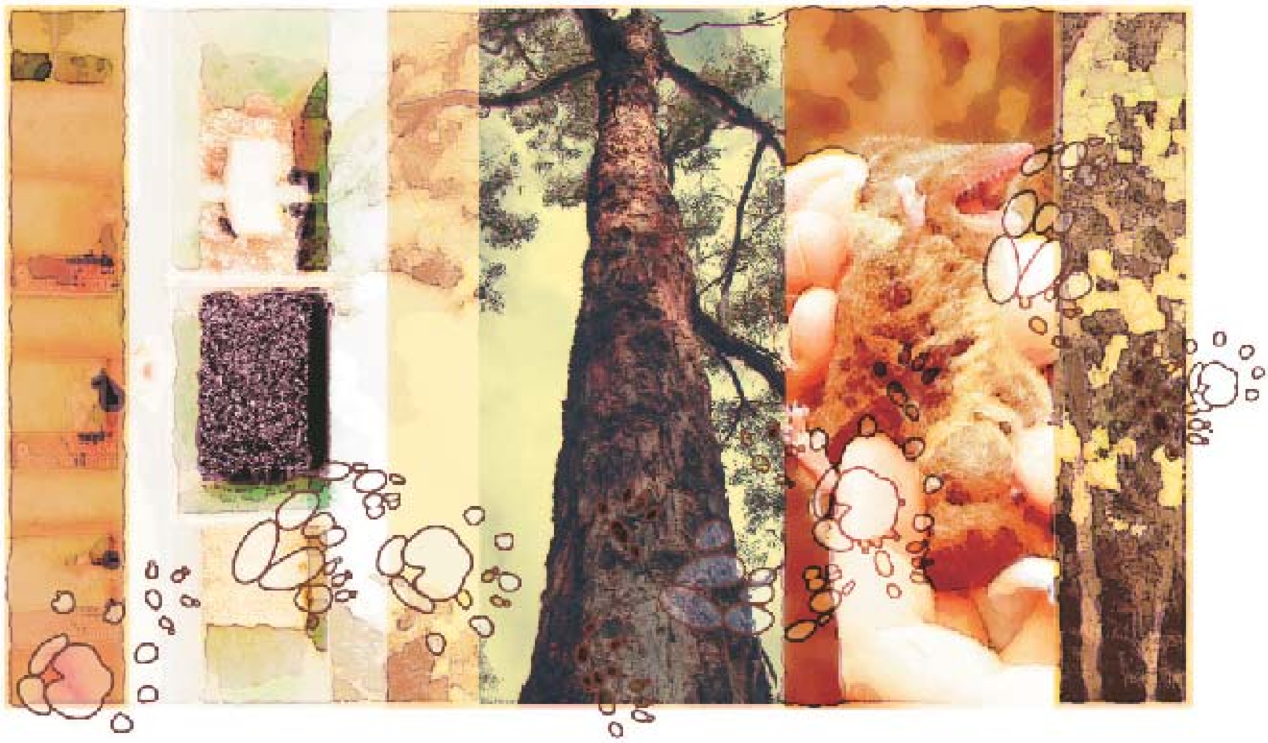

South East Biodiversity Corridors Strategy

Planning for tomorrow's biodiversity

The Development of Biodiversity Corridors within Forest Reserves in the Green Triangle Region of South Australia

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October 2003

ForestrySA

Government of South Australia

Foreword

As part of its role in growing commercial timber for industry, ForestrySA is committed to sound environmental management. This includes the management of 13,300 hectares of native vegetation for conservation in the South East of South Australia, representing 14% of its land.

The most significant areas have been proclaimed as Native Forest Reserves under the Forestry Act to ensure a high level of protection. ForestrySA undertakes active management programs within these Reserves including pest plant and animal control, revegetation and fire management.

Native Forest Reserves form about 22% of remnant native vegetation in the Lower South East, and contribute to regional biodiversity by conserving significant flora and fauna. Many of these reserves however, occur as habitat islands. In recent years, ForestrySA have taken a landscape approach to this problem, using Geographic Information Systems (GIS) to identify potential corridors, and have developed a strategy which will help secure the survival of many species well into the future.

The South Australian Forestry Corporation[1] has adopted this report and recommendations as the basis of its biodiversity corridor policy and implementation.

[1] ForestrySA

Executive Summary

This document explores the need for biodiversity corridors between isolated blocks of native forest within a predominantly *Pinus radiata* system in ForestrySA's Green Triangle plantations.

Studies are examined which show that biodiversity corridors are an effective method of increasing the abundance and diversity of native floral and faunal communities. They lower the probability of extinction due to catastrophic events and inbreeding.

Corridor value decreases with length, and as proximity to native vegetation decreases, because the potential use of the corridor decreases.

Corridor value within a *Pinus radiata* system is greater than that of open farmland, and therefore effective corridors do not need to be as wide.

The design of biodiversity corridors including plant structure and species diversity, shapes, and widths of the corridors are explored. A corridor design ranging between a minimum of 40 metres width, to a maximum of 80 metres width is recommended for Forest Reserves in the Green Triangle region.

The document also recommends the establishment of biodiversity corridors at eight locations where they would have a positive impact on plants and animals, with a provision for fifteen individual corridors through land currently planted with *Pinus radiata*. Potential corridors over private and adjacent land are also explored.

The establishment of biodiversity corridors is a long-term strategy and will be incorporated into ForestrySA's re-establishment schedules over the next 25 years.

The effective area of plantation required is 74.4 Ha, or approximately 0.1 percent of ForestrySA's productive land in the South East of South Australia.

In preparation of this report, the economic, social, and environmental considerations of the Charter for the South Australian Forestry Corporation have been taken into account.

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1 Introduction

ForestrySA manages approximately 13 300 ha of land for conservation in the South East of South Australia. These areas range in size from less than 1 ha to over 2 200 ha, and represent about 22% of the intact native vegetation in the Lower South East. These remnant areas make an important contribution to regional biodiversity, by conserving significant native floral and faunal communities (Biodiversity Plan for the South East of South Australia 1999).

These areas, however, generally occur as isolated habitat 'islands' surrounded by plantations or pasture that present difficulties for many species with migration and re-colonisation. Consequently there is little or no genetic interaction between populations of many species occurring across these islands (Krebs 2001). This can lead to a reduction in genetic diversity over time, and a species' ability to adjust to environmental change (Burgman & Lindenmayer 1998). Some examples of this include increased mortality rates, increased susceptibility to natural catastrophies, disease, and lower birth rates, resulting in increased probability of extinction (Possingham 1995; Horn 1998; Simberloff et al 1992; Lindenmayer 2000)(see Appendix 2).

