Recovery Plan for the
Pygmy Bluetongue Lizard
Tiliqua adelaidensis
2012

Government of South Australia

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

Cover photograph:
Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) (photo by Mark Hutchinson)

Contents

List of Tables

List of Figures

List of Appendices

SUMMARY

This recovery plan has been prepared in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The effective life-span of this recovery plan is five years, after which its effectiveness and further goals will need to be reviewed.

Conservation Status

The Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) is listed as Endangered nationally under the EPBC Act, and Endangered in South Australia under Schedule 7 of the *National Parks and Wildlife Act 1972*.

The Pygmy Bluetongue Lizard is currently known from 31 small, isolated sites located on private agricultural land. Effective liaison and cooperative management with private landholders are therefore essential to the recovery of this species.

Vision

The long-term vision for the Pygmy Bluetongue Lizard Recovery Program is to achieve down-listing of *Tiliqua adelaidensis* to conservation dependent.

For this to occur, the Pygmy Bluetongue Lizard will need to be valued by an informed regional community; and that regional community will need to have an increased capacity to sustainably manage their unique lizard and its habitats within existing and improved regional planning and land management practices.

Five-Year Objectives

Overall Objective

To improve the long-term viability of Pygmy Bluetongue populations by:

- clarifying the extent, abundance and habitat requirements of the species;
- achieving long-term protection and enhancement of habitat through sustainable land management practices and adequate awareness.

Specific Objectives

Objective 1: Protect existing Pygmy Bluetongue populations and habitat.

Objective 2: Clarify distribution and abundance.

Objective 3: Maintain, enhance and increase the area and quality of suitable habitat for Pygmy Bluetongues at known populations.

Objective 4: Monitor populations to evaluate the effectiveness of management and to detect trends which may require a management response.

Objective 5: Fill critical knowledge gaps to help guide adaptive management and recovery of the species.

Objective 6: Continue to engage the community and form partnership to promote the significance and improved management requirements of the Pygmy Bluetongue Lizards.

Objective 7: Manage the recovery process through an effective recovery team.

Recovery Actions

Action 1.1 Ensure landholders and relevant agencies are aware of, and protect, known Pygmy Bluetongue populations and their habitat.

Action 1.2 Encourage private land conservation agreements and other measures to secure protection of Pygmy Bluetongue populations and habitat.

Action 1.3 Undertake threat and risk assessment of known Pygmy Bluetongue populations.

Action 2.1 Determine the extent and size of known Pygmy Bluetongue populations.

Action 2.2 Identify and map potential habitat.

Action 2.3 Search additional potential habitat for new populations.

Action 3.1 Work with landholders to implement *Best Practice Management Guidelines.*

Action 3.2 Implement measures to increase suitable Pygmy Bluetongue habitat at known populations.

Action 4.1 Continue to undertake (and refine as required) long-term population monitoring at selected sites.

Action 4.2 Maintain (and refine as required) systems for data collection and management.

Action 5.1 Prioritise, promote and conduct key research projects needed to guide improved recovery outcomes.

Action 5.2 Undertake land management trials to refine regimes required to improve habitat quality.

Action 5.3 Continue efforts to establish a captive breeding population.

Action 6.1 Promote community awareness and ownership of, and involvement in, the recovery of the Pygmy Bluetongue Lizards.

Action 6.2 Establish a network of local mentors and champions to help drive and promote improved recovery of Pygmy Bluetongue populations and engage the community in recovery activities.

Action 7.1 Maintain an effective recovery team which supports, guides and evaluates the implementation and outcomes of the recovery plan.

Part A: Introduction

The Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) had been considered extinct until it was rediscovered near Burra, South Australia, in 1992 (the first record for 33 years) (Armstrong & Reid 1993, Armstrong *et al*. 1993). At the time of its rediscovery, very little was known about the species. It had previously been known from only 20 museum specimens, mostly collected in the nineteenth century (Ehmann 1982, Shea 1992). Richard Schomburgk's remark *'kommt nur auf sandigem, steinigem terrain vor'* ('found only in sandy, stony terrain'; quoted by Peters, 1863) was the only published first-hand information available on its ecology.

The Pygmy Bluetongue Lizard has been subject to a recovery program since 1992. To date, a major focus of the recovery program has been research to determine the distribution, habitat, ecology and management requirements of the species. The recovery program has also focused on raising awareness of this species, and proving guidelines for land management based on the research findings.

Part B: Species Information

Description

The Pygmy Bluetongue Lizard is the smallest member of the genus *Tiliqua*, which consists of seven species of lizards commonly known as bluetongues. It is a moderate sized skink with short limbs, a relatively heavy body and large head, with a total length of less than 20 cm. Its colour varies from grey brown to orange brown, and may or may not include a series of black flecks along the back and flanks. Unlike other members of this genus, it has a pink tongue.

Conservation Status

The Pygmy Bluetongue Lizard is listed as Endangered nationally under the *Environment Protection and Biodiversity Conservation Act 1999*(EPBC Act), and Endangered in South Australia under Schedule 7 of the *National Parks and Wildlife Act 1972* (NPW Act). These classifications are consistent with IUCN (2001) criteria (EN B2ab(iii)).

The distribution of the species is severely fragmented. Pygmy Bluetongue Lizards are known from only 31 localities, all on privately owned agricultural land and most surrounded by cropped land or other unsuitable habitat. This species is therefore particularly vulnerable to the impacts of land management activities and/or stochastic events.

Recovery Opportunities

The Pygmy Bluetongue Lizard is currently listed as Endangered in South Australia on the basis of the following combination of IUCN (2001) criteria:

- area of occupancy less than 500 km^2; and
- severely fragmented; and
- observed and projected continuing decline in the area, extent and/or quality of habitat (criteria EN B2ab(iii)).

Given the modified agricultural landscape in which Pygmy Bluetongue Lizards now occur, it is unlikely that the restricted area of occupancy and the fragmentation of populations could be substantially reversed. However, there are research and management actions identified in this plan that will attempt to overcome past habitat modifications. The best opportunities for improving the conservation status of Pygmy Bluetongue Lizards in the short-term therefore lie in halting and preventing the decline of their native grassland habitat. This recovery plan aims to address this goal by outlining measures for improving habitat protection and, where feasible, for improving the quality and extent of habitat.

Part C: Distribution and Location

Distribution and Population Size

The Pygmy Bluetongue Lizard is endemic to South Australia. Very little information exists on the past distribution of Pygmy Bluetongue Lizards, with the few known localities extending from the Adelaide Plains to the North Mount Lofty Ranges (Ehmann 1982, Hutchinson 1992). Prior to the rediscovery of this species, only 20 specimens were known, half of which have no precise location data, while some have localities that may only be addresses of the consigners of the specimens (Armstrong *et al.* 1993). The relative abundance of Pygmy Bluetongue Lizards in European collections in the 19th century (11 of the 20 specimens) suggests that the species was formerly more common, and has undergone a marked decrease in distribution (Shea 1992).

The Pygmy Bluetongue Lizard is now known from 31 sites, ranging from Peterborough in the north to Kapunda in the south, and to the South Hummocks (north of Port Wakefield) in the west (Figure 1). All known populations are located on private land, most of which is used for sheep grazing. They are generally surrounded by unsuitable habitat, usually cropped agricultural land. However, the full extent of most populations has not yet been determined, and it is possible that some apparently isolated localities (e.g. Blyth, Auburn and Kapunda) may belong to larger, more contiguous populations (Schofield 2007).

The total population size of the Pygmy Bluetongue Lizard is uncertain. The population estimate of around 5000 lizards in the previous recovery plan (Milne *et al.* 2000) was based on 10 known populations, but since this time another 22 populations have been discovered (and one is presumed lost). Since 2005, annual counts have been undertaken within one hectare monitoring plots at nine populations, but the area of occupancy at each site, and the variation in habitat quality and lizard densities across these sites, is unclear. Developing a better understanding of the extent and size of Pygmy Bluetongue populations will be a high priority for this recovery plan.

