantha*) (BDBSA 2010).

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Appendix 6: Native plant species commonly recorded in the Iron-grass Natural Temperate Grassland of South Australia ecological community

Species frequency in Biological Survey sites classified as Iron-grass Natural Temperate Grassland, compiled from the Biological Survey Data Base of SA, May 2009

		Sites	Records in Sites according to EPBC Confidence rating				Previous species coding		
Species	**Common name**	**Total**	**High**	**Med**	**Low**	**Very Low**	**Davies 1997**	**Robertson 1998**	**Specht 1972**
		143	84	16	39	4			
Lomandra effusa	Scented Iron-grass	100	59	12	26	3		2	VC
Convolvulus sp. (syn. *C. erubescens*)	Australian Bindweed	80	55	5	17	3			C
Aristida behriana	Brush Wire-grass	83	54	8	19	2	A	2	C
Lomandra multiflora subsp. *dura*	Stiff Iron-grass	92	53	11	26	2		2	VC
Oxalis perennans	Native Sorrel	78	46	6	23	3			R
Wahlenbergia luteola	Yellow-wash Bluebell	66	44	3	17	2	A		
Euphorbia drummondii (syn. *Chamaesyce drummondii*)	Caustic Weed	67	43	6	16	2		2	C
Maireana enchylaenoides	Wingless Fissure-plant	71	42	6	21	2			
Austrodanthonia caespitosa	Common Wallaby-grass	75	41	8	23	3			VC
Austrostipa blackii	Crested Spear-grass	68	40	7	18	3	A	2	
Austrostipa nitida	Balcarra Spear-grass	50	40	3	7				
Goodenia pinnatifida	Cut-leaf Goodenia	61	40	5	14	2	A	2	
Vittadinia gracilis	Woolly New Holland Daisy	67	38	7	19	3	A		
Ptilotus spathulatus	Pussy-tails	*44	34	2	6	2			R
Vittadinia cuneata var. *cuneata*	Fuzzy New Holland Daisy	*39	28	3	7	1		2	
Austrostipa eremophila	Rusty Spear-grass	45	27	7	8	3			C
Minuria leptophylla	Minnie Daisy	35	25	2	7	1		2	
Triptilodiscus pygmaeus	Small Yellow-heads	38	23	5	9	1	A	2	
Goodenia pusilliflora	Small-flower Goodenia	36	22	2	10	2			
Leptorhynchos squamatus subsp. *squamatus*	Scaly Buttons	25	22		3			2	
Chrysocephalum apiculatum	Common Everlasting	34	21	3	9	1		2	R
Enneapogon nigricans	Black-head Grass	38	21	3	13	1	A	2	C
Austrodanthonia eriantha	Hill Wallaby-grass	32	20	1	10	1		2	
Austrostipa nodosa	Tall Spear-grass	42	19	6	16	1			
Austrostipa setacea	Corkscrew Spear-grass	21	18	1	2		A	2	
Stackhousia monogyna	Creamy Candles	32	18	4	9	1		2	
Austrodanthonia setacea	Small-flower Wallaby-grass	29	16	2	10	1			
Calocephalus citreus	Lemon Beauty-heads	24	16	1	5	2	A	2	
Cryptandra campanulata (syn. *C.* sp. Long hypanthium (C.R. Alcock 10626))	Long-flower Cryptandra	24	16	2	5	1	A	2	
Vittadinia blackii	Narrow-leaf New Holland Daisy	23	16	1	6		A	2	
Sida corrugata var. *corrugata*	Corrugated Sida	*18	14	1	2	1	A		
Arthropodium strictum	Common Vanilla-lily	36	14	4	16	2			R
Bursaria spinosa subsp. *spinosa*	Sweet Bursaria	38	14	7	16	1			
Glycine rubiginosa	Twining Glycine	*19	13		5	1			
Einadia nutans subsp. *nutans*	Climbing Saltbush	*18	13		4	1			R
Asperula conferta	Common Woodruff	22	13	1	7	1		2	
Atriplex semibaccata	Berry Saltbush	19	13	1	4	1	A	2	R