A widely used solution to overcome fragmented ecosystems is to develop biodiversity corridors[2] between the habitat islands. This report details the value of biodiversity corridors, and appropriate designs for corridors between habitat islands predominantly within a *Pinus radiata* system are explored using working examples. Implementation methods are detailed, and valuable sites for biodiversity corridors in the Green Triangle region are identified. A range of recommendations that have been adapted by ForestrySA are included. It is expected that in future, similar investigations will be carried out for Forest Reserves in the Mount Lofty Ranges, and the Victorian portion of the Green Triangle region.

Historically the concept of biodiversity corridors was introduced to ForestrySA in the early 1980s by ForestrySA officer Barrie Grigg, following the discovery of the Yellow-bellied Glider in Snowgum Native Forest Reserve. The concept was taken further in the 1990's when a corridor linking The Bluff Native Forest Reserve with Windy Hill Native Forest Reserve was approved and established. This document will be used as a benchmark for issues relating to corridor policy, establishment and use in the future.

[2] Also known as Wildlife Corridors, Biodiversity Links and Biolinks

2 The Value of Biodiversity Corridors

The value of corridors to aid biodiversity on a landscape scale, has been well documented. Carruthers and Smith (1996) explain how corridors add value to fragmented landscapes, by overcoming the inability of species to recover from a catastrophic event because of their inability to re-enter the system. Noss (in Krebs 2001) summarises the potential advantages and disadvantages of corridors (Appendix 3). Haddad & Baum (in Krebs 2001) found that butterfly density doubled when a corridor was placed between isolated patches. In addition there has been much study into habitat fragmentation in a *Pinus radiata* setting in recent years including that from Lindenmayer (2000) and Lindenmayer et al (2001). Many of the recommendations from these and other studies include provision for biodiversity corridors within this matrix, in order to minimise the risks associated with small patch size and isolation, and provide a system that will sustain a higher level of biodiversity in the long term (Lindenmayer, 2000; Gepp 2001; Paull 1995; Paull 1999).

A number of factors make a carefully planned wildlife corridor valuable. Firstly, they provide habitat for different species of mammals, birds, reptiles, amphibians and insects. They provide food, shelter and protection. Secondly, and more importantly, corridors allow for the dispersal of species from one area of key habitat to another.

Corridors facilitate dispersal in two ways – diffusion dispersal and jump dispersal. With diffusion dispersal, individuals may live inside the corridor, and genetic transfer occurs from occasional migration of individuals between adjacent habitat islands and the corridor over several generations. Jump dispersal occurs where an animal may move large distances in search of food and habitat, or a mate (Krebs 2001). This is a common form of dispersal for juveniles driven from their parents' territory (Carruthers & Smith 1996; Bachmann, M. pers com 2002; Carthew, S. pers com 2002)

3 Determining Biodiversity Corridor Design

3.1 Structure and Species Diversity

To be effective for all species (including bird and reptile fauna), a corridor should by its structure and floral composition, provide all the elements of food, shelter, and protection from predators.

Studies in recent times have shown that road reserves containing remnant vegetation of reasonable quality, and narrow intact linkages (<40m wide) between remnant areas can facilitate dispersal between habitat fragments (Bennett 1988, Bennett 1990). This indicates that corridors established to replicate conditions similar to that of natural vegetation with a multi-layered structure, will in the long term provide an effective link between remnants.

Bennett (1988) found that the dispersal of native animals on roadsides was attributed to the retention of roadside vegetation (<40m) with a wide diversity of species and intact structure, and found Ringtail Possums (*Pseudocheirus peregrinus)*, Long-nosed Potoroos (*Potorous tridactylus)*, Bush Rats (*Rattus fuscipes)*, and Swamp Rats (*Rattus lutreolus)* lived in them. Bennett (1990) found the Southern Brown Bandicoot (*Isoodon obesulus)* utilising a roadside corridor as part of its home range, Antechinus species' using corridors to travel between patches, and Bush Rats and Swamp Rats living within the roadside vegetation habitat.

Soule and Gilpin (1991) found that well structured corridors would be useful for juvenile dispersal, and for adult migration and breeding. Goldingray & Kavanagh (1993) found that Yellow-bellied Glider (*Petaurus australis)* use of corridors is determined more by the habitat provided by the corridor such as the availability of food, and occurrence of hollow trees. Carruthers & Smith (1996) mention that habitat quality will determine the ultimate success of dispersing animals.

More information on obtaining structure and species diversity in newly planted corridors can be found in Section 4.

3.2 Width and Edge Effects

Width is a significant factor in influencing the effectiveness of a biodiversity corridor. This is vital because of the effects of different types of disturbances on its edges. These effects include changes in light, wind and other microclimate variables that affect habitat quality, and increased predation on corridor users (Labaree 1992). Figure 3.1 demonstrates the effects of fragmentation on vegetation edges. It can be clearly seen that by altering the shape and width of a remnant, the edge effects are altered. In Figure 3.1, they increase. This principle can be applied to biodiversity corridors. Section 3.4 and Figure 3.2 outline more closely how the adjoining landuse influences edge effects, and includes a Radiata Pine example. The impact of predator edge effects, namely from cats and foxes, can be greatly reduced by extending existing baiting programs.

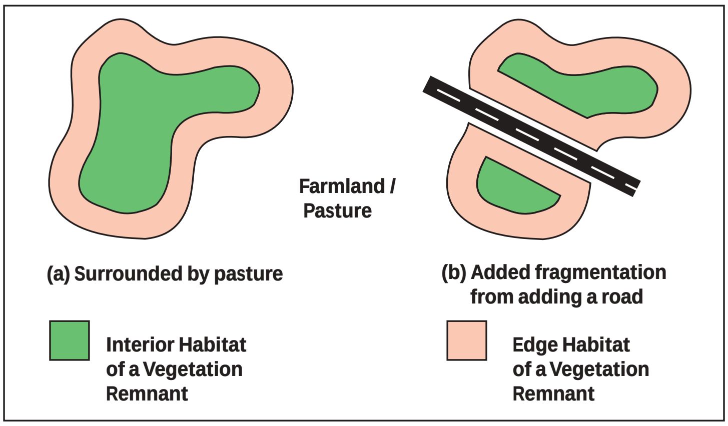

Fig 3.1 – Edge effects - modified from Labaree (1992).

Using Bennetts Data (1988; 1990), in the case of the Bush Rat, the density in roadside verges between 20 and 40 metres was significantly greater (approx 2.5 times) than that of verges under 20 metres wide (P = 0.02). This indicates that more animals will be able to live in wider corridors. They will have more protection from predators, and increased foraging space.