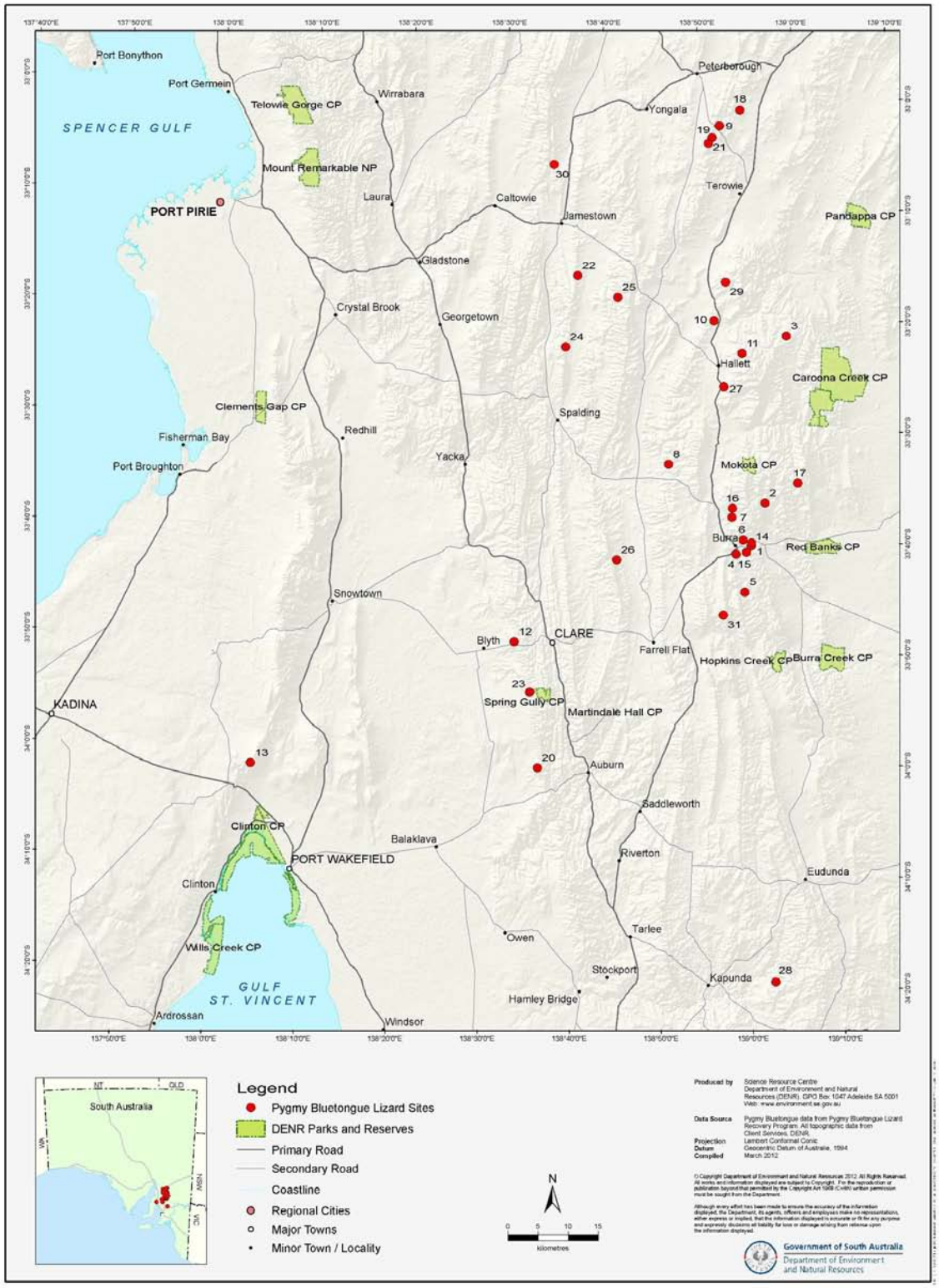

Figure 1. The locations of known populations of Pygmy Bluetongue Lizards (*Tiliqua adelaidensis*).

Habitat

Vegetation

The vegetation of all known sites is remnant native grassland or grassy woodland with a sparse over-storey of trees. Pygmy Bluetongue Lizards do not appear to be confined to a particular floristic community of native grassland, and have been recorded at sites dominated by species including spear grasses (*Austrostipa* spp.), wallaby grasses (*Austrodanthonia* spp.), bluebush (*Maireana* spp.), Brush Wire-grass *(Aristida behriana*) and iron-grasses (*Lomandra* spp.) (Hutchinson *et al.* 1994, Souter *et al.* 2007).

These vegetation types have been extensively cleared and fragmented. By 1995, native grasslands in South Australia had been reduced to around 0.3% of their original distribution (Hyde 1995).

The condition of grasslands in which Pygmy Bluetongue Lizards have been found is highly variable, ranging from grasslands that are highly degraded and dominated by exotic grasses to grasslands with a high diversity of native species. Vegetation cover ranges from moderate to sparse. *R*esearch to date indicates that Pygmy Bluetongue Lizards select burrows with a light or moderate level of surrounding grass cover in preference to areas with very little cover, and that the above-ground activity of lizards appears to be inhibited at burrows with no surrounding grass (Pettigrew & Bull 2011).

Shelter Sites

Pygmy Bluetongue Lizards use empty spider burrows, constructed by mygalomorph (trapdoor) and lycosid (wolf) spiders, as refuges, basking sites and as ambush points for hunting prey (Milne *et al.* 2003a). These spider holes are circular in cross section and up to about 20 mm in diameter. The average depth of holes is approximately 25 cm, ranging from 10 to 75 cm. Adult lizards favour the deeper holes which are made by mygalomorphs, and juvenile lizards prefer narrower burrows (Milne & Bull 2000). The lizards make no obvious external modifications to the holes, except for a slight bevelling of the edges, worn by their movement. The distinctive lids of the trapdoor spider holes may still be attached, enabling the hole builder to be identified. Data from around Burra indicate that one particular species, *Blakistonia aurea* (Idiopidae), is one of the more important hole builders (McCullough 2000).

A PhD study into the habitat requirements of Pygmy Bluetongue Lizards (Souter 2003) indicated that the abundance of the lizards within grasslands was dependent on the availability of deep spider burrows in well draining soils. Suitable lizard burrows were absent or scarce in areas that lacked native grassland or had a dense cover of introduced species.

Topography and Soil Type

Pygmy Bluetongue Lizards occur across a range of soil types, but are found in greater abundance at sites with more free-draining grey-brown or red calcareous soils, compared with sites of less free-draining red-brown earths. They are also found at sites with lithosol soils (sandy-type soil that has developed from the in-situ weathering of rock) (Souter 2003).

Soil which is either not deep enough or free-draining enough inhibits spiders from constructing suitable burrows, and therefore these areas lack habitat suitable for Pygmy Bluetongue Lizards. The lizards tend to be present in greatest densities on the lower slopes of hillsides, where the soil and consequently the spider burrows are deepest (Schofield 2006).

Climate

The region in which Pygmy Bluetongue Lizards occur has hot, dry summers and cool, moist winters, with mean annual rainfall ranging from 365 mm at Yongala to 632 mm at Clare (Bureau of Meteorology data 2010).

Habitat Critical to the Survival of the Species

Given the small total population size, the limited number of sites at which the Pygmy Bluetongue Lizard is known to occur, and the limited availability of suitable habitat, it is considered that all known habitat is critical to the survival of the species because:

- the habitat is required to maintain populations of other species essential to the Pygmy Bluetongue Lizard (e.g. wolf and trapdoor spiders which create spider holes);
- the habitat contains important Pygmy Bluetongue populations;
- the habitat is required to maintain genetic diversity, dispersal routes and population viability.

Any areas of native grassland or grassy woodland with a sparse overstorey which have not been previously ploughed and contain spider burrows may be capable of supporting Pygmy Bluetongue Lizards, particularly in areas with free-draining grey-brown or red calcareous soils or lithosol soils on the lower slopes of hillsides. Further surveys in such areas may identify new populations and additional habitat critical to the survival of the species.

Mapping of Habitat Critical to the Survival of the Species

It is considered that all currently occupied habitat of Pygmy Bluetongue Lizards (Figure 1) is critical to the survival of this species, as discussed above. As noted above, there may be additional habitat critical to the survival of the species which has not yet been surveyed or mapped.

Important Populations

All Pygmy Bluetongue populations are considered important due to the restricted and fragmented distribution of this species; hence all populations should be managed for the protection of this species. Significant genetic differentiation has been recorded between most of the studied populations (Rogers 1998, Smith 2006; Smith *et al.* 2009). Smith *et al.* (2009) sampled 229 Pygmy Bluetongue Lizards from six sites between Burra and Peterborough in the mid-north of South Australia (Sites 1, 2, 4, 6, 9 & 22 in Figure 1). They found that there was a distinct genetic structure among sample sites separated by only a few kilometres, including variations within small patches of continuous habitat, indicating a fine-scale pattern of isolation by distance in this species. They found no evidence of population bottlenecks in this species. Further research to clarify population size, extent and genetics will help to identify the largest populations (Action 2.1).

Part D: Biology and Ecology Relevant to Threatening Processes

Use of Burrows

Pygmy Bluetongue Lizards use burrows constructed by lycosid and mygalomorph spiders for shelter and as vantage points from which to stalk passing invertebrate prey (Milne *et al.* 2003a; Fellows *et al.* 2009). Only one adult lizard is found in each burrow. The lizards are extremely sensitive to both movement and noise, making it difficult to observe them basking outside their burrows unless approached extremely carefully.

Lizards bask with the back legs or tip of the tail remaining in the entrance of the burrow. From this position, the lizards can back rapidly into their burrows if disturbed. The hole dwelling behaviour of the Pygmy Bluetongue Lizards, initially an obstacle, has become a key factor facilitating its study. Use of an optic fiberscope permits direct observation of lizards in their burrows, and their sedentary nature enables regular monitoring of all animals in a given area.

Diet

Pygmy Bluetongue Lizards are omnivorous, feeding mainly on medium-sized arthropods which they capture by ambush. Examinations of Pygmy Bluetongue scats and stomach contents have recorded the remains of grasshoppers, ants, small spiders, beetles, snails, cockroaches and plant material (including *Dianella* seed, possible chenopod material, and several leaves and flowers of the introduced herb *Medicago*) (Ehmann 1982; Milne 1999; Fenner *et al.* 2007). Recent research suggests that Pygmy Bluetongue Lizards change their prey items opportunistically over spring and summer, with plant material incorporated in the diet to a greater extent as summer progresses (Fenner *et al.* 2007). Based on these dietary studies, it is suggested that Pygmy Bluetongue Lizards require a high abundance of arthropod prey, habitat where efficient prey capture is possible, and particular plant species which form part of their diet (Fenner *et al.* 2007).

Reproduction

Mating occurs in spring (October and November) (Hutchinson *et al.* 1994). Pitfall trapping has indicated that males are more active than females during spring, possibly because they are searching for mates at this time (Hutchinson *et al.* 1994). Females have been observed with newly born young from late January until late March, with the bulk of births taking place in February. Litter size ranges from one to four. At birth, Pygmy Bluetongue Lizards are approximately 45 mm snout-vent length (SVL) and weigh approximately 1.5 grams. Juveniles remain in the parental burrow for between one and twelve weeks, and then move out to smaller burrows of their own (Milne 1999; Milne *et al.* 2002).

