

Recovery Plan for

Lachnagrostis limitanea
(Spalding Blown Grass)

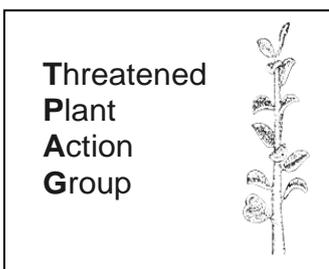
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Water and Natural Resources



Australian Government

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This recovery plan sets out the actions necessary to stop the decline of, 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 individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and 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.

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Abbreviations

ARG	Australian Rail Group
BDBSA	Biological Databases of South Australia
BEST	Biodiversity and Endangered Species Team
BGA	Botanic Gardens of Adelaide
DEH	South Australian Department for Environment and Heritage (now DEWNR)
DENR	South Australian Department of Environment and Natural Resources (now DEWNR)
DEWNR	South Australian Department of Environment, Water and Natural Resources (previously DEH and DENR)
DPTI	South Australian Department of Planning, Transport and Infrastructure
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
IUCN	International Union for the Conservation of Nature
NAC	Northern Areas Council
NRM	Natural Resources Management
NYNRM	Northern and Yorke Natural Resources Management Board
ORS	Office of Recreation and Sport
TPAG	Threatened Plant Action Group
UN	United Nations

1. SPECIES INFORMATION

1.1 Species description

Lachnagrostis limitanea (Spalding Blown Grass) (J.M.Black) S.W.L.Jacobs (formerly *Agrostis limitanea*) is a member of the Poaceae (Gramineae in Jessop & Toelken 1986). *Lachnagrostis limitanea* is a short-lived tufted perennial grass, growing erect to 30-45 cm tall. Leaf blades are bright green to blue-green with in-rolled edges, slightly rough to touch with a 4-6 mm long colourless membrane (ligule) at the base of the leaf blade. Fertile heads are produced in the spring to autumn season when conditions are favourable. The flowering head is much branched, 8-20 cm long; becoming open and loose soon after emerging from the leaf sheath, branches whorled, slender; flowers tiny (approx. 3 mm long) and borne singly on fine branches. A distinctive feature of this species is its lack of awns.

Lachnagrostis billardierei, an annual, occurs in the same habitat and the two species may occur together. The most obvious difference is the presence of a bent awn, which is easily visible protruding from the seed in *L. billardierei*. *Lachnagrostis limitanea* seeds lack an awn. While the original description of the species (Black 1931) was based on a single specimen, its taxonomic status as a distinct species has been supported (Jacobs 2001).

1.2 Conservation Status

Lachnagrostis limitanea was listed under the synonym *Agrostis limitanea* (Spalding Blown Grass) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and under the South Australian *National Parks and Wildlife Act 1972* (NPW Act) as Endangered. The species is “Critically Endangered” according to IUCN criterion CRB2, due to its limited area of occupancy (less than 10 km²), severely fragmented subpopulations, and its inferred continuing decline (IUCN 2001).

1.3 Distribution

Lachnagrostis limitanea is endemic to the Northern Lofty Ranges Region of South Australia. Only three extant naturally occurring and one translocated subpopulations are known. The known extent of occurrence is less than 1,000 square kilometres (obtained from mapping software using minimal convex polygons) and the area of occupancy is less than one hectare. Figure 1 shows the current known national distribution, and geographic locations of subpopulations.

In 1931, J.M. Black reported the distribution of *Lachnagrostis limitanea* as: “Northern Lofty (known from only one collection from near Riverton).” Riverton is adjacent to the Gilbert River; however the recorded location details indicated only that the species occurred as tussocks inside the railway fence. Some searches were undertaken at Riverton during the 1990’s, but failed to relocate the species (Davies 1995) and it was presumed extinct at the type location.

The species was not recorded again until 1989 when R. Bates collected it from a small water reserve on the upper Broughton River, near Spalding. This population (known as Yakkalo after the nearby waterhole) is still the main subpopulation known. A second subpopulation was discovered in 1994 on a rail reserve north of Tarlee. A subpopulation was discovered on a water reserve outside the town of Saddleworth in the early 1990’s, however the site did not receive the appropriate management and the species is believed to have become extinct at this location (R. Bates, pers. comm. 2005).

A third subpopulation was discovered in 2005 along a disused rail reserve just outside Riverton, and this is thought to be the type location (R. Bates, pers. comm. 2005). The Riverton site is located on the Mawson (cycling) Trail. A single individual was also located along Logan's Creek, on private property northwest of World's End, but is now believed to be extinct.

Potential suitable habitats in the region were searched for the species in 1997/8, focusing on road, rail and other minor reserves intersected by watercourses. A number of creek lines in the Spalding area were also unsuccessfully searched in 2005 (data held in the DEWNR office in Clare). Drainage lines and railway reserves throughout the species' range were searched unsuccessfully in 2007-2008 (Bates, unpublished).

1.4 Habitat that is critical to the survival of the species.

As this species is endangered, with a limited distribution, all known habitat in which *L. limitanea* occurs should be considered to be habitat critical to the survival of this species. Information on the habitat requirements of the species is limited to observations of the four known extant subpopulations. The known habitat consists of low-lying, flood-prone clay loam near watercourses in the Northern Lofty Flora Region of South Australia. All known extant populations occur in swampy habitat that is not regularly grazed by livestock.

Habitat of the major extant subpopulation (Yakkalo) is a swampy flat, on the banks of a perennial watercourse. Most of the area where *L. limitanea* occurs has moist surface soil throughout the year. The associated native vegetation is open sedgeland with Sea Rush (*Juncus kraussii*) and sedges over low-growing native herbaceous species, including: Beaded Samphire (*Sarcocornia quinqueflora*), Emu-grass (*Distichlis distichophylla*) and Creeping Brookweed (*Samolus repens*). The subpopulation of *L. limitanea* extends towards the river among stands of Common Reed (*Phragmites australis*), which dominate the riverbed. The associated soil is a clay loam of pH 9 ± 0.2 , which is light yellow brown when dry, and dark reddish-brown when wet. Soil salinity is fairly uniform across the site, although surface moisture varies.