Forestry companies in other states have provisions for biodiversity corridors in place. The Interim Best Operating Standards for Harvesting of Private Native Forestry (in NSW) (2001) states:

"A corridor exclusion area must be established between adjacent forested catchments greater than 500 ha in size and where the net harvest area for an operation exceeds 200 ha. Corridor exclusion areas must be a minimum of 40 m wide, and connect second (or higher) order streams, where present"

State Forests (NSW) have a similar policy, except "*across the ridge*" (corridors linking 2 catchments) corridors are a minimum of 80-metres wide for a single corridor, or 40-metres wide for two corridors. Their stream corridors also vary in width from 20 to 40 metres either side for 1st 2nd and 3rd order streams (J Sheilds pers com 2002). The 80 metre width is based on research by Recher et al (1987) and was the minimum corridor width where there was found to be no difference between species living in scrub blocks and corridors.

The author has observed Sugar Gliders, and Yellow-bellied Gliders foraging and nesting 10 to 20 metres from an edge. Southern Brown Bandicoots will forage near edges (Bennett 1990), while the Brush-tailed Phascogale (*Phascogale tapoatafa*) lived in roadside verges and remnants 40 metres wide in suitable habitat (van der Ree et al 2001).

A suitable width depends on the purpose of the corridor. An 80-metre width was suitable for Recher et al's target species to live in the corridor, whereas a 40-metre width may be suitable for animals to use solely for dispersal from one habitat island to another.

It may be sound to consider the development of corridors of varying widths between 40 and 80 metres. Each corridor should be assessed on its merits, keeping in mind its purpose. For example, a long corridor proposed to link two habitat islands which contain a species of high conservation significance such as the Yellow-bellied Glider, would require a corridor on the wider end of the scale. A corridor for a species with fewer requirements such as the Sugar Glider would not have to be as wide. Whether or not a corridor was surrounded by pine or farmland would also impact the best width.

3.3 Length

The ability of a given species to disperse along a biodiversity corridor is related to the corridor length (see Section 2 for dispersal). Table 3.1 demonstrates relative value of a biodiversity corridor depending on its length and proximity to existing quality native vegetation. This process, developed by Carruthers & Smith (1996) provides a useful guideline to identify optimum biodiversity corridor locations, using Geographic Information Systems (GIS). Downes et al (1997) found that species richness within corridors was less with increasing length, and supports this approach. In summary, corridor length, and proximity to native vegetation, combined with width, are crucial to the effective dispersal of native animals.

High Increasing value Low

Ecological value of link length

Low Increasing value High

Proximity to Habitat Patch

Value of Corridor	High link length up to 1 km	Moderate link length 1 - 2.5 km	Low link length 2.5 - 5 km	Unknown link length > 5 km
High within 1 km buffer				
Moderate within 2 km buffer				
Unknown outside 2 km buffer				

Table 3.1 – Value of Biodiversity Corridors (From Carruthers & Smith (1996))

3.4 Adjoining Land Use

Recent experimental studies have shown that patches of native vegetation surrounded by a matrix of pine plantation have a significantly higher biodiversity value than previously thought, and certainly a higher value than those enclosed by relatively barren and exposed farmland (Lindenmayer 2000; Lindenmayer et al 2001). When a corridor is placed within this type of system, it therefore provides better value for the economic investment than if situated through open farmland. This is a result of reduced edge effects. What this experimental evidence suggests is that a corridor would not have to be as wide if it abutted *Pinus radiata* plantation on either side. Figure 3.2 illustrates this phenomenon.

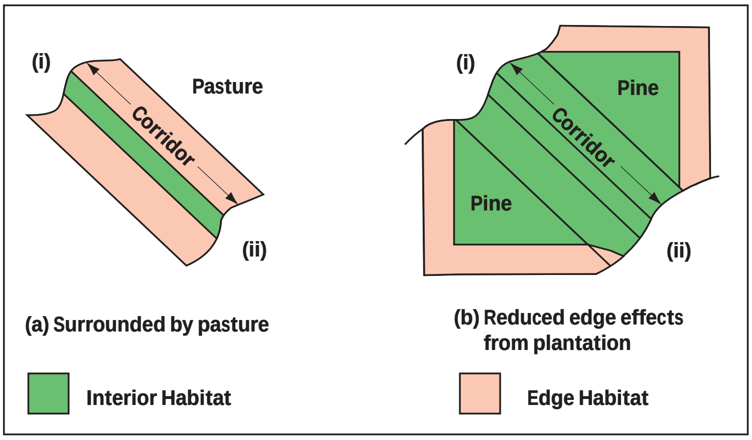

Fig 3.2 – Edge effects of corridors surrounded by (a) Pasture and (b) Plantation

4 Corridor Design for the Lower South East

In the previous chapters, species requirements, corridor structure, width, length, and edge effects, have been examined. These are used to provide the following design recommendations for a *Pinus radiata* system within the South East of South Australia.

4.1 Corridor Design Principles

Corridors should be designed in such a way as to provide a diversity of habitats (Labaree 1992). Since the purpose of the corridor is to encourage animals to travel from one area to another along the corridor, the preferred habitat of the target species should also be provided along the length of the corridor. An example of this is a newly planted corridor on ForestrySA land linking The Bluff NFR with Windy Hill NFR. Manna gum *(Eucalyptus viminalis)* and Brown stringybark (*Eucalyptus baxteri)* raised from seed collected on site have been planted in alternate rows along the length of the corridor over naturally occurring understorey species.

The understorey of a biodiversity corridor should be as thick as possible to ensure protective cover for terrestrial animals. This will help to guard against predators. A thick understorey may be obtained efficiently by direct seeding. Some important understorey plants such as *Astroloma spp,* and *Banksia marginata* may have to be propagated as seedlings and hand planted.

Since the overstorey is important for arboreal animals, and rapid growth and appropriate spacing of the trees is required, hand planting is recommended. Some overstorey trees such as Blackwood *(Acacia melanoxylon)* and Black wattle *(Acacia mearnsii)* can be included in the direct seeding mix. If these larger and quick growing overstorey species threaten the growth of the important understorey, the removal of some is recommended in the first two years.

It is recommended to place corridors between existing *Pinus radiata* plantations where possible, in preference to where there is open farmland either side. This would increase the effective width of the corridor by reducing the edge effects, and maximise the biological value.

Varying the width along longer corridors, in particular by creating ‘nodes’ may also improve their viability and reduce overall edge effects on target species. Opportunities for this should be pursued where proposed corridors pass features such as swamps, outcrops and conservation zones.

Corridors, when carefully designed, will not only link habitats, but also add habitat.