By the start of spring (September), juveniles are between 60 and 70 mm SVL and weigh between four and eight grams. By the end of summer (February), at approximately one year of age, SVL is from 75 mm to 85 mm and weight from six to 10 grams. Males are capable of reproduction in the next spring season, and females may also reproduce at this age, although some females

take another year to become reproductively active. Only females longer than 100 mm have been observed to have the maximum recorded four young, and it would take four years to reach this size according to current growth rate estimates.

It is estimated that fewer than 10 per cent of juveniles survive to adulthood (Milne 1999). In captivity, Pygmy Bluetongue Lizards are known to live to at least 18 years of age (M. Hutchinson, pers. comm.). Skeletochronological data from a small number of museum specimens show some wild individuals were at least eight years old when captured (S. Hudson, pers. comm.).

Part E: Known and Potential Threats

Identification of Threats

Changed Land Use

Changes in land use, particularly any changes that would permanently alter large or contiguous areas of habitat, are a major threat to Pygmy Bluetongue populations.

With only 31 known populations of this species remaining, the loss or reduced viability of even a single population would have significant implications for the long-term survival of this species.

Ploughing

Ploughing is a very significant threat as it will directly kill and displace both lizards and spiders, destroying their burrows. Ploughing will also break up the soil, making any burrows subsequently dug by spiders (which are likely to be very few) unstable and unsuitable for lizards. Even if a paddock is only ploughed once and left to regenerate naturally, the original lizard population will be lost.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1, 6.2 and 7.1

Ripping

Ripping is slightly less detrimental than ploughing, but would destroy lizards and their burrows in the direct path of the ripping lines. Ripping for new watering points may become more prevalent with the advent of paddock reconfiguration for rotational grazing.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1, 6.2 and 7.1

Inappropriate Grazing Regimes

While moderate grazing is generally compatible with the habitat requirements of Pygmy Bluetongue Lizards, heavy grazing by hard-hoofed stock is likely to be detrimental. Heavy grazing can be defined as that which may lead to destabilisation of the soil structure, causing the filling of burrows in the dry season, and the collapse of burrows in the wet season. Such heavy grazing may also increase exposure to predators and/or reduce the availability of prey. Increases to localised stocking densities through the installation of new water points will have similar impacts.

The complete removal of grazing at sites where Pygmy Bluetongue Lizards occur may also be a threatening process, if the current grazing regime is helping to maintain a suitable habitat structure. Removal of grazing may lead to increased weed growth and/or a reduction in inter-tussock spaces, which may impact on foraging and basking opportunities.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1, 6.2 and 7.1

Other Agricultural Development

In recent years there has been a trend towards new agricultural land uses in the region, e.g. establishment of saltbush pasture and viticulture. Any such changes involving soil disturbance, clearing or other habitat modification would be highly detrimental if they were to occur in areas occupied by Pygmy Bluetongue Lizards.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1, 6.2 and 7.1

Urban, Industrial and Infrastructure Development

Some Pygmy Bluetongue population sites, particularly those close to Burra, may be subject to future urban, industrial development. This may include the establishment of buildings, roads, wind farms and telecommunications infrastructure. Such development would disturb the native grassland and may directly destroy lizard burrows and the lizards themselves. One population near Burra is already believed to have been lost due to recent residential development (J. Schofield pers. comm.).

Wind farm developments are becoming increasingly common in the region. Turbines are typically installed on hill slopes and crests, which often are not optimal habitat for Pygmy Bluetongue Lizards. However, access roads, cabling and other associated infrastructure, which are often developed on flats and lower slopes, have the potential to cause further loss and fragmentation of Pygmy Bluetongue habitat. These include possible;

- weed invasion along roads and around infrastructure creating less suitable habitat;
- habitat fragmentation restricting movement for feeding and dispersal;
- changes to the hydrology from extra water run-off affecting the soil structure (burrow constructions by spiders) and vegetation compositions (denser ground cover); and
- shadow-flickering, vibration and noise from the turbine effecting the ability of the lizards to bask, feed and move around.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1, 6.1 and 7.1

<u>Weeds</u>

High and dense growth of wild oats and other weeds may reduce opportunities for Pygmy Bluetongue Lizards to bask, catch insects and find mates. Weeds may also render habitat unsuitable for burrowing spiders (Souter 2003).

Weed control may also be a threatening process if high-disturbance techniques are used or native plant species are affected (see *Part H: Management Practices* for information on appropriate weed control practices). Soil disturbance (e.g. ripping) may also promote weed establishment.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 5.2, 6.1 and 6.2

Pesticides

Insecticides and other pesticides are used in the region to control agricultural pests such as native locusts, grasshoppers and snails, including the introduced white snail (*Cernuella virgata*). These species are found at a number of Pygmy Bluetongue sites and can form a significant part of the lizards' diet.

Pesticide use may potentially impact on Pygmy Bluetongue Lizards either directly or indirectly. While the direct impacts of insecticides on Pygmy Bluetongue Lizards are unknown, insecticides are known to cause illness or death in some reptiles (Spur 1993, Khan & Hall 2005, Pauli *et. al.* 2010). Pelletised snail baits, which are often used in snail control, are also known to be very toxic to reptiles (Australian Pesticides & Veterinary Medicines Authority 2005).

Secondary impacts could include a reduction in the main food source of Pygmy Bluetongue Lizards, which could affect their survivorship or reproduction rates; or a reduction in burrowing spiders' abundance which may significantly reduce the availability of spider burrows which the Pygmy Bluetongue Lizards are dependent on for shelter sites. Cumulative secondary poisoning is also a potential risk.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.3, 3.1, 3.2, 5.2, 6.1 and 6.2

Herbicides

As with insecticide use, there is no direct evidence of the impacts of herbicide use on Pygmy Bluetongue Lizards. However, herbicides are known to cause fertility problems for small vertebrates (Pauli *et. al.* 2010), and are a potential threat to Pygmy Bluetongue Lizards.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.3, 3.1, 3.2, 5.2, 6.1 and 6.2

Inappropriate Fire Regimes

The effect of fire on Pygmy Bluetongue populations is not fully known. Fires were probably once a natural landscape process throughout the range of the Pygmy Bluetongue Lizard. However, given the small and isolated nature of the remaining Pygmy Bluetongue populations, fire could potentially have a significant impact.

It is likely that the impact of fire on Pygmy Bluetongue populations would depend largely on the timing and intensity of the fire. Fires that occur in spring, when males are active, or in late summer and early autumn, when juveniles are dispersing, could be particularly detrimental. Fires at other times of the year (mid-summer, late autumn, early spring) may be of less consequence, provided that they do not occur frequently or in conjunction with other adverse conditions or threats, although further research is required to clarify this (M. Bull, pers. comm.).

Monitoring was conducted before and after a Pygmy Bluetongue population site was burnt by accidental fire in December 2005 (Fenner & Bull 2007). The results of this study suggested that the lizards were able to take refuge from the fire in their deep burrows, as the fire did not kill adult lizards or affect the subsequent fecundity of females. While declines were initially observed in activity, foraging, body condition and juvenile survivorship following the fire,

these effects were short-lived, with no adverse impacts observed in subsequent years (A. Fenner, pers. comm.).

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 3.1, 5.2, 6.1 and 6.2

Habitat Fragmentation

Large tracts of cultivated land separate most of the Pygmy Bluetongue sites. Due to the lizards' small size and reliance on spider burrows, they are unlikely to disperse across cultivated land. Small, isolated populations may suffer from inbreeding, and are vulnerable to local extinction from stochastic events. Genetic data confirm that dispersal between current populations is low (Smith 2006, Smith *et al.* 2009). Research and management actions identified in this plan will attempt to overcome past modification practices to create habitat linkages between subpopulations potentially including the use of artificial burrows and establishment of habitat in previously ploughed land.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, 4.2, 5.2, 6.1 and 6.2

Planting (tall trees and shrubs)

It is uncertain whether the native grasslands in the mid-north region of South Australia had a tree layer prior to European settlement. The most accepted scenario is that they have always been largely treeless, with a few scattered local occurrences of eucalypts and she-oaks (Jessup 1948).

Trees and shrubs alter the characteristics of the soil, litter and understorey plant community beneath their canopy. There are no records of Pygmy Bluetongue Lizards living under trees, even in areas adjacent to open grassland containing Pygmy Bluetongue Lizards. Experiments have shown that artificial burrows established under trees quickly fill with soil and debris (Souter 2003).

Trees may increase predation risks for the lizards by providing perches for birds to stalk the burrows (compared to only hovering birds in open grassland), and by reducing the level of sunlight at ground level, which may result in lizards having to move further away from their burrows to bask.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 5.2, 6.1 and 6.2

Predators

Both introduced and native predators are known to prey on the Pygmy Bluetongue Lizard. Domestic dogs have been known to take Pygmy Bluetongue Lizards, and foxes and cats are also potential predators. Known natural predators include Australian Kestrels and Eastern Brown Snakes (Hutchinson *et al.* 1994, Fenner *et al.* 2008a, M. Hutchinson pers. comm.).

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 3.1, 5.2, 6.1 and 6.2

Fertilisers

Fertilisers may have a negative impact on grasslands, by encouraging weed growth at the expense of native grasses, which may in turn affect the lizards.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 3.1, 5.2, 6.1 and 6.2

Poaching

Despite the large fines or jail terms associated with poaching and smuggling of threatened species, there is a risk that poachers could target these animals, as Australian reptiles are generally in demand.

Threat addressed in Actions 1.1, 1.2, 1.3, 2.1, 4.1, 5.2, 6.1 and 6.2

Climate Change

The *loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases* has been identified as a Key Threatening Process under the EPBC Act. The higher temperatures and altered rainfall regimes that are predicted under climate change scenarios could potentially impact on Pygmy Bluetongue Lizards, their prey and habitat.

While there is currently little knowledge of the effects of climatic conditions on Pygmy Bluetongue Lizards, monitoring surveys recorded significantly lower fecundity, lower grass cover and more bare earth in 2007 and 2008 than in 2006 (A. Fenner pers. comm., J. Schofield pers. comm.). These trends may be linked to the prolonged drought in the region.