		Sites	Records in Sites according to EPBC Confidence rating				Previous species coding		
Species	**Common name**	**Total**	**High**	**Med**	**Low**	**Very Low**	**Davies 1997**	**Robertson 1998**	**Specht 1972**
Austrodanthonia auriculata	Lobed Wallaby-grass	24	13	4	6	1	A	2	
Convolvulus remotus	Grassy Bindweed	25	13		11	1			
Maireana excavata	Bottle Fissure-plant	22	13	2	7		A		
Austrostipa elegantissima	Feather Spear-grass	22	12	4	5	1			R
Elymus scaber var. *scaber*	Native Wheat-grass	21	12	1	8			2	
Ptilotus erubescens	Hairy-tails	17	12	2	2	1	A	0	
Rhodanthe pygmaea	Pigmy Daisy	22	12	2	6	2			
Austrostipa scabra subsp.	Rough Spear-grass	*21	11	3	7				VC
Bulbine bulbosa	Bulbine-lily	28	11	6	10	1		2	
Leptorhynchos tetrachaetus	Little Buttons	20	11	3	5	1	A	2	
Themeda triandra	Kangaroo Grass	30	11	5	12	2		2	R
Arthropodium fimbriatum	Nodding Vanilla-lily	17	10		7		A	2	
Plantago varia	Variable Plantain	13	10		3			2	
Vittadinia megacephala	Giant New Holland Daisy	13	10	1	2			1	
Dianella revoluta var. *revoluta*	Black-anther Flax-lily	*15	6	4	3	2			
Wurmbea dioica subsp. *dioica*	Early Star-lily	*19	9	2	7	1		2	R
Rumex dumosus	Wiry Dock	*10	9	1				1	
Austrodanthonia carphoides	Short Wallaby-grass	*9	8		1			2	
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush	*15	5	4	4	2			
Austrodanthonia pilosa	Velvet Wallaby-grass	*10	7		3				
Lomandra micrantha subsp. *micrantha*	Small-flower Mat-rush	*7	2	1	3	1		1	
Pimelea curviflora var.	Curved Riceflower	*3	2		1		A		

*This is an underestimate of frequency due to taxonomic variations

EPBC Confidence rating = confidence that the vegetation represents the Iron-grass Natural Temperate Grassland ecological community according to the definition in the EPBC Act Policy statement 3.7 (Australian Government 2007).

A total of 156 sites in the biological survey database were considered in a desk-top assessment for EPBC Confidence. These include sites where *Lomandra multiflora* subsp. *dura* and/or *L. effusa* were present as overstorey or understorey dominants or emergents, and sites where *Lomandra* was present in either Tussock Grassland, Hummock Grassland or Sedgeland formation. Of these, 143 sites were classified as having High, Medium, Low or Very Low confidence of being Iron-grass Natural Temperate Grassland from assessment of vegetation structure, species composition and site photo. The remaining 13 sites were determined as not Iron-grass Natural Temperate Grassland.

High confidence

- *Lomandra multiflora* subsp. *dura* or *L. effusa* as overstorey dominants
- Area of existing or pre-European mapping of grassland
- High percentage of 'grassy habitat' species

Medium Confidence

- *Lomandra* sp. as understorey dominant, overstorey trees and shrubs likely to be less than 10%

Low Confidence

- *Lomandra* sp. as understorey dominant, overstorey trees and shrubs may be more than 10%

References for definitions and sources of coding for species previously listed as grassy ecosystem species:

Australian Government (2007), *EPBC Act Policy Statement 3.7 Nationally Threatened Species and Ecological Communities: Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia*, Australian Government Department of the Environment and Water Resources, Canberra.

Davies, R. J.-P. (1997), *Weed Management in Temperate Native Grasslands and Box Grassy Woodlands in South Australia*, Black Hill Flora Centre, Athelstone, South Australia. Table 1, page 6. Plant species which are largely confined, in the agricultural regions of South Australia, to native grasslands and grassy woodlands. "A" signifies listed in table.