4.2 Land Requirements

The amount of plantation land required for a corridor is calculated by the following formula:

L_p = $(W_c + W_{Fp} - W_{Fe})$*Length

Where **L_p** = Loss of plantable land
W_c = Width of Biodiversity corridor
W_{Fp} = Width of the proposed firebreaks on both sides
W_{Fe} = Width of the existing firebreaks adjacent to proposed corridor

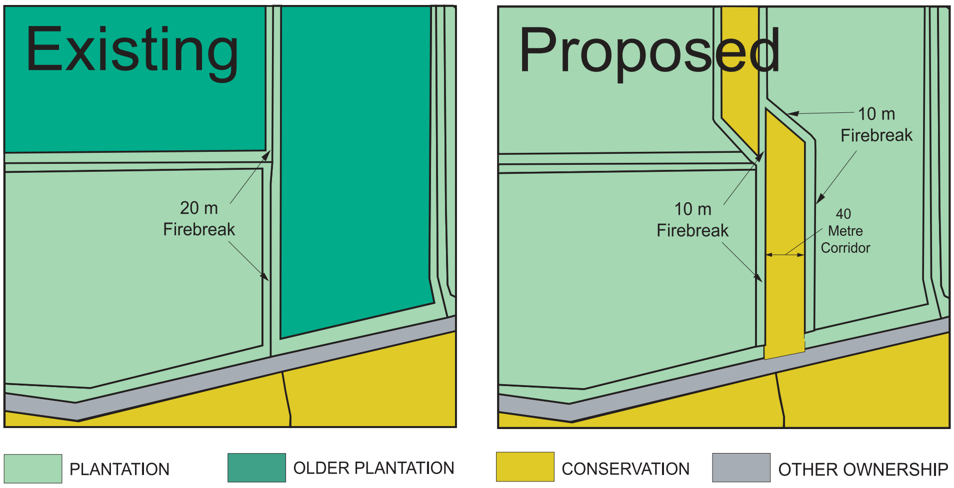

Fig 4.1 –Diagram showing the 20-metre firebreak being split into 2, 10-metre firebreaks.

4.2.1 Corridors Within Plantation

Corridors routed along existing internal firebreaks within plantations and bounded by 10-metre access tracks will incur a loss to the General Forestry Zone (Plantation) according to the formula:

L_p = $(W_c + W_{Fp} - W_{Fe})$*Length
Loss = (Corridor width) + (2 x 10 metre tracks) – (Original firebreak width)
eg = 40m + 20m – 20m
Loss = 40m*(Length)
(see Fig 4.1 for an example)

In some situations within plantations, it may be sound to reduce the requirement for a 20-metre firebreak to a 10-metre track / firebreak.

4.2.2 Corridors Along Plantation Edges

Corridors routed along external breaks adjoining non-ForestrySA land with a 10 m track separating plantation and corridor, and maintaining a 20 m break to the section of the road reserve boundary will incur a loss to the General Forestry Zone according to the formula:

L_p = $(W_c + W_{Fp} - W_{Fe})$*Length
Loss = (Corridor width) + (1 x 10 metre track + 20m Firebreak) – (Original width)
eg = 40m + 30m – 20m
Loss = 50m*(Length)

4.2.3 Corridors Utilising Adjoining land

A number of opportunities may exist to cooperate with Local Councils and adjoining landholders to utilise or add to existing unmade / unused road reserves. A recently planted biodiversity corridor at The Heath Native Forest Reserve is an example of co-operation.

4.3 Corridor Management and Implications for Forest Management

ForestrySA land is currently classified under three major land management zones under an agreement with the Native Vegetation Council. These are General Forestry, Conservation, and Transitional (from General Forestry to Conservation) Zones. Once established, corridors would be appropriately classified as Conservation Zones, or alternatively as a Biodiversity Corridor Zone.

4.3.1 Fire Prevention, Access and Management

Corridors will need a minimum of a 10-metre firebreak either side. The current policy is that areas enclosed by 20 metre tracks should not exceed 400 ha. (FSA Plantation manual 2002) (see Fig 4.1). Corridor establishment will be undertaken in accordance with the ForestrySA Plantation Manual.

Corridors will not be planted in long continuous blocks, but will be integrated into the existing plantation grid so that there is adequate access within the Forest Reserve. Figure 4.2 demonstrates how a proposed biodiversity corridor would be integrated into the existing system. The existing main tracks are maintained for fire access and safety, and 'T - junctions' have been avoided. The proper design of biodiversity corridors will also reduce the likelihood of 'wick' effects in the case of a wildfire.

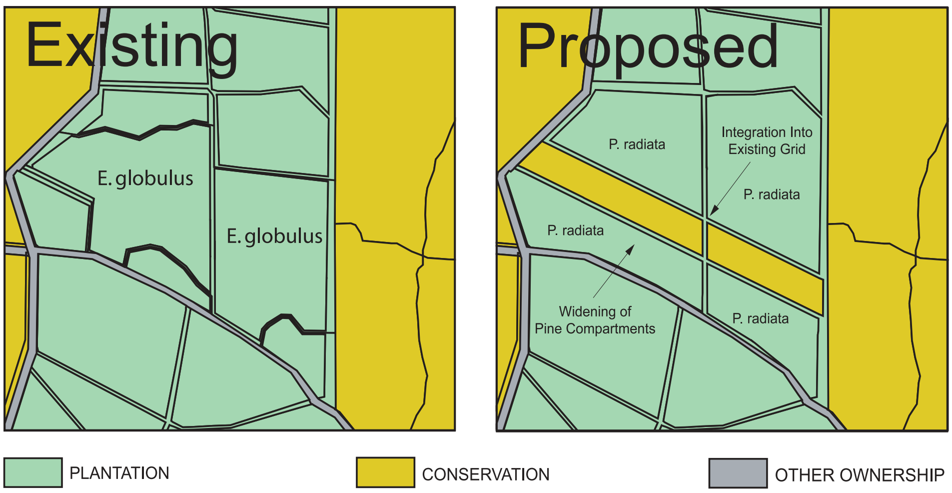

Fig 4.2 Integration of a biodiversity corridor into a plantation system

The implementation and design of biodiversity corridors on ForestrySA land will be undertaken in accordance with ForestrySA's Corporate Policy on Fire Protection, Suppression, and Cooperation with Other Organisations, the Country Fires Act 1989, and the Forest Owners Conference Plantation Design Guidelines.

As with existing native forest management plans, allowances will be made for the strategic prescribed burning of biodiversity corridors.