Pygmy Bluetongue Lizards could be particularly vulnerable to climate change due to the isolation and small extent of the remaining populations and suitable habitat, as there are very limited opportunities for dispersal or translocation if the current area of occupancy becomes unsuitable.

Threat addressed in Actions 2.1, 2.2, 2.3, 3.2, 4.1, 5.2, 5.3 and 7.1

Areas Under Threat

The threats identified above are not limited to specific areas. Rather, all Pygmy Bluetongue habitats are considered to be potentially at risk from all of the threats highlighted above.

Populations Under Threat

All known Pygmy Bluetongue populations are small populations in paddocks within commercial farming properties in the mid-north of South Australia. One population has been placed under a Heritage Agreement and another is being managed solely for the protection of the Pygmy Bluetongue Lizards (Nature Foundation SA 2011) and is therefore protected from major habitat modification. Otherwise, all of the identified threats are currently considered to be relevant to all populations. Populations in the north of the species range may be more vulnerable to the effects of climate change due to the increased temperature gradient in that region.

As a complete threat assessment has not been conducted at all known populations, further investigation is required in order to identify the populations that are most at risk from particular threats (see Action 1.3).

Part F: Recovery Actions to Date

The Pygmy Bluetongue Lizard has been subject to a recovery plan since 2000 (Milne *et al.* 2000). This initial recovery plan focused on addressing key knowledge gaps, establishing community involvement in the conservation of this species, and establishing guidelines for the management of Pygmy Bluetongue habitat.

Searches for New Populations

Searches for new populations in recent years have identified 22 new sites, taking the total number of known Pygmy Bluetongue sites to 31.

Surveys to Establish Population Extent

Previously, there was little information available on the precise extent of each Pygmy Bluetongue population, with many populations known only from a single point datum. Recent surveys have improved knowledge on the area of occupancy at several Pygmy Bluetongue sites and have provided landholders with better information to guide property management, such as areas where potentially adverse farming practices should be avoided.

Establishment of Conservation Agreements with Landholders

There are two types of conservation agreements that landholders may enter into (see Part G: Management Practices):

- Heritage Agreements on land titles, which are permanent, legally binding and transfer to future owners of the land.
- The Sanctuary Scheme, which involves non-binding agreements designed to assist landholders to provide wildlife habitat on their property, even when the property is managed primarily for other purposes.

To date, one population has been protected via a Heritage Agreement, and three Sanctuaries have been declared. This has contributed to efforts against Performance Criterion 1 from the previous recovery plan of having '*6 secure sites containing a minimum of 3000 individuals.*'

In 2010, an 80ha grassland property north-east of Burra was purchased by Nature Foundation SA. The property is known as Tiliqua Reserve and is managed for the protection of the Pygmy Bluetongue Lizards (Nature Foundation SA 2011).

Commencement of Long-term Monitoring

A permanently marked one-hectare monitoring plot was established at site 1 (see Fig. 1) by Flinders University in 1994, with an additional eight permanent monitoring plots established in 2005 (sites 2, 3, 4, 6, 9, 11, 12 and 22 in Fig. 1) by the Department of Environment and Natural Resources (DENR). These monitoring sites were established to provide long-term data on the lizards' population structures and densities.

The monitoring involves the examination of suitable spider-holes (circular in cross section, 10 mm to 20 mm in diameter and at least 10 cm deep) in the

one-hectare squares, using an optiscope (optic fiberscope) to determine the presence of Pygmy Bluetongue Lizards.

Searches are led by an experienced observer, with the assistance of novice volunteers. The surveys are undertaken in February-March, to coincide with the time of year with minimal ground cover. Refer to Appendix 1 for more details and data collected from 2005 to 2011. Trends between years are not necessarily absolute, given variation in observers; sampling time and vegetation cover (affecting detectability of lizard burrows) between years.

Pygmy Bluetongue numbers fluctuated between 2005 and 2011 (Appendix 1). Drought conditions during 2005 to 2009 may have affected the abundance of insects (i.e. food) and the abundance of spider burrows (i.e. shelter sites) which the lizards are dependent on (Sharp 2011), and this may reflect the fluctuating numbers of Pygmy Bluetongues observed. However, continued monitoring is required to better observe long-term population changes. In addition, part of an Australian Research Council (ARC) Linkage project under way at Flinders University (M. Bull pers. comm.) has a component to trial various monitoring techniques with monitors of varying ability to develop a better method of efficiently estimating lizard density.

Development of *Best Practice Management Guidelines*

The previous Pygmy Bluetongue Lizard Recovery Plan (Milne *et at.* 2000) identified a need to develop guidelines for the management of known habitat remnants. The *Pygmy Bluetongue Lizards: Best Practice Management Guidelines for Landholders* (Schofield 2006) have now been developed and distributed to landholders of some of the known Pygmy Bluetongue sites. This document describes ways to ameliorate known threats to Pygmy Bluetongue populations, and potentially increase lizard numbers and the quality and extent of habitat (see *Part H: Management Practices* for further detail).

Local government staff have also been contacted to raise their awareness of the potential impacts of land use change on Pygmy Bluetongue populations.

Research and Trials

Substantial progress has been made in filling some key knowledge gaps, which will help to guide recovery actions for this species.

<u>Ecology and General Biology</u>

Since 1992, studies have been undertaken to examine the behaviour, shelter site requirements, activity and movement patterns, life-history, diet, macrohabitat requirements, predators and parasites of Pygmy Bluetongue Lizards, and the ecology of wolf spiders (Milne 1999, McCullough 2000, Milne & Bull 2000, Milne *et al.* 2003a, Souter 2003, Souter *et al.* 2007, Fenner *et al.* 2007, Fenner *et al.* 2008b). Mark-recapture techniques were used to collect information on the basic demographic parameters of Pygmy Bluetongue Lizards, including reproductive output, growth rates, sexual development, longevity, population dynamics, mortality rates, body condition, and breeding patterns (Milne 1999). Annual natality, mortality and juvenile survival were estimated at one site (Milne 1999), and more recently, short-term population dynamics have been tracked at a second site (Fellows 2008).

Grazing Trials and Microhabitat Requirements

Grazing trials have been conducted through a collaborative project between DENR and the Mid North Grassland Working Group, to examine the potential effects of different grazing regimes on Pygmy Bluetongue burrows. There has been interest among landholders in switching to rotational grazing (which involves increased stock densities for short periods) in the mid-north region of South Australia, as it has been demonstrated to provide both productivity and conservation benefits. The grazing trials have determined that rotational grazing does not result in accelerated deterioration of spider burrows in comparison to traditional grazing regimes, and therefore appears to be compatible with the conservation of Pygmy Bluetongue Lizards (Sharp *et al.* 2010).

A PhD research project involving microhabitat manipulation associated with grazing found that heavy grazing management that results in the majority of vegetation being removed could have a negative impact on Pygmy Bluetongue Lizard recruitment and sustainability (Pettigrew & Bull 2011). Given the choice of good quality burrows with or without surrounding grasses, Pygmy Bluetongue Lizards will prefer the burrow with relatively sparse grass cover (Pettigrew & Bull 2011). This means that different grazing regimes within Pygmy Bluetongue habitat should be carefully monitored so that heavy grazing that removes much of the grass cover can be avoided (Pettigrew & Bull 2011).

Captive Breeding

Since the mid-1990s, a small captive population of Pygmy Bluetongue Lizards has been held at Adelaide Zoo (T. Morley pers comm.). Attempts to establish breeding in this population have been unsuccessful, possibly due to the aggressive and territorial behaviour exhibited by the lizards in captivity, and/or to unsuitable ambient conditions in the captive enclosure. There has also been uncertainty with regard to the age and fecundity of the individuals in the original captive population.

Research conducted on the fate and dispersal of juveniles in the wild (Fellows 2008) will assist in determining appropriate take rates for future supplementation of captive populations. An additional ARC Linkage project is currently underway at Flinders University (M. Bull pers comm.) to examine social and reproductive behaviour in captive populations; trial the use of larger, lower density, outdoor enclosures; and develop suitable strategies for the release of translocated lizards.

Artificial Burrows

Pygmy Bluetongue Lizards are known to use, and breed in, artificial burrows (Milne & Bull 2000, Milne *et al.* 2003b). Holes hammered in the ground using steel rods have been the most successful type. Trials in the use of artificial burrows at one population have suggested that they may enhance local lizard abundance and recruitment success, at sites with free draining soils, appropriate habitat, and limited availability of deep spider holes (Souter *et al.* 2004). To date there has been no evidence of adverse outcomes (e.g. negative social interactions) associated with the use of artificial burrows.

However, soil compaction through the artificial creation of burrows may be an issue at some sites where free draining burrows are required due to high water run-off. Further research is required to determine the long term success of artificial burrows across different soil types and land-form.

Genetics

Substantial progress has been made in genetic studies of Pygmy Bluetongue Lizards. Microsatellite markers have been developed and used to establish baseline genetic information, including genetic profiles of eleven populations (Smith *et al.* 2009, J. Scholfield, unpublished) at sites 1, 2, 3, 4, 6, 9, 11, 12, 13, 22 & 26 (Figure 1).

Information on DNA microsatellite allelic variation has suggested that there is a relatively high frequency of multiple matings (females mating with different males). High genetic diversity and low levels of inbreeding have been recorded within populations (Smith *et al.* 2009), and so intervention is not required to maintain genetically viable populations in the short term (M. Bull pers comm.).