The Tarlee subpopulation occurs on a rail reserve north of Tarlee, in the valley of the Gilbert River and is prone to seasonal flooding. The plant association at the site is a mixture of introduced and native grassland species, including Emu-grass (*Distichlis distichophylla*). The *L. limitanea* plants at the Riverton site are on the edge of a creek line dominated by Common Reed (*P. australis*), while the Logan's Creek site is a swamp dominated by Sea Rush (*J. kraussii*) and Common Reeds (*P. australis*). DEH (2005) details a full species list for Yakkalo and preliminary lists for Tarlee and Riverton. Additional areas in the Mid North meeting the environmental variables described above may be considered potential habitat for *L. limitanea*.

Figure 1 shows the location of the habitat critical to the survival of the species (the only known extant occurrences of the species).

1.5 Populations

Only four subpopulations are known and all but one are very small. Table 1 summarises their locations, abundance, land tenure and managing authority. Habitat types have been described above.

Table 1. *Lachnagrostis limitanea* subpopulations.

Site	Abundance (Established plants only)	Tenure	Manager
Yakkalo	4000+/-500 (2006 estimate)	water reserve and private land	NAC and landholder
Tarlee	61	rail reserve	DPTI*
Riverton	100	disused rail reserve	ORS
Logan's Creek	1 (possibly extinct)	private land	Landholder
Spalding 2009 Translocation	39	reserve	NAC
Total	4200 +/- 500		

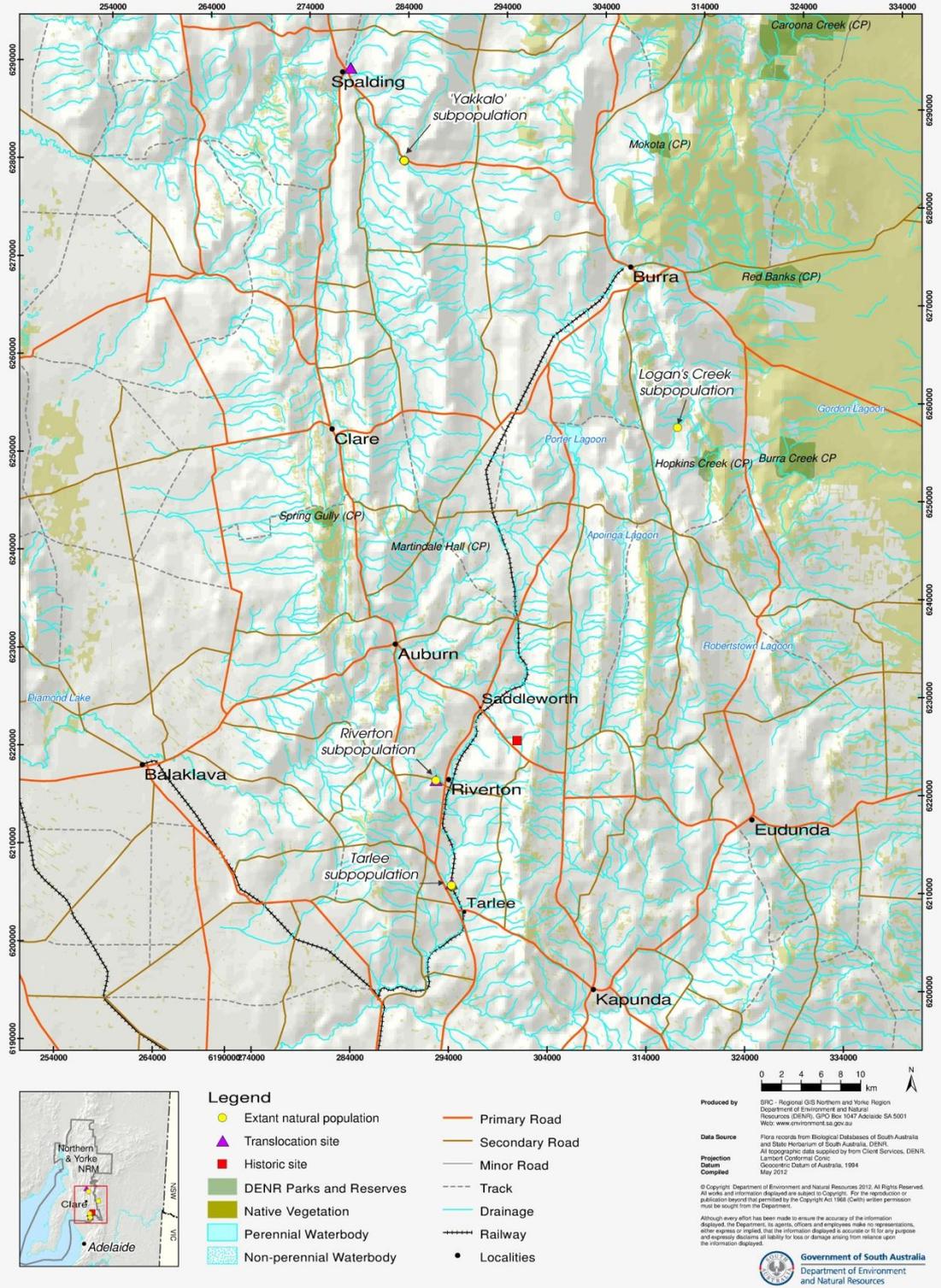
* This site is owned by the Department of Planning, Transport and Infrastructure and managed by Australian Rail Group.

A sub-set of the subpopulation at Yakkalo has been monitored since 1994 in 20 contiguous 5m x 5m grids. This monitoring appears to show fluctuations in the number of plants (Table 2). As a result of intensive management, the subpopulation at Tarlee has increased from six plants in 1994 to 61 adults in 2011.

Table 2. Results of *Lachnagrostis limitanea* monitoring at naturally occurring sites.

Date	Count	Translocated	Total
TARLEE			
1994	6		
2005	-	524?	530
2007	-	-	177
Jan-08	-	-	224
Dec-08	179	37	216
Dec-09	169	7	176
Oct-11	56	5	61
RIVERTON			
2005	2	0	2
2007	2	0	2
Dec-08	3	23	26
Dec-09	-	-	approx. 200
Oct-11	-	-	100
YAKKALO GRID			
Jul-94	732		
Jun-95	296		
May-96	212		
Sep-97	257		
Oct-98	563		
Oct-99	679		
Jan-06	315		
Jan-08	257		
Dec-08	261		
Dec-09	157		
Oct-11	80		

Figure 1.
Distribution of known historic and extant subpopulations of *Lachnagrostis limitanea*



1.6 Biology and ecology relevant to threatening processes

This species occurs on flat to gently undulating land, along streams. The habitat has been almost entirely cleared for cereal cropping and pasture in the Northern Mount Lofty Ranges Region. These low-lying areas are generally dominated by alien plant species. The profile and hydrology of most streams in the region have been altered by the replacement of native perennial vegetation with annual crops over wide areas, and by stock watering.