4.3.2 Operational Implications

The establishment of biodiversity corridors will mean that management costs related to an increased interface area between native vegetation and plantations will increase. Plantations immediately adjacent to corridors will be subject to the requirements of ForestrySA's buffer policy where herbicide, fertilizer and other operations may be restricted. Fire protection works may also be slightly increased. Any increase in costs associated with ground based herbicide and fertiliser operations can be minimised by future plantation design incorporating straight corridor edges, and row direction parallel to corridors.

5 Proposed Corridors for the Lower South East Forest Reserves

The above information has been used to recommend the proposal of twenty-one biodiversity corridors for the Forest Reserves in the Lower South East of South Australia. Fifteen of the corridors are proposed over ForestrySA land, and two of the fifteen will link native vegetation owned by ForestrySA, to that owned by the Department of Environment and Heritage (DEH). Six corridors are proposed in key locations that may involve establishment on private land, or rehabilitating road reserves.

5.1 Location and Area

The corridors recommended are shown in Table 5.1, and have been divided into eight distinct groups, with the aim of increasing the net effective area of native forest and faunal habitat. Proposed areas can be viewed in Fig 5.1 – 5.4. The areas are described as Caroline, Mt Gambier, Tantanoola / Mt Burr South, Mt Burr, Mt McIntyre, Penola, Comaum South, and Comaum.

Corridor groups have been identified using Geographic Information Systems (GIS), and criteria such as reserve size, quality of vegetation, and isolation of the reserve have been taken into account. For example, reserves with too great a distance between them have been excluded from the same corridor group, such as Native Wells NFR, and Burr Slopes South NFR. Kay NFR is too far from any particular group, so it was not considered. Laslett NFR, and Hells Hole NFR were too small, and too isolated to be considered for a biodiversity corridor. A case study which involves the use of GIS technology is found in Appendix 1 in Section 7.

5.1.1 Caroline Group

Three new corridors will be planted in this group for a total of four corridors. These corridors will be vital for extending the effective area of arboreal marsupial habitat, including that of the Yellow-bellied glider, and a variety of other threatened species that live in this area. Two of these corridors are planned directly alongside of firebreaks, one of which will partly cover a road reserve. The other corridor (Honeysuckle – Dry Creek) is planned for an area of Bluegum plantation. If implemented, the connected reserved area will increase to 1667 hectares, by linking all major Native Forest Reserves and Parks in the Caroline area. Corridors in this Group will be 80m wide for Snowgum NFR – Dry Creek NFR, Dry Creek NFR – Honeysuckle NFR and approx 50m wide for Honeysuckle NFR – Penambol CP.

5.1.2 Mt Gambier Group

Two corridors are planned in this group. These corridors would cater for ground and arboreal species of mammal, and birds. One of these corridors is already being implemented between Wandilo NFR and Hackett Hill NFR over an area known as the Pasture Strip. The corridor between Wandilo NFR and Grundy Lane NFR would follow the firebreak. Another corridor to link Telford Scrub would require cooperation between private landholders to implement. Corridors in this group will be 50 metres wide.

Corridor Group	***Reserve***	***Reserve Area (Ha)***	***Approx Length of Corridors Required over GF land (m)***	***Explanatory Notes***
Caroline	Snowgum NFR	191.8		
	Dry Creek NFR*	747.7	1400	**(Dry Ck In Progress)*
	Honeysuckle NFR	266.4	860	
	Pond Flat NFR	32.8	1960	
	Warreanga NFR	250		
	Penambol CP	179		
Total		**1667.7**	**4220**	
Mt Gambier	Hackett Hill NFR	493.1		
	Wandilo NFR	419.6	1110	
	Grundy Lane NFR	287.8	1950	
	Telford Scrub CP	174		*(770 m Private land)*
Total		**1374.5**	**3060**	
Tantanoola / Mt Burr Sth	Kangaroo Flat NFR	302		
	Honan NFR	1050.9	*623*	*(Honan - Woolwash)*
	Long NFR	147.1		
	The Woolwash NFR	263.6	117.6	
	The Bluff NFR	73.1	1270	
	Windy Hill	139.6	*105	*(WH-BL In progress)*
	Gower CP	40	630	
	Mt Watch NFR	50	**1030	*(2 Corridor system)*
	Glencoe Hill NFR	66.6	0	
	Native Wells NFR	619.5	1140	
Total		**2752.4**	**4915.6**	
Mt Burr	Burr Slopes Sth NFR	135.5		
	The Marshes NFR	569.5	1480	
Total		**705**	**1480**	
Mt McIntyre	Whennen NFR	244.4		
	Mt McIntyre NFR	63.1	620	
	McRosties NFR	111.2	640	
	Overland Track NFR	144.1	***553	*(Existing Rd Reserve*
Total		**562.8**	**250m min,1810m max**	*requiring improvement)*
Penola	The Heath NFR	203.7		
	Topperweins NFR	174.8		
	Yeates Scrub / Heritage	435		*(Along Road Reserve)*
	McDougall	110		
	Other FSA	60	100m*	*(In progress)*
	Muddy Flat		150	*(disjunct from other Penola)*
Total		**983.5**		*potential for 2000m Rd reserve / other landholders*
Comaum Sth	Boolara NFR	84		
	Comaum NFR	157	1270	
	Private Scrub	30		
Total		**271**	**1270**	
Comaum	Deadmans Swamp NFR	533.2	*130 (existing private land)	*(Links Northern part of*
	Glenroy CP	541	150 (over FSA NFR land)	*Deadmans Swamp to*
	Wombat Flat NFR	135.1		*the southern vegetation)*
	Private Scrub	262		
Total		**1471.3**	**0**	
Grand Total		**9788.2**	**Minimum 15322.6 Maximum 16882.0**	

Indicates corridor within a reserve   Indicates corridor between reserves

Table 5.1 – Summary of Proposed Biodiversity Corridors

5.1.3 Tantanoola / Mt Burr South Group

This group, when implemented, would enable the establishment of the largest connected area of inland woodland in the South East. Most corridor routes are planned to adjoin firebreaks and connect reserves by the shortest route. The corridors also allow for the connection of two distinct Bandicoot populations between Mt Burr, and Mt Gambier. Corridors in this group range from 40 to 50 metres wide.

5.1.4 Mt Burr Group

This group consists of a small corridor between Burr Slopes South NFR and The Marshes NFR. The corridor on this site is narrower than the rest of the sites, being 20 metres, and then 40 metres wide, following a road reserve for part of the way adjacent to an area of new plantation.

5.1.5 Mt McIntyre Group

Two corridors are proposed over General Forestry land to link three reserves. In addition to the proposed corridors, two narrow road reserves with native vegetation currently link this site with Overland Track NFR, and The Marshes NFR (Mt Burr Group). The two corridors planned over ForestrySA land would be implemented adjacent to firebreaks. Corridors in this group over ForestrySA land will be 40 metres wide.