Significant genetic differentiation has been recorded between most of the studied populations. Genetic differences have been greatest between the most geographically distant populations, with no genetic exchange between northern and southern populations (Rogers 1998, Smith 2006, J. Scholfield, unpublished). Research to date suggests there is no migration between geographically close populations, and limited dispersal within populations. It is therefore likely that naturally low dispersal rates, together with habitat fragmentation, are responsible for the genetic differentiation between populations (Smith 2006; Smith *et al.* 2009). This type of information will be valuable in evaluating the need, and developing protocols, for future management options such as relocation, reintroductions or supplementation of existing populations.

Community Engagement

The Pygmy Bluetongue Lizard Recovery Project has been extensively promoted through the media, and through liaison with landholders and community groups, including the local Biodiversity and Endangered Species Team (BEST) and the Burra Community School. This has helped to increase community awareness of, and involvement in, actions to help conserve the Pygmy Bluetongue Lizard. Contributions from community groups and landholders in activities such as monitoring and habitat protection have made an important contribution to the recovery effort. These have been important achievements against Performance Criterion 3 of the previous recovery plan of '*active participation by local people in species conservation*'.

Communication Strategy

A communication strategy has recently been developed to identify and prioritise communication activities and target stakeholders, to help support the objectives and actions of the recovery plan.

Part G: Objectives, Actions and Performance Criteria

Vision

The long-term vision for the Pygmy Bluetongue Lizard Recovery Program is to achieve down-listing of *Tiliqua adelaidensis* to conservation dependent.

For this to occur, the Pygmy Bluetongue Lizard will need to be valued by an informed regional community; and that regional community will need to have an increased capacity to sustainably manage their unique Lizard and its habitat within existing and improved regional planning and land management practices.

Ten-year Targets

- To have refined habitat predictors and indicators, and to have searched for Pygmy Bluetongue Lizards in known potential habitat.
- To have at least 75% of known populations protected and managed through the adoption of the *Best Practice Management Guidelines* by landholders.
- For land management practices at all known Pygmy Bluetongue sites to be sympathetic with Pygmy Bluetongue Lizard conservation requirements.
- To have determined the feasibility of reducing the fragmentation of populations, and increasing the area of occupancy.

Objectives of this Recovery Plan (Five-year Objectives)

Overall Objective

To improve the long-term viability of Pygmy Bluetongue populations by:

- clarifying the extent, abundance and habitat requirements of the species;
- achieving long-term protection and enhancement of habitat through sustainable land management practices and adequate awareness.

Specific Objectives

Objective 1: Protect existing Pygmy Bluetongue populations and habitat.

Objective 2: Clarify distribution and abundance.

Objective 3: Maintain, enhance and increase the area and quality of suitable habitat for Pygmy Bluetongues at known populations.

Objective 4: Monitor populations to evaluate the effectiveness of management and to detect trends which may require a management response.

Objective 5: Fill critical knowledge gaps to help guide adaptive management and recovery of the species.

Objective 6: Continue to engage the community and form partnership to promote the significance and improved management requirements of the Pygmy Bluetongue Lizards.

Objective 7: Manage the recovery process through an effective recovery team.

Objective 1: Protect existing Pygmy Bluetongue populations and habitat.

Action 1.1 **Ensure landholders and relevant agencies are aware of, and protect, known Pygmy Bluetongue populations and their habitat.**

In order to avoid inadvertent loss or degradation of Pygmy Bluetongue habitat or populations, it is important that landholders and relevant agencies are aware of the locations and management requirements of these sites. This is particularly important in areas that may be at risk of development, subdivision or changed land use. It is also important that the requirements of, or potential impacts to, Pygmy Bluetongue Lizards are adequately addressed in relevant policies and processes.

Methods

Engage in ongoing liaison with relevant authorities and landholders to encourage open communication and consideration of Pygmy Bluetongue populations, threats and habitat requirements, in processes such as property management planning, local government planning processes, change of land ownership and land use, and regional pest control activities.

Liaise with relevant authorities to ensure that potential impacts to Pygmy Bluetongue Lizards are routinely considered in the assessment of development proposals or the development of plans and policies that could impact on Pygmy Bluetongue Lizards. Provide maps of known Pygmy Bluetongue locations and of potential habitat.

Relevant organisations will include local councils (including planning and bushfire prevention staff), Primary Industries and Resources SA (PIRSA), the Northern and Yorke Natural Resource Management Board, and any other agencies or companies involved in infrastructure development, Environmental Impact Assessments, or agricultural extension in the region.

Specifically, ensure that relevant authorities are aware of, and have processes in place to ensure routine consideration of:

- the locations of known Pygmy Bluetongue populations;
- characteristics and known locations of potential Pygmy Bluetongue habitat;
- management and land-use activities that may impact on Pygmy Bluetongue populations;
- appropriate strategies to avoid and mitigate potential impacts to Pygmy Bluetongue populations; and
- the need to seek advice from DENR before approving any practices which may adversely impact on Pygmy Bluetongue Lizards.

Evaluate the effectiveness of current policies such as the insect control quarantines and buffer zones imposed by PIRSA, and encourage revision if required.

Disclosure of detailed information on the location of Pygmy Bluetongue populations should be restricted to landholders and agencies that require this information for protection of Pygmy Bluetongue habitat.

Action 1.2 **Encourage private land conservation agreements and other measures to secure protection of Pygmy Bluetongue populations and habitat.**

'Secure' protection of Pygmy Bluetongue habitat will not necessarily involve the formal protection of habitat in the public reserve system. If managed appropriately, agricultural grazing is often compatible with Pygmy Bluetongue Lizard conservation requirements, and in many cases it will be important to continue grazing management in order to maintain a suitable habitat structure.

Methods

Undertake further liaison with landholders to encourage the protection of Pygmy Bluetongue populations under conservation agreements (Stewardship Agreements, Heritage Agreements, Individual Property Management Plan) or adoption of *Best Practice Management Guidelines*, taking into account both conservation and primary production objectives. This can be done in conjunction with Action 3.1.

Consult with relevant government agencies and non-government organisations to investigate new approaches to facilitate the secure protection and appropriate ongoing management of habitat.

Action 1.3 **Undertake threat and risk assessment of known Pygmy Bluetongue populations.**

An assessment of threats and risks at each Pygmy Bluetongue population site will help to:

- identify and proactively address imminent threats which could cause further declines in population size, habitat extent or habitat quality; and
- ensure that recovery efforts are targeted to areas where they will be of most benefit.

Methods

Undertake a risk assessment of the current and potential threats, their likelihood and potential consequences based on site observations, discussions with land managers, and knowledge of local land use practices and trends. Use this information, in conjunction with an assessment of the relative importance of each population, to determine priority actions and priority areas for recovery efforts.

Objective 2: Clarify distribution and abundance.

Action 2.1 **Determine the extent and size of known Pygmy Bluetongue populations.**

To date, most estimates of population size at Pygmy Bluetongue sites have been derived from a single sample plot, extrapolated against the estimated area of suitable grassland habitat at each site. However, at most sites, the actual area of occupancy, spatial variation in abundance and total population size are unknown.

Further sampling effort across these sites will help to establish more accurate estimates of the size and extent of each population. This information will provide landholders with better information to guide farming practices, such as areas to avoid when applying herbicides or pesticides. Accurate baseline

information on population extent and lizard abundance will also assist in measuring population trends, identifying threats, prioritising sites for management, and assessing the effectiveness of recovery actions.

Methods

Undertake area of occupancy surveys at all known sites, with the cooperation of landholders. Assess the abundance of lizards in both core and marginal habitat and calculate population estimates for each site. Encourage volunteer involvement in these surveys.

For each site, map the area of occupied habitat, and any unoccupied potential habitat, and store this information in a geospatial database.

***Action 2.2* Identify and map potential habitat.**

As virtually all suitable habitat for Pygmy Bluetongue Lizards occurs on private agricultural land, there are likely to be unsearched areas of potential habitat which may support additional populations. Pygmy Bluetongue Lizards tend to retreat to their burrows when disturbed, and may go undetected unless a targeted search is undertaken.

Methods

Establish appropriate methods for identifying and mapping potential habitat for undiscovered populations (or with the potential to support translocated populations in the future) or potential dispersal habitat. Methods may include interpretation of aerial photographs, GIS analysis, gleaning local knowledge and targeted field reconnaissance surveys. Use media reports and field days to encourage community members to report areas of potentially suitable habitat, and any potential sightings of the lizards.

***Action 2.3* Search additional potential habitat for new populations.**

Whilst some of the mid-north area has been surveyed in the past several years, further searches in potential habitat identified via Action 2.2 above may find new populations of Pygmy Bluetongue Lizards, thereby increasing the known extent of occurrence or area of occupancy of the species.

Due to the small number and isolated nature of currently known Pygmy Bluetongue populations, the discovery of any additional populations would be of high significance for the conservation and management of this species.

Methods

Liaise with landholders to arrange access to priority sites which are considered to be potential Pygmy Bluetongue habitat. Document habitat condition and undertake searches for the lizards using an optic fiberscope or other appropriate technique.

Keep thorough records of all areas that have been searched for Pygmy Bluetongue Lizards, and of any areas that may be suitable as future translocation sites. Ensure that the location of any new populations are documented in appropriate databases, and communicated to relevant landholders and land management agencies.

Objective 3: Maintain, enhance and increase the area and quality of suitable habitat for Pygmy Bluetongues at known populations.

Action 3.1 **Work with landholders to implement *Best Practice Management Guidelines.***

The *Pygmy Bluetongue Lizards: Best Practice Guidelines for Landholders* (Schofield 2006) provide landholders with land management recommendations for the conservation of the Pygmy Bluetongue Lizards, based on available information on the lizards' ecology and habitat requirements. Ongoing liaison with landholders will be required to maintain awareness of these issues, and encourage implementation of the guidelines.

Methods

Contact landholders and local government officers to discuss the guidelines and to offer advice and assistance in their implementation. Arrange site visits where possible.

At sites where access is permitted for survey or monitoring purposes, continue to provide regular feedback to landholders on the monitoring results and any management implications.