Robertson, M. (1998), *A Biological Survey of Grasslands and Grassy Woodlands of the Lofty Block Bioregion of South Australia 1995-1996*, Department for Environment, Heritage and Aboriginal Affairs, South Australia. Table 7, page 21. Native species occurring predominantly (75% or more of quadrat records) in grassy vegetation in Lofty Block Bioregion. 2, 1, 0 are varying levels of significance of association with grassy vegetation sites.

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Appendix III page 259. Plant Species Recorded in the "Savannah" land systems. 1. Native species. Association: Lomandra dura-L. effusa, Burra Terowie region (original source Jessup 1948). VC=very common, C=common, R=rare, X=present.

Appendix 7: Native fauna of Iron-grass Natural Temperate Grassland of South Australia

The following information on macro-fauna of the Iron-grass Natural Temperate Grassland ecological community is based mainly on biological surveys of *Lomandra multiflora* subsp. *dura* Open Tussock Grassland and *Lomandra effusa* Open Tussock Grassland in the Mid North, as reported in Neagle (2008a) and Hyde (2000).

Mammals

Large mammals are the most conspicuous native animals in Iron-grass grasslands, but contribute least to species diversity. The Western Grey Kangaroo (*Macropus fuliginosus*) is the most commonly recorded species. Euros (*M. robustus*) (Neagle 2008a) and Red Kangaroos (*M. rufus*) (Hyde 2000) are less frequent. Four species of bats have also been recorded in surveys at Iron-grass Natural Temperate Grassland sites: Gould's Wattled bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*C. morio*), Southern Freetail-bats (*Mormopterus* species complex) and White-striped Freetail-bat (*Tadarida australis*). These probably forage for grassland insects, but may rely on nearby woodlands for roosting habitat (Brandle 2008a). Short-beaked Echidnas (*Tachyglossus aculeatus*) are likely to occur and have been sighted or recorded in other native grassland vegetation within the distribution range of Iron-grass grasslands (Neagle 2008a, Appendix 16; J.Turner, personal observation). Other small to medium-sized terrestrial mammals that may have been part of the ecological community, have not been recorded in recent surveys and are presumed extinct (Brandle 2008a).

Birds

Bird species richness at grassland sites is low compared with other structural vegetation groups (Neagle 2008b). Twenty-nine bird species, including three exotic species, were recorded in Iron-grass Natural Temperate Grassland and other associated tussock grasslands at Mokota Conservation Park (Hyde 2000). Birds recorded are predominantly ground-feeding and ground-nesting species; insect, seed and leaf-eating specialists; or birds of prey; and generalist species that forage in open spaces. The Galah (*Eolophus roseicapillus* syn. *Cacatua roseicapilla*) is the most commonly recorded native bird in Iron-grass Natural Temperate Grassland (Neagle 2008b). Richard's Pipit (*Anthus novaeseelandiae*) is the most characteristic species, indicative of the grassland bird assemblage (Neagle 2008a, 2008b). Other frequently recorded species include Brown Songlark (*Cincloramphus cruralis*), Little Raven (*Corvus mellori*), Wedge-tailed Eagle (*Aquila audax*), Australian Magpie (*Cracticus tibicen*), Crested Pigeon (*Ocyphaps lophotes*) and Common Bronzewing (*Phaps chalcoptera*). Grassland specialist birds recorded in general surveys include Stubble Quail (*Coturnix pectoralis*) and Little Button-Quail (*Turnix velox*) (Hyde 2000). Emus (*Dromaius novaehollandiae*) can be seasonally abundant (Hyde 2000).

The Plains-wanderer (*Pedionomus torquatus*) is a ground-dwelling bird of sparse native grassland (Baker-Gabb 1998), rated as vulnerable nationally and endangered in SA. Iron-grass Natural Temperate Grassland is potential habitat for Plains-wanderers (Threatened Species Scientific Committee 2007) if the habitat structure suits their requirements (NPWS 2002). There has been a recent, unconfirmed sighting of a Plains-wanderer near Mokota Conservation Park (M. Robertson pers. comm.).