5.1.6 Penola Group

This group would link five sites together by rehabilitating un-made road reserves, and planting road reserves. This group contains important habitat for arboreal marsupials, as well as a population of Southern Brown Bandicoots. A narrow corridor of 40 m wide is planned for Muddy Flat NFR to link the two parts of the reserve.

5.1.7 Comaum South Group

This group would improve a degraded unmade road reserve by adding 20 metres of width to ForestrySA land.

5.1.8 Comaum Group

A significant area to the North of Deadmans Swamp NFR could be linked to the Southern part of the reserve over private land. This area also would link onto Glenroy Conservation Park, Wombat Flat NFR, and private scrub to give an area of 1471 hectares of connected native forest. Some improvements over ForestrySA land will be necessary, as well as promoting improvements on private land. Inset on Figure 5.4 is a map of Cave Range Forest Reserve. The corridor shown inset was approved after the production of the original report recommendations.

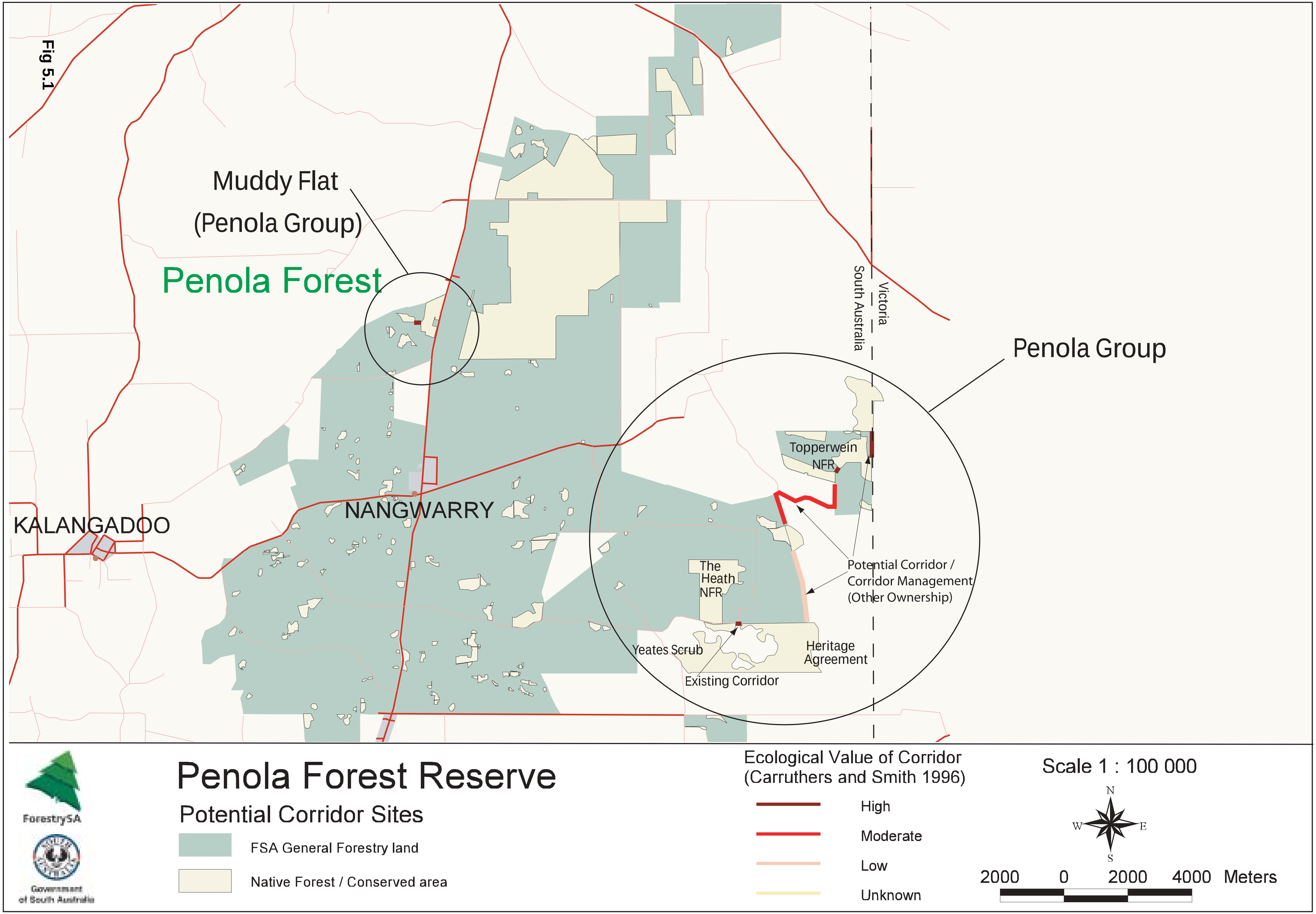
Fig 5.1
Muddy Flat
(Penola Group)
Penola Forest
Penola Group
Victoria
South Australia
KALANGADOO
NANGWARRY
Topperwein
NFR
The
Heath
NFR
Yeates Scrub
Existing Corridor
Heritage
Agreement
Potential Corridor /
Corridor Management
(Other Ownership)
Penola Forest Reserve
Potential Corridor Sites
FSA General Forestry land
Native Forest / Conserved area
Ecological Value of Corridor
(Carruthers and Smith 1996)
High
Moderate
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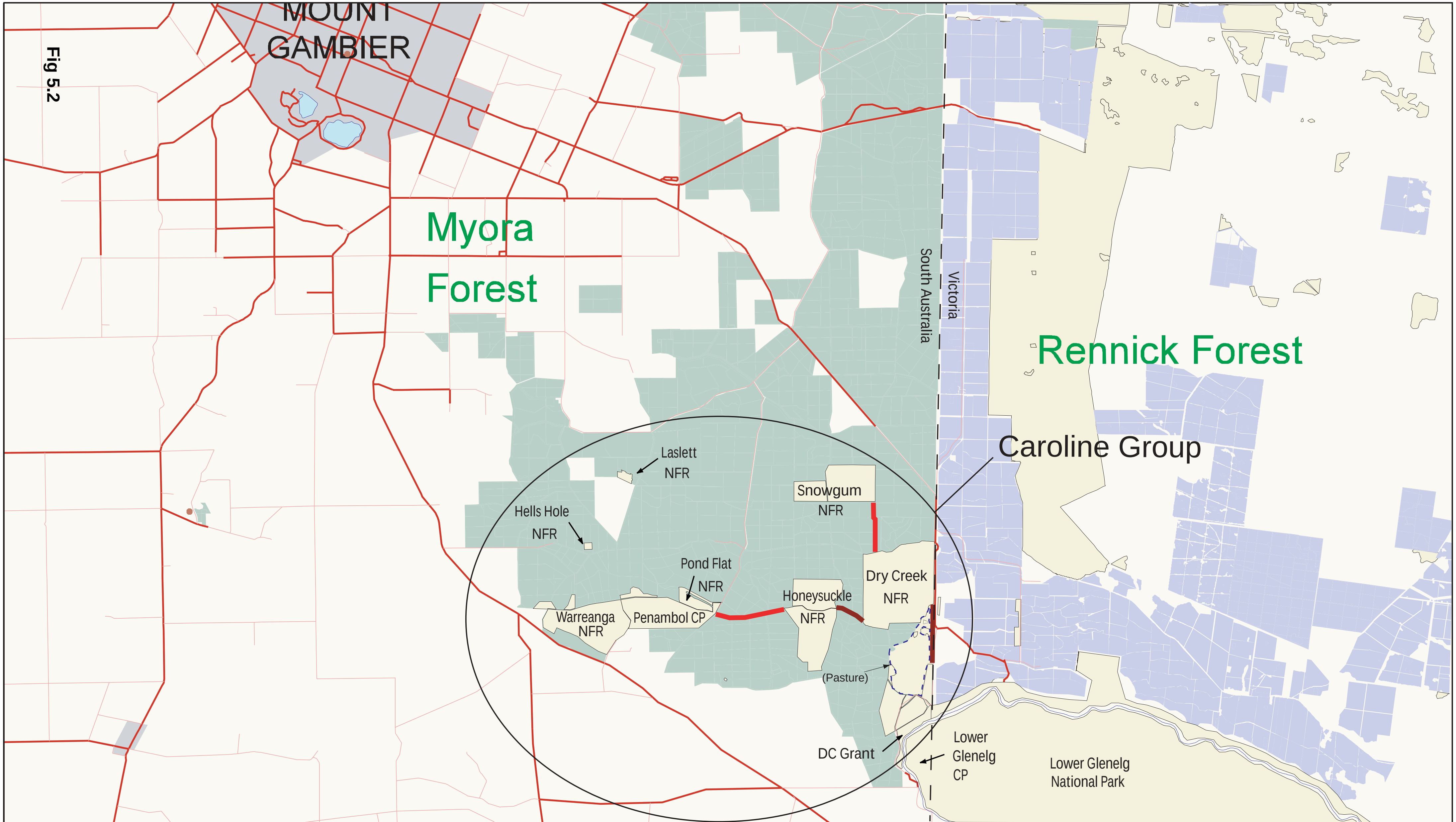