Lachnagrostis limitanea is a short-lived, shallow-rooted perennial grass that is highly susceptible to grazing. It occurs in permanently moist drainage lines that are particularly prone to weed invasion and are generally accessible to stock. Little is known about its specific habitat requirements. A fire escaping from adjacent farmland in 1997 burnt the main Yakkalo site, but the subpopulation doubled in the following year. To germinate, seeds typically require bare ground and rain at the appropriate time, and can be readily cultivated from seed (T. Jury, TPAG, pers. comm. 2005). In the wild, healthy green leaves are most evident in spring to summer and abundant fertile heads may be produced in spring to autumn when conditions are favourable. Flower spikes are produced in March. Seeds are small (less than 2 mm) and readily spread by wind and presumably water. The entire seed head also readily breaks off and can be dispersed as a unit. In cultivation it has also produced new plants from runners (D. Potter, Blyth Native Nursery, pers. comm. 2001).

While *L. limitanea* grows among dense reeds (*Phragmites australis*) and other native wetland plants on the edge of the Broughton River, it does not survive invasion of its habitat by large alien perennial grasses such as Phalaris (*Phalaris aquatica*) and Tall Wheat Grass (*Thinopyrum elongatum*).

1.7 Identification of threats

The threats to the survival of *L. limitanea* are identified in Table 3 and addressed in more detail below.

Table 3: Identified Threats to the Recovery of *Lachnagrostis limitanea*

Threats	Threat to Short-term Survival	Threat to Long-term Survival
Competition from weeds	High	High
Grazing	High	High
Lack of formal protection	Medium	High
Small isolated populations	Medium	High
Lack of genetic variation	Medium	High
Lack of knowledge	Medium	Medium
Chemical pollution	Unknown	Unknown
Altered hydrology	Low	Unknown- potentially high
Climate change	Low	Unknown- potentially high

1.7.1. Competition from environmental weeds

All the subpopulations of *L. limitanea* occur in modified habitats that are dominated by alien plant species to varying degrees, particularly annual grasses. The species occurs on remnant native grasslands existing as narrow strips adjacent to agricultural land and transport corridors. These habitats are also threatened by invasion of perennial weeds.

1.7.2. Grazing

Lachnagrostis limitanea appears to be highly susceptible to grazing by domestic stock (T Jury, TPAG, pers. comm. 2005). The subpopulation outside Saddleworth is believed to have become extinct as a result of grazing pressure and the first translocation attempt was unsuccessful due to the delay in erecting a stock fence. At the Yakkalo subpopulation, plants colonising the edges of a cropping paddock on private land adjacent to the reserve do not survive stock grazing in summer, indicating that continued exclusion of stock is needed to protect the population. Grazing is likely to be the single biggest threat to any unknown subpopulations on private land.

1.7.3. Lack of formal protection

Currently Yakkalo, which is under Heritage Agreement, is the only known subpopulation of *L. limitanea* occurring within any areas formally protected for conservation. All but one of the known sites are located on land such as water or rail reserve managed by public authorities. The recovery effort is largely dependent on the continued support of landowners and managers. Lack of protection results in a higher level of risk to the species from threats such as clearing, disturbance, or change of land management practices.

1.7.4. Small isolated populations

Lachnagrostis limitanea is now found in four small, isolated subpopulations. Such subpopulations are more vulnerable to extinction by a single catastrophic event. The species is believed to be extinct at two former known locations. Extinction of any of the remaining subpopulations would have a significant impact on the species' potential for long-term survival. Small isolated subpopulations also have a high edge to area ratio and are more susceptible to factors such as exposure to fertiliser drift, grazing and weed invasion.

1.7.5. Lack of genetic variation

Small, isolated subpopulations are particularly at risk of genetic problems such as inbreeding depression. The three smallest subpopulations (Tarlee, Riverton and Logan's Creek) show no within-site genetic variability, most likely due to inbreeding (Jusaitis et al 2007).

1.7.6. Lack of knowledge

The ecological requirements and tolerances of *L. limitanea* are largely unknown, and this may impact on the ability of the Recovery Team to make appropriate management decisions. There is a particular lack of knowledge on the species' life history, hydrological requirements and salinity tolerances and seed longevity in-situ.

1.7.7. Chemical pollution

Chemical spray drift from adjacent farmland and the spraying of herbicide along the operational railway line is a threat to the Tarlee subpopulation.

1.7.8. Altered hydrology

Changes to agricultural practices and/or diversion of water from natural streams may result in altered hydrology and/or salinity levels at each of the wild subpopulations. Developments upstream could have significant impact, even if occurring at some distance from the subpopulations. The impact of altering hydrology is unknown.

1.7.9. Climate change

The nature of the potential impacts of climate change on this species is currently unknown, but may be severe. *Lachnagrostis limitanea* is confined to moist habitats; if the climate becomes much drier and/or more variable, the habitat occupied by the species may become unsuitable. At present the best insurance against the risk of climate induced extinction is to conserve seed ex-situ, maximise the number of subpopulations, reduce weed competition, increase genetic diversity within sites to maximise adaptive potential, and identify potential future suitable translocation sites (as indicated by regional climatic change models).

1.8 Areas and subpopulations under threat

All subpopulations of *L. limitanea* are endangered by the threats discussed above, although these may manifest themselves in different ways at each of the four locations.

- Yakkalo

The Yakkalo subpopulation is threatened by invasion of Phalaris (*Phalaris aquatica*) and other weeds and is dependent on a continuing management program to abate this threat. The site is fenced to protect it from stock grazing and inadvertent disturbance by maintenance activities and vehicles.

- Tarlee

The Tarlee subpopulation is vulnerable to chemical spray drift from adjacent farmland and the spraying of herbicide along the operational railway line. The subpopulation is particularly vulnerable to competition from weeds and further weed invasion due to its small size, the narrowness of the site and the dominance of non-native species. Tall Wheat-grass (*Thinopyrum elongatum*) is threatening the site. It may also suffer from the effects of inbreeding depression, because the subpopulation was reduced to only three individuals in the mid 1990's. This subpopulation is also under threat from occasional stock grazing. The fencing is inadequate, with a number of gaps, and it fails to completely exclude cattle during the occasional stock movement along the road.