The Australian Bustard (*Ardeotis australis*) is a ground-nesting bird of grasslands, grassy woodlands and shrublands (Garnett and Crowley 2000). The species is rated nationally as 'least concern' (Garnett and Crowley 2000), but listed as vulnerable in South Australia. Australian Bustards have been recorded in grassy habitats in the Lofty Block and adjoining bioregions, including in Iron-grass Natural Temperate Grassland at Mokota Conservation Park (M. Robertson pers. comm.).

Reptiles

Formal survey effort and trapping rates for reptiles in Iron-grass Natural Temperate Grassland have been relatively low (Brandle 2008b) making it difficult to draw

conclusions on commonly occurring and characteristic species of the ecological community. The Flinders Worm Lizard (*Aprasia pseudopulchella*) strongly favours grassland habitats (Brandle 2008b) and was the most frequently observed reptile species in surveys at *Lomandra multiflora* subsp. *dura* Open Tussock Grassland sites in the Mid North (Neagle 2008a). Other reptile species with higher than expected relative abundance in grasslands and recorded in Iron-grass Natural Temperate Grassland include Bougainville's Skink (*Lerista bougainvillii*), Dwarf Skink (*Menetia greyii*), Sleepy Lizard (*Tiliqua rugosa*) (Brandle 2008b, Neagle 2008a) and Central Bearded Dragon (*Pogona vitticeps*) (Hyde 2000). Shed skins of the Eastern Brown Snake (*Pseudonaja textilis*) have been observed in Iron-grass Natural Temperate Grassland (J. Turner, personal observation).

The Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) is a nationally endangered reptile associated with grassland habitats (BDBSA 2010). Iron-grass Natural Temperate Grassland is considered potential habitat for this species (Threatened Species Scientific Committee 2007). Pygmy Bluetongue Lizard populations have been found at sites described as degraded Iron-grass grassland (Hutchinson *et al*. 1994; Souter *et al*. 2007), and more recently in 'good quality Iron-grass grassland' (J. Schofield, pers. comm.) but these sites have not as yet been formally assessed against the EPBC condition class criteria.

The Flinders Worm Lizard (*Aprasia pseudopulchella*) is a nationally vulnerable species found in grassland and grassy woodland habitats including Iron-grass Natural Temperate Grassland (Neagle 2008a). Increased survey effort in South Australia found that the species is more common than previously thought and the Flinders Worm Lizard is no longer listed in the Threatened Species Schedules of the SA NPW Act. An assessment of its status in the Northern and Yorke region determined that Flinders Worm Lizard populations are stable or increasing and rated the species as 'least concern' (Gillam and Urban 2008).

Invertebrates

Insects, spiders and other invertebrates are a major component of fauna species diversity in grassland communities and have important roles in community functions. They pollinate many grassland forbs, recycle nutrients by consuming and breaking down plants and other organic matter and strongly influence soil structure and fertility (Curry 1994). They are important food for grassland birds and reptiles (e.g. Baker-Gabb 1998; Fenner *et al*. 2007); and create or provide habitat for other species (e.g. Curry 1994; Souter 2003).

Very little information is available on the invertebrates of Iron-grass Natural Temperate Grassland (N. Neagle, pers. comm.). Recent surveys of Iron-grass Natural Temperate Grassland sites in the Northern and Yorke Region found at least 34 different insect taxa from 10 different orders, including species of cockroach, earwig, grasshoppers, aphids, cicadas, bugs, thrip, lacewing, beetles, flies, midges, moths/butterflies and wasps (Queale and Neagle 2008, unpublished data). Eight non-insect invertebrate taxa were also recorded, representing six different orders including springtails, mites, centipedes, isopods, molluscs and earthworms (Queale and Neagle 2008 and unpublished data).

Wolf Spider (lycosid) and Trap-door Spider (mygalomorph) burrows are essential habitat for Pygmy Bluetongues Lizards (Souter 2003; Schofield 2006). These groups of spiders occur in Iron-grass Natural Temperate Grassland.