ForestrySA

Government of South Australia

Myora Forest

Potential Corridor Sites

FSA General Forestry land

Native Forest / Conserved area

Victorian Plantation

Ecological Value of Corridor (Carruthers and Smith 1996)

High

Moderate

Low

Unknown

Scale 1 : 100 000

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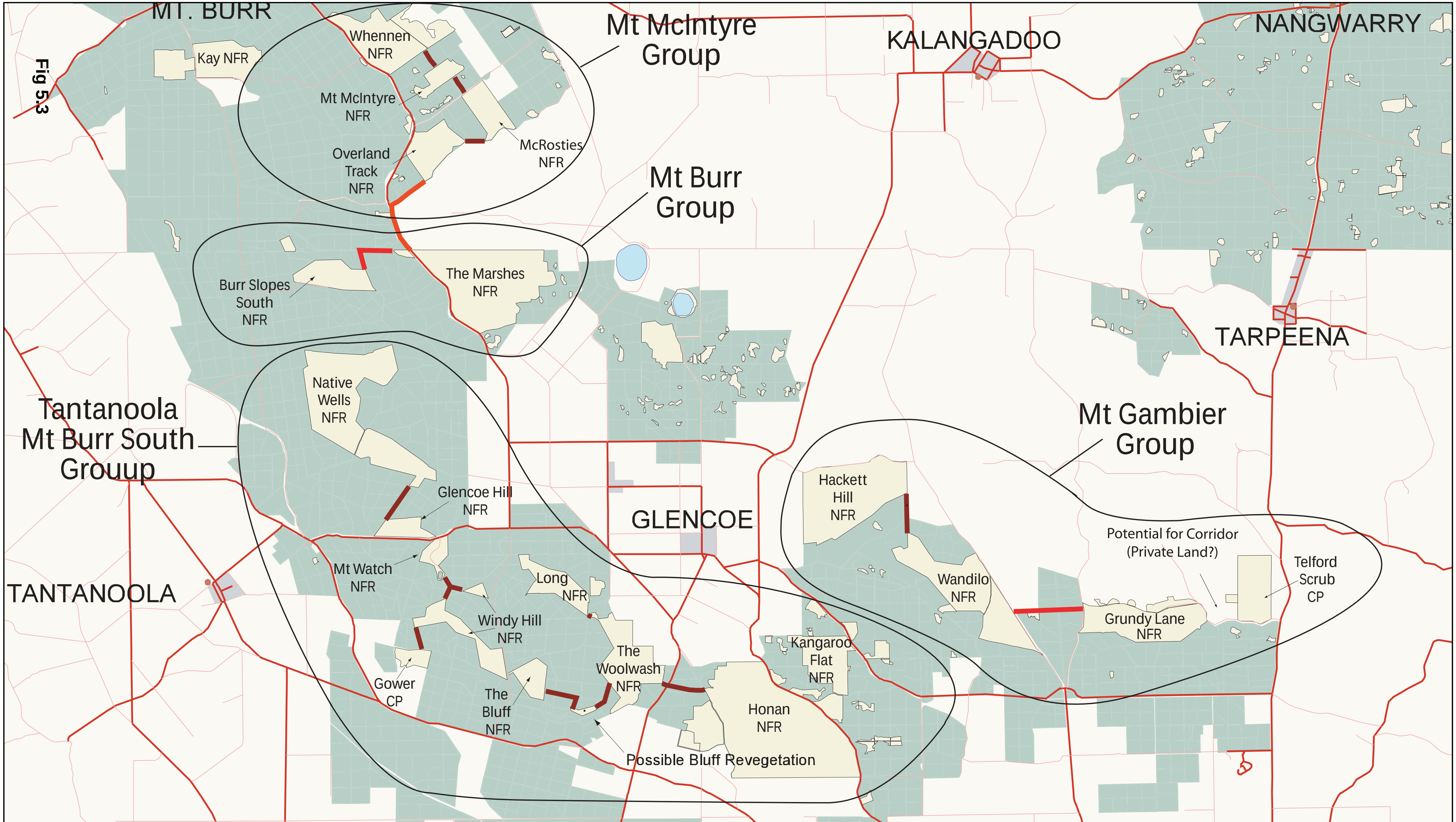