Encourage local councils to work cooperatively with the recovery team in identifying any changes (or potential changes) in land ownership or land management at Pygmy Bluetongue sites. Ensure that new landholders are made aware of the recovery program, threatening processes, and *Best Practice Management Guidelines*.

Update the guidelines as required, e.g. as new information to guide management becomes available, and redistribute to all relevant land managers.

Action 3.2 **Implement measures to increase suitable Pygmy Bluetongue habitat at known populations.**

Knowledge gained through the actions in this recovery plan (e.g. threat and risk assessments, grazing trials and research) will assist in identifying opportunities and priorities to increase suitable Pygmy Bluetongue habitat. Implementation of these measures will enhance the long-term viability and recovery of Pygmy Bluetongue populations.

Methods

Implement opportunities to increase the area and quality of habitat at priority sites, as identified through the threat and risk assessments, and the results of research and trials.

Examples of opportunities to increase habitat extent or quality may include adjustments to grazing management regimes, installation of artificial burrows or related recovery actions for the grassy habitats themselves.

Further research and trials over the life of this recovery plan (see actions 5.1 & 5.3) will assist in assessing the feasibility of translocation from captive or existing populations, in order to supplement populations or establish new populations. If translocation is found to be a feasible management option in future, protocols should be developed to guide the application and implementation of this technique.

Monitoring should be conducted to evaluate the effectiveness of any efforts to enhance Pygmy Bluetongue populations and habitats.

Objective 4: Monitor populations to evaluate the effectiveness of management and to detect trends which may require a management response.

Action 4.1 **Continue to undertake (and refine as required) long-term population monitoring at selected sites.**

Long-term monitoring of key Pygmy Bluetongue populations is required to evaluate the effectiveness of recovery actions, evaluate the impacts of land management regimes, and to detect trends which may require a management response.

A further understanding of temporal and spatial trends in population densities will assist in refining appropriate monitoring protocols.

Methods

Continue annual monitoring (in late Summer to Autumn) of population densities and population structure at the nine established monitoring sites.

For remaining sites not included in the annual monitoring program, conduct baseline surveys to measure population density and structure (part of Action 2.1).

Monitor and evaluate the effectiveness of recovery actions to protect, maintain, enhance or increase the quality of the habitat and to determine if any management response is required.

Refine monitoring procedures if required. Take into account knowledge of spatial and temporal distribution patterns, habitat use and population structure.

Conduct trials using various monitoring techniques with personnel of varying ability (expertise, training) to develop a better method of efficiently estimating lizard density.

Action 4.2 **Maintain (and refine as required) systems for data collection and management**

An effective data collection and management system is required to ensure that data relating to Pygmy Bluetongue populations and habitat is stored in a systematic manner, to facilitate efficient data analysis, priority setting and information sharing.

Methods

Maintain and update Biological Data Base of South Australia (BDBSA) to:

- provide systematic and comprehensive storage of monitoring data for Pygmy Bluetongue populations;
- provide clear documentation of the extent of habitat and/or populations that have been surveyed;
- record searched areas in which the lizards have not been recorded, in additional to areas where they have been located;
- assist in identifying potentially suitable habitat;

- assist in providing information in appropriate scales and formats to relevant land managers including landholders, local government and PIRSA; and
- allow analysis of population and distribution trends and effects of management and impacts.

Objective 5: Fill critical knowledge gaps to help guide adaptive management and recovery of the species.

Action 5.1 **Prioritise, promote and conduct key research projects needed to guide improved recovery outcomes.**

Research into the Pygmy Bluetongue Lizard to date has helped to improve knowledge of the habitat and management requirements of this species. Additional research to address key knowledge gaps will aid in further developing and refining management guidelines and recovery actions for this species.

Methods

Develop a research prospectus to identify critical knowledge gaps and priority research projects. Promote research needs and opportunities to South Australian research institutions, Natural Resources Management (NRM) boards and other relevant agencies. Facilitate implementation of priority projects.

Key areas for research may include:

- adult home range and dispersal;
- juvenile dispersal, survival and recruitment into adult populations;
- response to translocation;
- factors that influence reproductive success;
- impacts of pesticide and herbicide use, including on spiders;
- relationship between climatic fluctuations and survival and recruitment;
- response of Pygmy Bluetongue Lizards to altered land use;
- temporal variation in abundance and survivorship;
- mating system, social organisation and social interactions;
- selection pressures and their role in maintaining social systems;
- genetic structure of populations;
- the role of endemic and exotic parasites and pathogens;
- effects of different fire regimes on Pygmy Bluetongues and their habitat;
- time taken for Pygmy Bluetongues to re-occupy previously ploughed land;
- how to increase area of occupancy around existing populations surrounded by cropping land;
- interactions between the lizards and the spiders that build the burrows, and the ecology and habitat requirements of the spiders; and
- effects of different grazing regimes;

- impact on the movement, dispersal and survival of the Pygmy Bluetongue Lizards from wind farm development; and
- effects of shadow flickering and noise and vibration from wind turbine on the lizards ability to bask, feed and move around.

Action 5.2 **Undertake land management trials to refine regimes required to improve habitat quality.**

In order to refine and improve the *Pygmy Bluetongue Lizards: Best Practice Management Guidelines for Landholders* and develop a better understanding of optimal management regimes to improve habitat quality, further experimental manipulations and monitoring programs are required.

Methods

Continue microhabitat research and grazing trials to
- establish optimal microhabitat characteristics for Pygmy Bluetongue populations (including impacts on the abundance of prey and burrowing spiders);
- optimal grazing regimes to maintain these microhabitat characteristics; and
- establish trial to improve previously ploughed land to increase the area of occupancy of exiting populations and to link populations.

Continue to opportunistically monitor the effects of any unplanned wildfires at Pygmy Bluetongue sites. Evaluate the effects of experimental burns or wildfires in areas of similar habitat that are not occupied by Pygmy Bluetongue Lizards (e.g. Mokota Conservation Park) and evaluate the implications for Pygmy Bluetongue Lizards. Conduct a risk and needs assessment to determine whether prescribed experimental burn trials at sites occupied by Pygmy Bluetongue Lizards are a viable option.

Action 5.3 **Continue efforts to establish a captive breeding population.**

The establishment of a captive breeding population and the development of a husbandry manual will help safeguard against population declines in the wild by providing management contingencies should they be needed in future.

A captive breeding population may also provide opportunities for controlled studies of social interactions, which may provide insight into social behaviour in the wild, and thus help to inform future management strategies.

Methods

Continue to maintain a population of Pygmy Bluetongue Lizards in captivity. Apply the findings of relevant field research (e.g. research into social organisation, social aggression, genetics and diet) to the management of the captive population.

Conduct experimental trials (e.g. manipulating enclosure design, diet, burrows, cover, temperature, population densities and level of relatedness between individuals) in an attempt to establish breeding in captivity, and to determine the factors which are conducive to breeding success. Document findings in a husbandry manual for future reference.

Objective 6: Continue to engage the community and form partnership to promote the significance and improved management requirements of the Pygmy Bluetongue Lizards.

Action 6.1 **Promote community awareness and ownership of, and involvement in, the recovery of the Pygmy Bluetongue Lizards.**

As all Pygmy Bluetongue populations occur on private agricultural land, the awareness and involvement of landholders, local communities and relevant land management agencies is essential for the recovery of this species, through the behaviours they adopt and support.

Methods

In accordance with the Pygmy Bluetongue Lizard Communication Strategy, continue to foster the interest and ownership of the regional community in the Lizard as an iconic, locally endemic species. Encourage involvement of the community in implementing recovery actions, and continue to promote the recovery program and management issues in the media.

Encourage the reporting of suspicious behaviour at known lizard sites, such as digging by unknown people.

Action 6.2 **Establish a network of local mentors and champions to help drive and promote improved recovery of Pygmy Bluetongue populations and engage the community in recovery activities.**

Regional protection of threatened species must be community-driven and to ensure capacity building, land managers and individuals must have access to relevant training, extension services, and support networks.

Methods

Support interested locals with a passion for protecting and conserving the natural environment in their area to establish a network of mentors and champions, who can be there in their community, to promote, engage and build capacity of landowners, managers and interested people about the protection and management of the Pygmy Bluetongue Lizards. The network will have a range of people with knowledge/skills and interest for other threatened species and ecological communities including Iron-grass Natural Temperate Grassland, Peppermint Box Grassy Woodland, Spiny Daisy (*Acanthocladium dockeri*) and threatened orchids.

Objective 7: Manage the recovery process through an effective recovery team.

Action 7.1 **Maintain an effective recovery team which supports, guides and evaluates the implementation and outcomes of the recovery plan.**

An effective recovery team will assist in assessing progress, priorities and opportunities for the recovery program, and provide expertise and input as required to support the implementation of recovery actions.

Methods

Maintain representation from relevant government agencies, landholders, conservation groups, researchers and community groups on the recovery team. The recovery team should meet twice annually or as required to

review priorities, progress and outcomes in relation to implementation of the recovery plan; and to assess and respond to emerging issues and opportunities.

Actions, Performance Criteria, Priorities and Responsibilities

Table 1 outlines performance criteria, responsibilities and level of priority for each action.