- Riverton

The most obvious and immediate threat to the subpopulation at Riverton is competition from weeds. Many of the weeds typically associated with disturbed grasslands in the Mid North occur at this site. *Lachnagrostis limitanea* is also threatened by a dense stand of *Casuarina glauca*, which is invading the rail corridor from the western side. Neighbouring agricultural practices may also leave the subpopulation vulnerable to further weed invasion. As the *L. limitanea* plants are located along a public walking/cycling trail there is a risk of disturbance of the site by members of the public and the introduction of new weed species. There is also potential for the subpopulation at this site to be affected by in-breeding depression, due to the extremely small number of original individuals (two).

- Logan's Creek

To date, only a single *L. limitanea* individual has been located. Seeds have been collected from this plant but translocation at the site has not been successful. Grazing by livestock has continued at the site and the population is believed to be extinct. .

2. RECOVERY PROGRAM

2.1 Past and Current Management Actions

2.1.1. Recovery Team

The Spalding Blown Grass Recovery Team was formed in late 1998. The Recovery Team provides linkages between local and non-local stakeholders and its membership includes: Spalding Community Management Committee, TPAG, NAC, DEWNR, DPTI, Greening Australia regional representatives, University of Adelaide and private landowners. The Recovery Team meets twice a year in the Mid North. Contact between the Threatened Plant Action Group (TPAG), DEWNR and the local community is maintained between meetings. The Recovery Team is providing guidance and broadening participation in the recovery process.

2.1.2. Site management

Intensive on-ground work by members of TPAG and project management by the Northern & Yorke Region of DEWNR are currently driving the recovery of *L. limitanea*. Land managers and neighbouring landowners have contributed substantially. All land managers are aware of the presence of, and the management issues for, *L. limitanea*.

Site Action Plans are being implemented for the Tarlee, Yakkalo and Riverton subpopulations (DEH 2005). The management of each site is designed to restore the mainly perennial native plant community, which should reduce invasion by annual weeds to manageable levels in the longer term. Selective weed control is ongoing at these three sites. Large perennial species are removed by hand and direct application of herbicide. Annual weed species are controlled by slashing (timed to prevent seed set), hand pulling and spot spraying. Weeding progresses outwards from the subpopulation, and the area of habitat under active management is increased each year with an equivalent amount of effort. The Site Action Plans list the most suitable treatments for the major weeds occurring at the 3 larger sites.

2.1.3. Monitoring

A sub-set of the Yakkalo subpopulation and the total size of the smaller subpopulations are monitored on an ongoing basis. A monitoring plan has been developed to ensure consistent monitoring between sites, observers and years.

2.1.4. Research

The genetic relationships within and between subpopulations of *L. limitanea* was recently examined by Jusaitis *et al.* (2007) indicating that:

- a) All four subpopulations are genetically distinct;
- b) Most of the genetic diversity is in the largest natural subpopulation (Yakkalo);
and
- c) The Logan's Creek, Riverton and Tarlee subpopulations show no within-site genetic variability, with inbreeding the most likely cause.

2.1.5. Habitat Surveys

Previous surveys for new subpopulations have been undertaken on public lands, such as road, rail, water and other minor reserves belonging to local councils or the Crown. Few surveys have been conducted in suitable habitat on private land.

2.1.6. Ex situ conservation

The subpopulations at Riverton and Tarlee have been augmented by plants grown *ex situ*. The plants re-introduced to each site were grown from seed collected from that site. At Riverton the translocated plants have established and increased in number, whereas the Tarlee translocation has resulted in the death of a few and the survival of most.

A mixed-gene translocation trial is underway. The Freshwater Creek/Howley's Crossing site on the outskirts of Spalding, (approximately 10km north-west of the Yakkalo site) has been chosen as the most suitable site. This site contains suitable habitat, is council reserve and is managed by Northern Areas Council. A detailed translocation plan has been developed in line with the guidelines of the Australian Network for Plant Conservation (Vallee *et al.* 2004).

A previous attempt at translocation near Gulnare (detailed in Steed, 2002) was unsuccessful.

Table 4. Translocated *Lachnagrostis limitanea* plants at Spalding site.

Date	Alive	Dead
Dec-2009	54	7 +
Oct-2011	36	

2.1.7. Previous recovery plan

The recovery objectives of the previous plan (Robertson and Steed 2000) were to: increase the extent of occurrence; minimise loss of genetic variability; and increase the number of subpopulations, area of occupancy and abundance. Most of the specific recovery objectives were met, with the exception of area of occupancy, and the medium term goal of recovery (to increase the probability of survival) was met. However, the long term goal to improve the conservation status of the species, requires an ongoing active recovery program. An additional action not included in the previous plan was the re-stocking of the Tarlee population with propagated specimens.

The majority of actions implemented were successful, as shown by evaluating the Performance Criteria:

- 1) *Yakkalo subpopulation maintains or increases area of occupancy and abundance within 5 years* – Achieved
- 2) *Tarlee subpopulation protected from major threats and increased abundance to 50 ± 10 plants within 5 years* – Achieved. Tarlee subpopulation had 117 adults in 2006.
- 3) *Seed from all known populations collected and stored* – Achieved. Seed was collected for long term storage from Yakkalo and Tarlee (2005) and Riverton (2007).
- 4) *At least 2 translocation sites selected, fenced and management agreed, and new populations of at least 200 established within 5 years* – Not achieved. Attempted translocation at one site failed due to a fence not being constructed as land ownership was in doubt.
- 5) *Total number of plants in the wild increased from 700 to at least 1000 ± 100 within 5 years and at least 1800 within 10 years* – Achieved. Both the 5 and 10 year goals have been achieved, with the total population now over 3600.
- 6) *Total area of occupancy increased by 50% to 1.5 ha within 10 years through threat abatement and establishment of new subpopulations* - Not achieved. One

new subpopulation has been established, and 2 new subpopulations have been discovered (one of these is extant). The area of occupancy has thereby increased only marginally. In 2005 the area of occupancy was estimated as approximately 0.35 hectares: (Yakkalo = >500m²; Tarlee = 2880m²; Riverton = 2m²).

- 7) *Active involvement of the local community in the implementation, monitoring and promotion of recovery actions* - Partly achieved. Although the level of local community involvement in the recovery process was maintained, it did not increase.

See Appendix 1 for a review of implementation of recovery actions under the previous recovery plan.

2.2 Recovery objectives and timelines

The recovery objective is to prevent extinction of *Lachnagrostis limitanea*, maintain its genetic variation and improve its conservation status in the wild.