Larval host plants of some butterflies and moths (Lepidoptera) commonly occur in the ecological community, providing potential habitat for these species. The White-spot Skipper (*Trapezites luteus*), uses only *Lomandra* species, including Stiff Iron-grass as its larval food plant (Grund 2002) and has been recorded at Mokota Conservation Park (Hyde 2000). This species is considered vulnerable in South Australia (Grund 2009). Other butterflies and their host plants recorded by Hyde (2000) in Iron-grass Natural Temperate Grassland include the Painted Lady (*Vanessa kershawi*) which feeds on daisies including *Chrysocephalum apiculatum*, the Meadow Argus (*Junonia villida*)

which uses native plantains, (*Plantago* spp.) and the Common Grass Blue (*Zizina labradus*) which uses native peas, including *Swainsona* and *Cullen* species. The Two-spotted Line-blue (*Nacaduba biocellata*) which feeds on *Acacia* species, including *A. pycnantha*, also has been recorded at an Iron-grass Natural Temperate Grassland site (Queale and Neagle 2008, unpublished data).

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Appendix 8: Weed species affecting the Iron-grass Natural Temperate Grassland of South Australia ecological community

Weeds currently posing the most significant threat to Iron-grass grasslands include:

- Annual grasses and herbs:– Wild/Bearded Oats (*Avena barbata*), Brome grasses (*Bromus* spp.), Saffron Thistle (*Carthamus lanatus*), Salvation Jane (*Echium plantagineum*), Clovers (*Trifolium* spp.), Medics (*Medicago* spp.), and other species;
- Perennial grasses:– African Feather Grass, Fountain Grass and Feather-top (*Pennisetum* spp.), Pussytail Grass (*Pentaschistis pallida*), Tall Wheat-grass (*Thinopyrum elongatum*), African Lovegrass (*Eragrostis curvula*), Phalaris (*Phalaris aquatica*), Cocksfoot (*Dactylis glomerata*), Perennial Veldt Grass (*Ehrharta calycina*) (sandy soils);
- Perennial herbaceous plants:– Horehound (*Marrubium vulgare*), Cape Tulip (*Moraea* spp.), Thread Iris (*Moraea setifolia*), Onion-grasses (*Romulea* spp.) and Wild Sage (*Salvia verbenaca*);
- Perennial woody weeds:- Olive (*Olea europaea*), Briar Rose and Dog Rose (*Rosa* spp.), Cotton bush (*Gomphocarpus cancellatus*), African boxthorn (*Lycium ferocissimum*), Boneseed (*Chrysanthemoides monilifera* subsp. *monilifera*), and tree and shrub seedlings from adjoining revegetation.

Annual exotic grasses and herbs are the most frequently recorded weed species at Iron-grass Natural Temperate Grassland survey sites (Hyde 1995; Davies 1997; Robertson 1998; Neagle 2008a; BDBSA 2010). Wild/Bearded Oats and Brome grasses are the most commonly encountered weed species in the ecological community and contribute the highest cover/abundance and weed biomass at most sites. These Mediterranean annual grasses have significant negative impacts on native species diversity in Iron-grass grasslands, directly through competition with native perennial grasses and forbs; and indirectly through build-up of litter, which suppresses regeneration of native grasses and forbs and favours regeneration of the exotic annual grasses (Lenz *et al.* 2003).

Needle grasses (*Nassella* spp.) and Coolatai Grass (*Hyparrhenia hirta*) (in the southern Lofty Block region) and Buffel Grass (*Cenchrus ciliaris*) (in the northern Lofty Block region) have not been recorded in Iron-grass Natural Temperate Grassland, but would have significant impacts on the ecological community if they invaded, and should be considered as potential threats.

Many small annual weed species, such as Hairgrasses (*Aira* spp.), Lesser Quaking Grass (*Briza minor*), Bulbous Meadow-grass (*Poa bulbosa*), Guildford Grass (*Romulea* spp.), Velvet Pink (*Petrorhagia dubia*), Pimpernel (*Anagallis arvensis*), are widespread and often abundant in Iron-grass Natural Temperate Grassland. Generally these only have dominant cover in degraded grassy ecosystems with a long history of sustained heavy grazing, are difficult to control and are considered a lower threat to native biodiversity than the other species listed above.

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