Table 1: List of the performance criteria, priorities and responsibilities for each action

Objective 1: Protect existing PBT populations and habitat.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
1.1	Ensure landowners and relevant agencies are aware of, and protect, known PBT populations and their habitat.	• Landholders at all known PBT sites communicated with and provided with relevant information about PBT and *Best Practice Management Guidelines* by Year 2 (with Action 3.1). • All relevant authorities provided with information on PBT populations and habitat where PBT is known to occur by Year 1. • No avoidable decline in PBT populations or degradation of habitat due to lack of awareness of locations or of appropriate management practices especially from locust control and infrastructure development (e.g. wind farm).	DENR, local councils, PIRSA, NRMB, CFS, Landholders	High
1.2	Encourage private land conservation agreements and other measures to secure protection of PBT populations and habitat.	• At least 50% of known populations managed under conservation agreements (Stewardship Agreements, Heritage Agreements, individual property management plans) or through adoption of *Best Practice Management Guidelines* by landholders by Year 5	DENR, NRMB, Landholders	High
1.3	Undertake threat and risk assessment of known PBT populations.	• Threats and risk assessment completed at all known population sites by Year 2. • Priority actions and priority areas for recovery efforts determined for all known PBT population sites by Year 2.	DENR, RT	High
Objective 2: Clarify distribution and abundance.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
2.1	Determine the extent and size of known PBT populations.	• Area of occupancy mapped for all known PBT sites by Year 5. • Sound population estimates obtained for all known PBT sites by Year 5.	DENR, NRMB, Research institutes	High
2.2	Identify and map potential habitat.	• Map of potential habitat produced by Year 3.	DENR, NRMB, Research institutes	High
2.3	Search additional potential habitat for new population.	• Searches conducted at 10 or more potential sites per year (identified from Action 2.2).	DENR, NRMB, Research institutes	High

Objective 3: Maintain, enhance and increase the area and quality of suitable habitat for Pygmy Bluetongues at known populations.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
3.1	Work with landholders to implement *Best Practice Management Guidelines*.	• Evidence of improved land management practices at 20% of known sites by Year 5 as a result of the guidelines and associated advice.	DENR, RT, NRMB, Landholders	High
3.2	Implement measures to increase suitable PBT habitat at known populations.	• Management options to increase occupied habitat assessed for priority PBT sites (from Action 1.3) by Year 5. • Measures to increase occupied habitat at 5 priority sites (from Action 1.3) implemented by Year 5.	DENR, RT, NRMB, MNGWG, Landholders	Medium
Objective 4: Monitor populations to evaluate the effectiveness of management and to detect trends which may require a management response.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
4.1	Continue to undertake (and refine as required) long-term population monitoring at selected sites.	• Monitoring at the 9 long-term monitoring sites completed annually. • At least 50% of PBT sites with active management (from Action 1.2 & 3.1) monitored annually to evaluate effectiveness of management actions and adapted as required. • Results of long-term monitoring reviewed annually. • Current monitoring methods evaluated and various other monitoring techniques trialled to develop a better method of efficiently estimating lizard density by Year 5.	DENR, RT, Research Institutions	High
4.2	Maintain (and refine as required) systems for data collection and management.	• BDBSA updated annually with PBT populations, extent of habitat and searched areas and the information provide to relevant authorities as required.	DENR	Medium
Objective 5: Fill critical knowledge gaps to help guide adaptive management and recovery of the species.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
5.1	Prioritise, promote and conduct key research projects needed to guide improved recovery outcomes.	• Research priorities identified (from main text of Action 5.1) and promoted to South Australian research institutions by Year 2. • At least 1 new research projects initiated in response to these priorities by Year 5.	DENR, RT, NRMB, Research Institutions,	Medium

5.2	Undertake land management trials to refine regimes required to improve habitat quality.	• Land management trial (e.g. grazing trials, fire) to improve habitat quality conducted on at least 5 sites by Year 5 (with Action 3.1 & 3.2). • Knowledge acquired from the results of land management trials used to refine and improve the *Best Practice Management Guidelines* by Year 5.	DENR, NRMB, MNGWG, Research Institutions	Medium
5.3	Continue efforts to establish a captive breeding population.	• Breeding in captivity achieved by Year 5 through the development of appropriate techniques, conditions and facilities. • Husbandry manual for captive breeding developed by Year 5.	Zoo, Research Institutions	Low
Objective 6: Continue to engage the community and form partnership to promote the significance and improved management requirements of the Pygmy Bluetongue Lizards.				
6.1	Promote community awareness and ownership of, and involvement in, the recovery of the PBT.	• Local community are kept informed of the recovery program through media articles, newsletters and community events. • Level of volunteer participation in monitoring and other recovery actions is maintained or increased from 2008 levels and reported on annually.	DENR, RT, NRMB	High
6.2	Establish a network of local mentors and champions to help drive and promote improved recovery of PBT populations and engage the community in recovery activities.	• A network of local mentors and champions established by Year 2. • Opportunities for interested volunteers to participate in on-ground recovery activities identified and promoted through networks including integration with other threatened species and communities activities including Iron-grass grassland, Peppermint Box Grassy Woodland, Spiny Daisy and Mount Lofty orchid recovery - ongoing.	DENR, RT, NRMB	Medium
Objective 7: Manage the recovery process through an effective recovery team.				
Action	**Summary Description**	**Performance Criteria**	**Responsibility**	**Priority**
7.1	Maintain an effective recovery team which supports, guides and evaluates the implementation and outcomes of the recovery plan.	• Recovery Team has appropriate representation from relevant stakeholders (Table 3). • Recovery Team meets twice annually to review progress and priorities. • Recovery team has reviewed and improved priority setting, planning and implementation of the recovery program annually.	DENR, RT	High

PBT – Pygmy Bluetongue Lizard; **DENR** – Department of Environment and Natural Resources (SA); **MNGWG** – Mid North Grassland Working Group; **NRMB** – Natural Resource Management boards; **PIRSA** – Primary Industry and Resources SA; **CFS** – Country Fire Service; **RT** – Recovery Team; **BDBSA** – Biological Data Base of South Australia

Recovery Program Evaluation

The recovery team will monitor progress in the implementation of recovery actions, and evaluate the effectiveness of recovery actions. Performance criteria have been established for each action to assist in this evaluation. Currently the recovery team includes representation from:

- Department of Environment and Natural Resources
- South Australian Museum
- Flinders University
- Zoos South Australia
- Goyder Council
- Landholders of Pygmy Bluetongue sites
- Mid North Grassland Working Group
- Nature Foundation

The success of the plan and future directions should be reviewed after five years by the recovery team or an external reviewer.

Part H: Management Practices

The *Pygmy Bluetongue Lizards: Best Practice Management Guidelines for Landholders* (Schofield 2006) have been developed to provide landholders with land management recommendations for the conservation of the Pygmy Bluetongue Lizard. Some of the major recommendations in relation to management practices are outlined below.

Grazing Regimes

Most sites that support Pygmy Bluetongue populations are currently grazed, most commonly by sheep. Continuing with this practice at moderate rates should not pose a threat to the survival of the Pygmy Bluetongue Lizard, and it is recommended that sites that are currently grazed should continue to be stocked (Schofield 2006). Moderate grazing may be beneficial for Pygmy Bluetongue habitat by maintaining a lighter cover of plant matter. It is thought that dense vegetation may reduce the visibility of, or access to prey, and may also reduce basking opportunities by shading the burrow entrance (Pettigrew & Bull 2011.) However, if a site is not currently grazed and lizard populations appear stable, the establishment of grazing may not be necessary (Schofield 2006).

If stocking rates are high, it is recommended that grazing be reduced to moderate levels (Schofield 2006). Very heavy grazing is not recommended as the hard hooves of sheep and cattle may break up the soil, causing lizard holes to collapse. Sparse vegetation cover as a result of heavy grazing may also support lower densities of invertebrate prey, and increase the vulnerability of the lizards to predation (Pettigrew & Bull 2011).

Rotational grazing involving short periods of high stocking (up to seven Dry Sheep Equivalent) appears to be compatible with the needs of Pygmy Bluetongue Lizards, as it does not cause accelerated loss of burrows (Sharp *et al.* 2010).

The placement of watering points on or near the lizard populations is not recommended because stock traffic will impact on the soil and may cause erosion or burrow collapse.

Insect Control Practices

Caution is needed when applying insecticide near Pygmy Bluetongue sites.

During locust plagues, PIRSA adopts an aerial locust spraying buffer zone around Pygmy Bluetongue populations. The current recommendations for aerial spraying near threatened species populations are to allow a downwind buffer zone of one kilometre from the threatened population or an upwind buffer zone of three to five kilometres. Boom or backpack spraying should not occur closer than 500m to the threatened species population.

A number of species of snails are known agricultural pests in the Northern and Yorke region, including the introduced White Snail (*Cernuella virgata*) which is found at a number of Pygmy Bluetongue sites, and can form a significant part of the lizards' diet. Snail control is often achieved through the use of pelletised snail baits, which are known to be very toxic to reptiles (Australian Pesticides & Veterinary Medicines Authority 2005) and are a potential threat

to Pygmy Bluetongue Lizards. If snail control is required, non-toxic methods are encouraged. These methods may include stubble burning or summer grazing. Stubble burning should be avoided in spring and early autumn, when the lizards are most active above ground.

Weed Control

The adoption of a conservative grazing regime will help to prevent grassland degradation and minimise the risk of weed infestation. Rotational grazing at moderate levels may help to control weed growth.

Minimal disturbance weeding techniques should be used wherever possible (Robertson 1997). Herbicides have not been adequately tested for their side effects on reptiles, and have been known to affect fertility of small vertebrates (Pauli *et. al.* 2010). If herbicide use is required, it should be applied directly to the target plants rather than through broad-scale application.

Fire

It is likely, given the high incidence of fire in the Australian landscape and the lizards' habit of living in deep burrows, that they would be adapted to and protected from wildfire. However, wildfire is likely to pose some threat to the lizards' survival, as lizards caught out of their burrows may be killed by the fire (particularly males in the spring, and dispersing juveniles in late summer/early autumn). Therefore, burning of native grasslands in the region during these periods is not recommended.

Tree Planting

Tree planting should not be undertaken within known Pygmy Bluetongue populations. Any revegetation of grasslands that includes tree planting is discouraged and advice should be sought first. If undertaken, revegetation should be conducted with extreme caution and using minimal disturbance techniques, to reduce the adverse impacts on the grassland flora and fauna.