Over the next five years, the specific recovery objectives are to

1. Prevent total extinction and maintain genetic variation by ex situ storage of seed from all subpopulations.
2. Maintain area of occupancy and extent of occurrence by managing subpopulations in the wild.
3. Increase the size of smaller subpopulations to sustainable levels and increase genetic variability within existing small subpopulations by translocation and management of habitat.
4. Increase the number of known subpopulations by searching for unknown subpopulations and by implementing a translocation program. New sites for translocation may be outside existing extent of occurrence; therefore this action, if successful, will increase extent of occurrence as well as area of occupancy.

2.3 Performance criteria

The following performance criteria will be used to gauge whether the objectives have been achieved:

1. Seed from all known subpopulations is collected within one year and stored long term through the Seed Conservation Centre of DEWNR.
2. The population size and area of occupancy of the main subpopulation at Yakkalo are maintained and quality of habitat improved over five years.
3. The quality of habitat and size of smaller subpopulations at Tarlee and Riverton are increased within five years.
4. Supplementary translocations at Tarlee and Riverton are established, with at least 50% survival and evidence of recruitment within five years.
5. Two more subpopulations are established in addition to the existing three natural and one translocated subpopulations, within five years.
6. Co-operative joint management of the project, including the sharing of resources and information, and involvement of a wide range of stakeholders is maintained, or increased over five years.
7. No subpopulations become extinct within five years.

2.4 Evaluation of this recovery plan

The Recovery Team will play an active role in planning and implementing all actions, and monitoring the success of the project. Progress will be assessed against the recovery plan objectives at each meeting of the Recovery Team. The recovery plan will be thoroughly reviewed in Year 5 and, if necessary, will be revised and updated.

2.5 Recovery actions

Recovery actions are listed below in priority order. All actions are to be co-ordinated by and managed through the Threatened Flora Project Officer for the DEWNR Northern & Yorke Region and the Recovery Team.

- Action 1. Collect seed from all wild subpopulations, for: storage to minimise loss of genetic variation and prevent extinction; subpopulation enhancement; and translocations.
- Action 2. Continue threat abatement and site management (see DEH 2005 for details).
- Action 3. Enhance the small subpopulations (Tarlee, Riverton) by planting seedlings raised *ex situ*.
- Action 4. Establish two new mixed-gene subpopulations through translocation into suitable habitat.
- Action 5. Locate any existing unknown subpopulations.
- Action 6. Conduct research into the ecology and biology of *L. limitanea* in order to manage the species better.
- Action 7. Coordinate recovery program and increase the involvement of the local community in the recovery process.

Details of actions are described below. All management action will be appropriately recorded and documented.

Action 1. Collect and store seed

To secure the genetic variability of the species and provide a last defence against extinction, seed will be collected from all four wild populations. Seed collection will only occur when seed production within each subpopulation is sufficient so collection does not threaten the wild subpopulation. Members of the TPAG and regional DEWNR staff will collect the seed in conjunction with the Seed Conservation Centre. Collected seed will be used for: long-term storage of genetic material; use in the enhancement of the three small subpopulations (Action 3); and establishing a translocated population (Action 4).

Seed will be processed, tested for viability and stored at the Seed Conservation Centre of the Botanic Gardens of Adelaide (BGA). The seed will be re-tested to ensure its viability after the first and fifth year. A further collection may be required if the stored seed stored is not viable. This process will need to be repeated for any new subpopulation located.

Action 2. Threat abatement and site management

The aim is to improve the quality of *L. limitanea* habitat in order to minimise the possibility of a reduction in species abundance and/or extinction.

2.a) Encourage landholders to manage the areas for conservation

Liaison with land managers is essential to minimise the risk of deleterious activities, and to ensure these agencies/individuals support threat abatement. The Recovery Team will continue to liaise with the relevant landowners/managers to encourage them to manage sites for conservation, and ultimately consider the merits of placing the sites under Heritage Agreements.

2.b) Weed control

Selective weed control, as detailed in the Site Action Plans (DEH 2005) will continue at the Tarlee, Yakkalo and Riverton sites.

2.c) Fencing and signage

The fences at Yakkalo will be maintained and any new subpopulations threatened by stock grazing will be fenced as required. DPTI, ARG, DEWNR and TPAG will act co-operatively to ensure the fence at the Tarlee site is repaired. The Riverton subpopulation lies along the Mawson Trail, a public recreation area. This site will require interpretative signage to ensure the general public does not negatively impact on the species and to increase awareness of the Spalding Blown Grass Recovery Program.

2.d) Monitor subpopulations

All extant subpopulations will be monitored yearly to gauge the effectiveness of management actions and to assess population trends, in accordance with the monitoring plan. Data from all surveys and monitoring will be entered into the DEWNR Biological Databases (BDBSA).

The following will be monitored:

- Number of mature plants and seedlings;
- Area of occupancy (including areas adjacent to those managed);
- The number of plants flowering or in seed;
- Levels of herbivory;
- Extent of weed invasion or re-invasion.

Action 3. Enhance small subpopulations

Although the number of individual plants at Tarlee is increasing, the subpopulation is still very small, due to low levels of natural recruitment. Some of the seed harvested under Action 1 from the small subpopulations will be used to raise seedlings *ex situ* in the Blyth Nursery. Seedlings will then be transplanted to suitable habitat at the site the seed was collected (not in the immediate vicinity of existing plants). Once the results of the mixed-gene translocation test are known, seedlings from seed collected at different sites (including the Yakkalo site) may be used to enhance the genetics of each subpopulation.

Action 4. Establish two new mixed-gene subpopulations

Although the genetic study by Jusaitis et al (2007) recommends translocating seedlings of each subpopulation into all other subpopulations, the Recovery Team has decided on a more cautious approach of undertaking a mixed-gene translocation at a new non-historic site, as a controlled experiment. The Recovery Team will also reassess the need for additional translocations, based on the success of the experimental translocation, and the results of surveys for additional subpopulations. If the mixed-gene translocation proves successful, intermixing will be implemented at the four extant subpopulation sites (as described under Action 3.). The aim is to ensure all subpopulations are self-sustaining.

4.a) Site selection and planning

Sites for future translocations will be selected in the Mid North region, on flood plains and adjacent reedy watercourses where conditions are suitable, where the land is not otherwise required for incompatible land uses, and where appropriate protection and management can be implemented. In choosing sites, emphasis will be placed on areas of historical occurrence and land subjected to conservation agreements. As described in Section 2.1, a site for the mixed-gene translocation has been identified and a translocation plan developed. If further translocations are needed, a translocation plan

will be developed for each site, following the guidelines of the Australian Network for Plant Conservation (Vallee *et al.* 2004).

4.b) Prepare propagules

Seeds collected from all four extant subpopulations under Action 1 will be used. If there is insufficient seed, then seed from existing cultivated plants may also be used. Seed will be germinated and propagules maintained at the Blyth Nursery.

4.c) Site preparation, planting and maintenance, introduction of propagules

The Spalding site will be prepared through fencing, weeding, signage and the planting of other native species, as appropriate. For any possible future translocations, a management program will be prepared and implemented for each site prior to the introduction of any propagules.

4.d) Monitor translocated subpopulations

All translocated subpopulations will be monitored in accordance with the *L. limitanea* monitoring plan. Monitoring of translocated subpopulation will be timed to coincide with monitoring of the existing subpopulations (Action 2.4).

4.e) Genetic analysis of mixed-gene translocation

Samples from any germinants appearing in Year 2 will be taken for genetic analysis (allozyme electrophoresis) to determine if cross-population pollination has occurred and its effects on genetic diversity. Follow up monitoring will occur beyond the life of this project to determine the survivorship, growth and vigour of the resulting offspring and their parent plants. This information will be used to guide any future translocation efforts and inform management strategies for the existing sites.

Action 5. *Locate any existing unknown subpopulations.*

It is important to locate any unknown subpopulations, especially those on private land, due to the species' high susceptibility to grazing and potential need for weed control efforts. The Recovery team will increase community awareness to encourage reporting of sightings and active searching.

5.a) Increase landholder awareness.

Landowners know their properties best and they will be encouraged to identify areas of suitable habitat on their land. DEWNR staff will develop and circulate information on habitats where *L. limitanea* might be found, diagnostic characters of the species, and how to send in a herbarium specimen for identification. The Threatened Flora Ecologist and the Recovery Team will offer assistance with identifying specimens and habitat and follow up any contacts.

5.b) Search for new subpopulations

Areas of potential habitat on private land will be identified and DEWNR will liaise with landholders for permission to access properties for searches. Records of any newly discovered subpopulations will be entered into the DEWNR Biological Databases, herbarium specimens lodged in the State Herbarium, and the DEWNR member of the Recovery Team notified. Efficient communication within DEWNR, and between DEWNR and TPAG, is required to ensure that all those involved in the recovery effort are made aware of any new discoveries. The Threatened Flora Ecologist will perform periodic (every 6-12 months) searches of the herbarium database to ensure no collections have been made without the knowledge of the Recovery Team.

5.c) Manage any newly discovered subpopulations

A Site Action Plan will be written for any newly discovered subpopulations in order to identify threatening processes and to determine appropriate management actions. Necessary actions are likely to be in the form of weed control and fencing. Responsibilities for managing any newly discovered populations would be shared between DEWNR, TPAG and the appropriate land manager, with other landholders and the local community encouraged to play an active role where appropriate.

5.d) Monitor any newly discovered subpopulations

Monitoring of any newly discovered subpopulations will follow standard protocols and results will be entered in the DEWNR Biological Databases. Monitoring of newly discovered subpopulations will be timed to coincide with monitoring of the existing subpopulations under Action 2.4.

Action 6. Conduct research

Whilst some studies can be performed utilising the existing skills of the Recovery Team, and can be incorporated into existing management activities, other projects will require additional funding for DEWNR, university students or other researchers.

6.a) Conduct life history study

DEWNR will conduct a study to collect information regarding the life history of the species. A sample of the germinants appearing in Year 1 at all of the known subpopulations will be tagged and life history information (proportion surviving and length of juvenile and mature stages,) recorded. This can be performed in conjunction with the annual population monitoring and observations taken during routine site visits.

6.b) Research ecological requirements and tolerances

Research into the ecological requirements and tolerances of *L. limitanea* is needed in order to further refine management actions at the existing sites. This information may also be used to focus search efforts on the most suitable habitats and to allow developments or activities with the potential to impact on *L. limitanea*, to be more accurately identified. The highest priorities for research are hydrological requirements, salinity tolerances, and responses to disturbances such as fire.

Action 7. Coordinate recovery program and increase community involvement in the recovery process

7.a) Coordinate recovery program

The *Lachnagrostis limitanea* recovery program is currently overseen by a Recovery Team. The Recovery Team will direct recovery activities, regularly assess progress against the recovery objectives, and the members will report to their parent organisations on recovery activities. The continued involvement of all members is essential to achieving the objectives of this plan. Through the Recovery Team, landholders (both public and private) will be encouraged to recognise the sites under their control, and to build appropriate management strategies into their management plans.

7.b) Increase community participation in the recovery process

The Recovery Team will seek involvement of the local community, through councils, schools and interested individuals and community groups. The Recovery Team will promote the project locally, through regional media and field days.

DEWNR has established a community group in the Northern and Yorke Region: the Biodiversity and Endangered Species Team (BEST), to assist in implementing recovery

actions. Members of TPAG will assist in these activities, including training BEST volunteers in site management techniques.

2.6 Management practices

Management required for wild and translocated populations of *L. limitanea*, described above, can be integrated and summarised as follows:

- Fence each subpopulation and maintain liaison with management authorities to protect them from grazing and other physical disturbance such as grading.
- Integrate management to reduce fuel hazard and weed invasion and competition.
- Manage weeds using techniques and timing that minimise impact on all native species to improve habitat (See DEH 2005).
- Liaise with adjoining landholders to minimise chemical spray drift.
- Some upstream developments may impact on the species through changing hydrology or altering water quality. Such developments need to be avoided and the associated approval process needs to consider the potential impact on *L. limitanea* and its habitat.

Actions which may have a significant impact on *L. limitanea* are those occurring: in habitat critical to survival of the species, or within the local catchment area of a subpopulation, which could result in any of the following:

- Removal of, or damage to, *L. limitanea* plants;
- Disturbance to the soil (including compaction and erosion);
- Increase in weed density or abundance;
- Increase in grazing pressure;
- Increase in chemical use (including fertilizer and herbicides);
- Changes in hydrology.

2.7 Costs, duration and responsibilities

The costs, duration and responsibilities for recovery actions are shown in Table 5.