Fertilisers

The use of fertilisers is not recommended at Pygmy Bluetongue sites or where the effects of fertilisers may have an impact on populations or habitat, as fertilisers may encourage weed growth, which may in turn affect the lizards. Care should be taken when applying fertilisers to croplands, where run-off may flow into adjacent Pygmy Bluetongue habitat.

Avoidance of Management Practices That Will Directly Impact on Pygmy Bluetongue Habitat

The *Best Practice Management Guidelines* also raise awareness of, and discourage, management practices which are likely to have significant adverse impacts on Pygmy Bluetongue habitat, including ploughing, ripping, changed land use, or infrastructure development.

Infrastructure Development

This may include the establishment of buildings, roads, wind farms and telecommunications infrastructure. The placements of these infrastructures have the potential to directly effect Pygmy Bluetongue populations or cause further loss and fragmentation of Pygmy Bluetongue habitat.

Due to the difficulty of surveying for Pygmy Bluetongues (timing, technique, effects), it is recommended that the Pygmy Bluetongue Lizard Recovery Team and/or DENR be contacted during initial project planning. Discussion should include the possible impact to Pygmy Bluetongues, their habitats, methods for surveying and post development monitoring and alternative options for infrastructure placements to eliminate or minimise possible impacts.

Management Agreements and Incentives

Heritage Agreements

A Heritage Agreement is a permanent and legally binding agreement between the landholder and the South Australian Minister for Sustainability, Environment and Conservation, and is attached to the land title. A range of incentives are available to landowners who enter into these agreements, including technical advice, financial assistance for the management of the land, rate rebates, and fencing assistance if required. Heritage Agreements do not usually allow any form of production on the protected area of the land, as they aim to preserve native vegetation and any associated fauna. However, specific clauses can be written in, for example if grazing significantly increases the biodiversity value of the native grasslands, then a certain level of grazing may be permitted.

Sanctuary Scheme

The Sanctuary Scheme is a voluntary scheme administered by the DENR which encourages and assists landholders to provide habitats for wildlife on their property. Under this scheme, an agreement which recognises the conservation value of the land and the landholder's commitment to managing the land for conservation, can be signed by the landholder and the South Australian Minister for Sustainability, Environment and Conservation. The Minister then declares the land to be a Sanctuary under the NPW Act by notice in the Gazette. The agreement is not attached to the title of the property, and may be revoked by the landholder by writing to the Minister. The holder of a Sanctuary Agreement may be more likely to receive funds from various funding bodies, to assist in activities that will protect or enhance habitat values for wildlife.

Part I: Duration, Estimated Costs and Benefits

Duration and Estimated Costs

This recovery plan has been prepared in accordance with the EPBC Act. The effective life-span of this recovery plan is five years, after which its effectiveness and further goals will need to be reviewed. Table 2 outline the estimated costs of implementing the identified actions for the duration of the Recovery Plan.

Table 2. Duration and Estimated costs of recovery actions.

Action	Summary Description	Priority	Cost Estimate ($)					
			Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
1.1	Landowner aware of and protect known populations and habitat	High	2,000	2,000	2,000	2,000	2,000	**10,000**
1.2	Private conservation agreements	High	1,000	1,000	1,000	1,000	1,000	**5,000**
1.3	Threat and risk assessments	High	1,000	1,000	1,000	1,000	1,000	**5,000**
2.1	Determine the extent and size of populations	High	40,000	40,000	40,000	40,000	40,000	**200,000**
2.2	Identify and map potential habitat	High	5,000	5,000	5,000	5,000	5,000	**25,000**
2.3	Search for new populations	High	10,000	10,000	10,000	10,000	10,000	**50,000**
3.1	Implement *Best Practice Management Guideline*	High	500	500	500	500	500	**2,500**
3.2	Implement measures to increase suitable habitat	Medium	2,000	2,000	2,000	2,000	2,000	**10,000**
4.1	Long-term population monitoring	High	20,000	20,000	20,000	20,000	20,000	**100,000**
4.2	Data collection and management	Medium	500	500	500	500	500	**2,500**
5.1	Research projects	Medium	80,000	80,000	80,000	80,000	80,000	**400,000**
5.2	Land management trials	Medium	20,000	20,000	20,000	20,000	20,000	**100,000**
5.3	Captive breeding program	Low	15,000	15,000	15,000	15,000	15,000	**75,000**
6.1	Community awareness, ownership, involvement	High	2,000	2,000	2,000	2,000	2,000	**10,000**
6.2	A network of local mentors and champions	Medium	20,000	20,000	20,000	20,000	20,000	**100,000**
7.1	Maintain an effective recovery team	High	500	500	500	500	500	**2,500**
	TOTAL		**219,500**	**219,500**	**219,500**	**219,500**	**219,500**	**1,097,500**

Affected Interests

The community groups and statutory organisations presented in Table 3 have been identified as current and potential stakeholders in the management of Pygmy Bluetongue Lizards.

Table 3. Current and potential stakeholders in the management of Pygmy Bluetongue Lizards.

National Stakeholders
Australian Department of Sustainability, Environment, Water, Population and Communities
World Wide Fund for Nature(WWF) Australia
General Public
State Stakeholders
SA Department of Environment and Natural Resources
Nature Foundation SA
Primary Industries and Resources SA
South Australian Museum
Zoos South Australia
Flinders University, South Australia
SA Herpetology Group
Native Vegetation Council
General Public
Regional Stakeholders
Northern and Yorke Agricultural District NRM Board
South Australian Murray-Darling Basin NRM Board
NRM Regional Facilitators
Burra Community School
Private Landholders
Friends of Burra Parks
Biodiversity and Endangered Species Team
Mid-North Grasslands Working Group
Regional Council of Goyder
District Council of Peterborough
Clare and Gilbert Valleys Council
Wakefield Regional Council
District Council of Barunga West
Country Fire Service (CFS)

Role and Interests of Indigenous People

The Aboriginal Partnerships Section of SA Department of Environment and Natural Resources undertook indigenous consultation for this plan in September 2009. No specific comments were made regarding this species and the recovery plan.

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.

Benefits to Other Species and Ecological Communities

Implementation of this recovery plan will also benefit a range of other species and communities that share a common distribution with Pygmy Bluetongue Lizards. Threatened grassland species which will benefit from the actions in this plan include the Plains Wanderer (*Pedionomus torquatus*) (Vulnerable nationally and Endangered in South Australia) and Diamond Firetail (*Stagonopleura guttata*) (Vulnerable in South Australia).

Actions addressed as part of this recovery plan will also assist in the conservation of Iron-grass (*Lomandra effusa/ L. multiflora* subsp. *dura*) Natural Temperate Grassland of South Australia, which is listed as a critically endangered ecological community under the EPBC Act. This community is one of the habitats where Pygmy Bluetongue Lizards are found.

No negative biodiversity impacts are anticipated from the implementation of this plan.

Social and Economic Impacts

The implementation of this recovery plan is unlikely to cause significant adverse social and/or economic impacts. Most of the recommended recovery actions are compatible with productive land management, and may in fact help to increase the capacity of native grasslands for primary production.

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Appendix 1: Long-term Monitoring Methodology

Aim: To gather data on the Pygmy Bluetongue's population structure and density at selected sites over time.

Method: Examine all suitable spider-holes using an optiscope (opti fiberscope) to determine the presence of Pygmy Bluetongue Lizards in a one-hectare square plot. Suitable spider-holes are circular in cross section and 10 to 20 mm in diameter and greater than 10 cm deep.

To observe the inside of the spider-hole, gently push the tip of the optiscope tube down the burrow until an occupant, or the bottom of the burrow is observed. The hole dwelling behaviour of the Pygmy Bluetongue Lizards, is a key factor facilitating its monitoring. Use of an optiscope permits direct observation of lizards in their burrows, and their sedentary nature enables regular monitoring of all animals in a given area.

Location: Permanently marked one-hectare square plots established at population sites 1, 2, 3, 4, 6, 9, 11, 12 & 22 (Figure 1).

Timing: Monitoring to be conducted annually in February-March, to coincide with the time of year with minimal ground cover making it easier to spot the spider-holes.

Observer: Monitoring should be conducted by an experienced observer, with assistance from volunteers. To increase the number of experienced observers, volunteers should be trained over a number of surveys (or until competent) by an experienced person.

All nine sites (except Site 22 in 2005 and 2006) were monitored between 2005 and 2009. Only sites 1, 2, 4, 6, 11 and 12 were monitored in 2011 due to time and funding constraints. In 2010, a new survey method was trialled using a percentage density count and the data are not included here as comparison could not be made between the two methods.

The number of Pygmy Bluetongue Lizards was observed to fluctuate at all sites since 2005. Pygmy Bluetongue populations will fluctuate over time depending on the abundance of insects (i.e. food) and the abundance of spider burrows (i.e. shelter sites) (Sharp 2011). Drought conditions during 2005 to 2009 may have been responsible for the observed fluctuation, rather than failure of recovery actions. Other reasons may include a lag period between when abundant resources are available and when increase in lizard numbers is detected, lizards may move around considerably from year to year or changes to grazing management of the monitoring paddocks (Sharp 2011). There is a need to continue monitoring in the long-term to better observe the population trends over time.

DENR long-term monitoring data for 2005-20011.

	2005	2006	2007	2008	2009	2011
Site 1	32	37	16	9	15	22
Site 2	12	40	32	19	11	9
Site 3	10	11	34	26	5	-
Site 4	10	8	12	3	1	0
Site 6	10	22	40	14	25	14
Site 9	14	5	7	4	0	-
Site 11	10	5	15	10	1	6
Site 12	16	24	57	20	15	9
Site 22	-	-	26	19	13	-

- Site not surveyed.