Table 5: Duration, responsibilities and estimated costs of recovery actions

Action	Responsible Parties	Year 1		Year 2		Year 3		Year 4		Year 5		TOTAL
		Project Costs	PO Salary Costs									
1 Collect and store seed*	DEWNR, TPAG, BGA	1500	357	100	357	100	0	100	0	1000	0	3514
2 Threat abatement & site management												
2.a) Landholder liaison	Rec Team, DEWNR	0	1784	0	1784	0	1784	0	1784	0	1784	8920
2.b) Weed control	TPAG, DEWNR, NAC, DPTI, ORS, ARG, landholder	11800	2854	12670	2854	12716	2854	13351	2854	14019	2854	78826
2.c) Maintain/erect fences & signs	DEWNR, NAC, ORS, DPTI, TPAG, landholder	6700	1070	500	357	525	357	551	357	579	357	11353
2.d) Monitor	DEWNR, TPAG	400	2498	100	1784	105	1784	110	1784	116	1784	10465
3. Enhance small subpopulations	TPAG, DEWNR, BGA	200	714	210	357	221	357	232	357	243	357	3248
4 Translocations												
4.a) Select sites and plan	Rec Team	3150	4638	500	4638	0	0	0	0	0	0	12926
4.b) Prepare propagules	DEWNR, TPAG	320	1070	560	1070	0	0	0	0	0	0	3020
4.c) Prepare sites, plant & maintain	DEWNR, TPAG	5000	2498	7250	4282	2200	3568	2310	3568	2426	3568	36670
4.d) Monitor translocations	DEWNR	200	714	100	1427	105	1427	110	1427	116	1427	7053
4.e) Study genetics	DEWNR	10273	2498	5000	1784	0	0	0	0	0	0	19555
5 Identify unknown subpopulations												
5.a) Increase landholder awareness	DEWNR, Rec Team	1000	5352	1050	5709	1103	2854	1158	2854	1216	2854	25150
5.b) Search for subpopulations	TPAG, DEWNR	2380	2498	4998	4995	2624	2498	2755	2498	2893	2498	30637

Action	Responsible Parties	Year 1		Year 2		Year 3		Year 4		Year 5		TOTAL
		Project Costs	PO Salary Costs									
5.c) Manage new subpopulations**	TPAG, DEWNR	**	**	**	**	**	**	**	**	**	**	
5.d) Monitor **	DEWNR	**	**	**	**	**	**	**	**	**	**	
6 Conduct Research												
6.a) Life history	DEWNR	100	2854	105	1784	110	1784	115	1784	122	1784	10542
6.b) Ecology	DEWNR, research institutions	0+	1784+	3000+	1784+	0+	0+	0+	0+	0+	0+	6568+
7 Coordinate recovery and increase involvement												
7.a) Coordinate recovery	DEWNR, Rec Team	6300	2498	6615	2498	6946	2498	7293	2498	7658	2498	47302
7.b) Community involvement	DEWNR, Rec Team, TPAG	1000	6422	1050	6422	1103	3568	1158	3568	1216	3568	29075
TOTAL		50323	42103	43808	43886	27858	25333	29243	25333	31604	25333	344824

Note: The successful implementation of this recovery plan will require one-third of the time of a regional threatened flora project officer (PO) and one-sixth the time of a community liaison officer, at a cost of \$30,923 and \$15,467 respectively, per year (including on-costs, office and operating expenses) for the first two years. After the first two years a smaller percentage of these two officers' time should be required to implement this plan. These salary costs have been broken down and for each recovery action and are included under the salaries component.

ARG – Australian Rail Group; BGA – Botanic Gardens of Adelaide; DEWNR – Department of Environment, Water and Natural Resources; DPTI – Department of Planning, Transport and Infrastructure; NAC – Northern Areas Council; ORS – Office of Recreation and Sport; Rec Team – Recovery Team; TPAG – Threatened Plant Action Group.

* Cost estimate for the four currently known populations. If further populations are located additional funding may be required.

** Action may not be required, and costs and timing cannot be estimated as it will depend on the number of additional populations found, when they are found, their location and the habitat condition at the site/s.

+ Cost shown is for liaison with potential researchers, cost of the ecological research is additional.

2.8 Resource allocation

The recovery of *Lachnagrostis limitanea* has been identified as a conservation priority in the Northern & Yorke Biodiversity Plan (Graham *et al* 2001). The Northern & Yorke Natural Resource Management Plan (NYNRM 2009) identifies Spalding Blown Grass as a valuable asset and the implementation of threatened species recovery plans is among its action targets. Investment in this program will also deliver gains in relation to other Natural Resource Management (NRM) objectives, such as weed control and the protection of grassland habitat. The implementation of this plan will also contribute to *No Species Loss: A Nature Conservation Strategy for South Australia 2007-2017* (DEH 2007).

While the objectives and actions from the recovery plan complement other regional biodiversity and natural resource management initiatives, the limited extent and site-specific nature of *L. limitanea* recovery means work at these sites will only occur through implementation of the recovery plan. Regional/landscape scale vegetation management approaches are highly desirable in many situations; however the conservation of this species can only be achieved through a species recovery approach. Support for this work is being sought through state sources and the Northern & Yorke NRM Board.

The involvement of DEWNR staff, the local council and local community members (including those associated with regional NRM planning and implementation) through the Recovery Team ensures that resources are used efficiently, unnecessary duplications are avoided and opportunities to coordinate regional activities are realised.

2.9 International Obligations

Lachnagrostis limitanea is not listed under any international agreement, therefore this plan will not impact on Australia's international obligations made under the Convention on Migratory Species or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1975). However the implementation of this Recovery Plan is in keeping with the principles of the Rio Declaration on Environment and Development (Agenda 21) (UN 1992a). This plan is also consistent with Australia's obligations under the United Nations Convention on Biological Diversity (UN 1992b), ratified by Australia in 1993, and the subsequent National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996).

2.10 Affected interests

The main subpopulation (Yakkalo) occurs on a small water reserve that is under the care and control of the Northern Areas Council (NAC). The council is involved in the Recovery Team and participates in decision-making that affects the reserve. A major pipeline along a pipeline easement is adjacent to the subpopulation and managers of the pipeline (SA Water) are consulted on any activities that may affect their interests. The subpopulation at Tarlee occurs on a railway reserve beside an operating railway line and the managers Australian Rail Group (ARG), and owners Department of Planning, Transport & Infrastructure (DPTI) are informed of all visits and consulted on any activities. *Lachnagrostis limitanea* individuals at Riverton occur along a public trail under the jurisdiction of the Office of Recreation and Sport (ORS), which is consulted on subpopulation management.

Local landholders adjoining the subpopulations are informed of all activities and a number are members of the Recovery Team. Spalding Primary School has also been involved in the establishment of a demonstration planting of the species on the school grounds.

2.11 Indigenous people

The relevant indigenous communities in the region affected by this plan (Mid North of South Australia) have been consulted through the Aboriginal Partnerships Unit, Department of Environment, Water and Natural Resources (DEWNR). The implementation of recovery actions under this plan will consider the role and interest of such communities.

The requirements of the *Native Title Act 1993* (NT Act) only apply to land where Native Title rights and interests may exist. When implementing any recovery actions in this threatened species plan where there has been no Native Title determination, or where there has been no clear extinguishment of Native Title, there needs to be consideration of the possibility that Native Title may continue to exist.

Generally, the NT Act requires certain procedures to be followed prior to undertaking activities – known as future acts that may include certain recovery actions in this plan – which may affect Native Title rights and interests. This threatened species plan is released and will be adopted subject to any Native Title rights and interests that may continue in relation to the land and/or waters. There are no actions in this plan intended to affect Native Title. The relevant provisions of the NT Act should be considered before undertaking any future acts that might affect Native Title. Procedures under the NT Act are additional to those required to comply with the *Aboriginal Heritage Act 1998*.

2.12 Benefits to other species

The main subpopulation of the species occurs in a relatively diverse remnant grassy wetland, which is also a regionally threatened plant community (Graham *et al* 2001). Recovery actions for *L. limitanea* will also benefit this threatened habitat and other species of regional conservation significance, such as *Eragrostis infecunda*, Cottonbush (*Maireana aphylla*), and Creeping Monkey Flower (*Mimulus repens*) (Briggs and Leigh 1996). The other natural subpopulations occupy highly modified sites, which are undergoing restoration. The recovery plan contributes to the conservation of grasslands in the region through protection and restoration of the sites. It also contributes to knowledge of intensive management techniques that can potentially be applied to other sites and species, and raises awareness of grassy wetland habitats in the region.

2.13 Social and economic impacts

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts. The area of land on which actions will be undertaken is small and, with the exception of the Logan's Creek site, is not used for productive purposes. The implementation of the plan does not require major expenditure or losses by the authorities responsible.

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APPENDIX 1: Evaluation of Implementation of Recovery Actions in the Previous Recovery Plan (Robertson and Steed 2000)

ACTION	IMPLEMENTATION	EVALUATION OF SUCCESS
1. Threat abatement for all known populations	Site Action Plans are being implemented for the Tarlee, Yakkalo and Riverton subpopulations (DEH 2005). The management of each site is designed to restore the mainly perennial native plant community.	
1.1. Control weeds through continuing use of selective techniques at both Yakkalo and Tarlee sites	Selective weed control is ongoing at three sites. The Site Action Plans list the most suitable treatments for the major weeds. Weed control has been conducted regularly (3-4 times / yr) at Tarlee, but more intermittently at Yakkalo and Riverton (3-4 times / yr since 2011). Minimal control at the Spalding Translocation site. Weed control was initiated at Logan's Creek, but not continued, as it is likely the species is extinct at this site.	Successful at 4 of the 5 sites - a noticeable decrease in weed coverage and increase in <i>L. limitanea</i> abundance
1.2. Exclude herbivory from Yakkalo and any other populations as required	Fencing is maintained at the three natural sub-populations. New plantings are protected initially with tree guards.	Successful
1.3. Exclude grading from Tarlee population through fencing, signage and liaison	Completed	Successful
2. Search for unknown populations in the Mid-North region	Surveys for new subpopulations have been undertaken in suitable habitat on public lands, along water reserves and adjacent road or rail reserves. Limited survey work has been conducted on private land. The area searched includes watercourses between Georgetown, Tarlee and Burra. As a result, the type location (Riverton) and the Logan's Creek subpopulation were found.	Successful
3. Collect and store seed from all wild populations to minimise loss of genetic variation	Seed was collected for long term storage from Yakkalo (2005) and Tarlee (2005) and Riverton (2007).	Successful

ACTION	IMPLEMENTATION	EVALUATION OF SUCCESS
4. Establish new populations through translocation into suitable habitat.		
4.1. Select sites with suitable environmental conditions and management	The Freshwater Creek / Howley's Crossing site on the outskirts of Spalding was chosen as the most suitable site for a mixed-gene translocation trial. This council reserve contains suitable habitat and is managed by Northern Areas Council.	Completed
4.2. Prepare sites by fencing and weed control, management agreements	A detailed translocation plan has been developed for the Spalding site, in line with the guidelines of the Australian Network for Plant Conservation (Vallee <i>et al.</i> 2004).	Completed and successful for the Spalding site, but site management is on-going
4.3. Introduce propagules (seed & / or seedlings)	Completed for Spalding site. A previous attempt at translocation near Gulnare (detailed in Steed, 2002) was unsuccessful.	Successful at Spalding – recruitment is evident. Unsuccessful at Gulnare
5. Broaden participation in the recovery process	TPAG has become less active due to funding restrictions. The BEST group and other community individuals have participated to a minor extent.	Not successful
6. Monitor all known populations	All subpopulations are monitored, annually if possible. A monitoring plan has been developed to ensure consistent monitoring between sites, observers and years.	
6.1. Monitor Yakkalo and Tarlee populations	A sub-set of the Yakkalo subpopulation and the total size of the Tarlee subpopulation are monitored. Monitoring has been intermittent, but consistent enough to track population trends.	70% successful
6.2. Monitor any newly discovered or translocated populations	The Riverton and Spalding subpopulations are monitored for total population size. Monitoring has been intermittent, but consistent enough to track population trends.	70% successful
6.3. Maintain the Threatened Plant Population Database records of <i>Agrostis limitanea</i>	The Threatened Plant Population Database is no longer used by most staff; however new Spalding Blown Grass records have been added to the State Herbarium Database and to BDBSA. There has been some difficulty in maintaining a central (or regional) monitoring data store.	50% successful

ACTION	IMPLEMENTATION	EVALUATION OF SUCCESS
<p>7. Manage the project through the Recovery Team</p>	<p>The Recovery Team was formed in 1998. The Team meets twice a year and provides linkages between local and non-local stakeholders. Its membership includes: Spalding Community Management Committee, TPAG, NAC, DEWNR, DPTI, Trees for Life, Greening Australia regional representatives, University of Adelaide and private landowners. Contact between the Team members is maintained between meetings. Due to funding inconsistencies, there has not always been a project officer.</p>	<p>80% successful</p>