ForestrySA

Government of South Australia

Mt Burr / Mt Gambier Forests

Potential Corridor Sites

FSA General Forestry land

Native Forest / Conserved area

Ecological Value of Corridor (Carruthers and Smith 1996)

High

Moderate

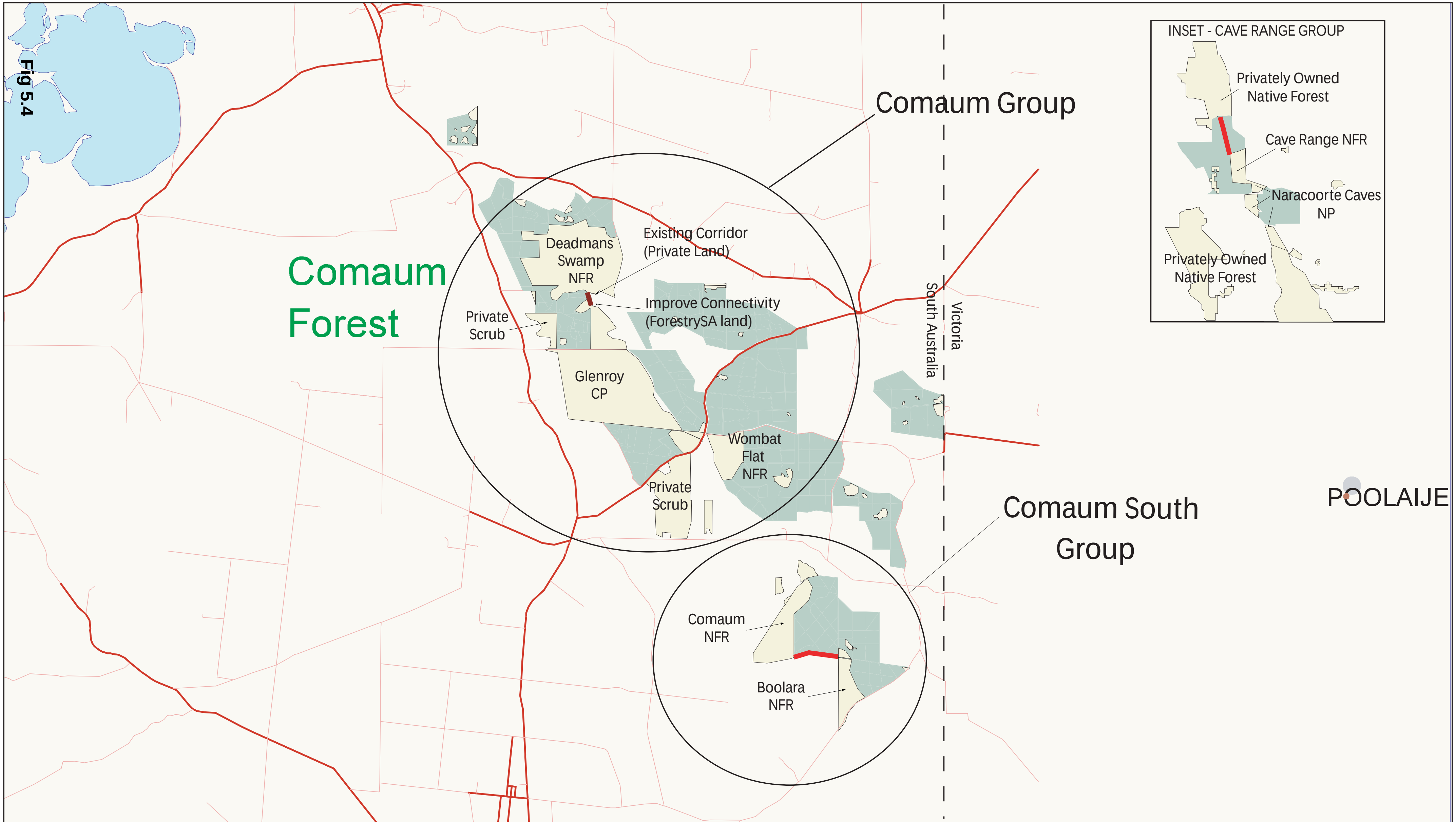
Low

Unknown

Scale 1 : 100 000

N W E S

2000 0 2000 4000 Meters



ForestrySA

Government of South Australia

Comaum Forest Reserve

Potential Corridor Sites

FSA General Forestry land

Native Forest / Conserved area

Ecological Value of Corridor (Carruthers and Smith 1996)

High

Moderate

Low

Unknown

Scale 1 : 100 000

N W E S

2000 0 2000 4000 Meters

6 Implementation and Evaluation

6.1 Implementation

The establishment of biodiversity corridors is proposed to coincide with the scheduled clear-fall and subsequent site preparation of the compartments. An implementation timetable is provided for those areas currently consisting of *Pinus radiata* plantation (Table 6.1). It is expected that the timetable will be complete somewhere between 2024 and 2030, with most corridors established by 2015 / 2016.

Implementation works involve site preparation following *Pinus radiata* plantation clear-fall and the planting of native forest. Site preparation consists of initially harvesting or chipping the area selected to be a biodiversity corridor. Pine stumps should be cut as close to the ground as is manageable so as to allow ease of access to direct seeding machinery when the corridor is to be planted.

The site should be heaped and burnt, and chopper-rolled in accordance with normal plantation establishment practices. Some of the logging residue may be kept on site in key locations to provide habitat for ground-dwelling animals. This residue may also be placed inside the corridor area at a later date. An example where Plantation land has previously been converted to a biodiversity corridor is at “The Bluff” locality in Mount Gambier Forest Reserve, linking The Bluff Native Forest Reserve to Windy Hill Native Forest Reserve.

Weed control is necessary when re-establishing parts of a biodiversity corridor, and when possible, should be undertaken in conjunction with works in neighbouring Plantation areas. This will save both time and resources, as it is a greater economy of scale. Some weed control in excess of that undertaken in conjunction with the plantation establishment may be necessary, as direct seeding relies on minimal weed competition.

Volunteers and community groups may be involved in the establishment of the corridors. Groups such as Green-Corps, Friends of the Forests, catchment groups, and local schools, have contributed time, money, and resources towards environmental projects on Forest Reserves. The benefits are not only there for ForestrySA, but also for the people involved in the projects.

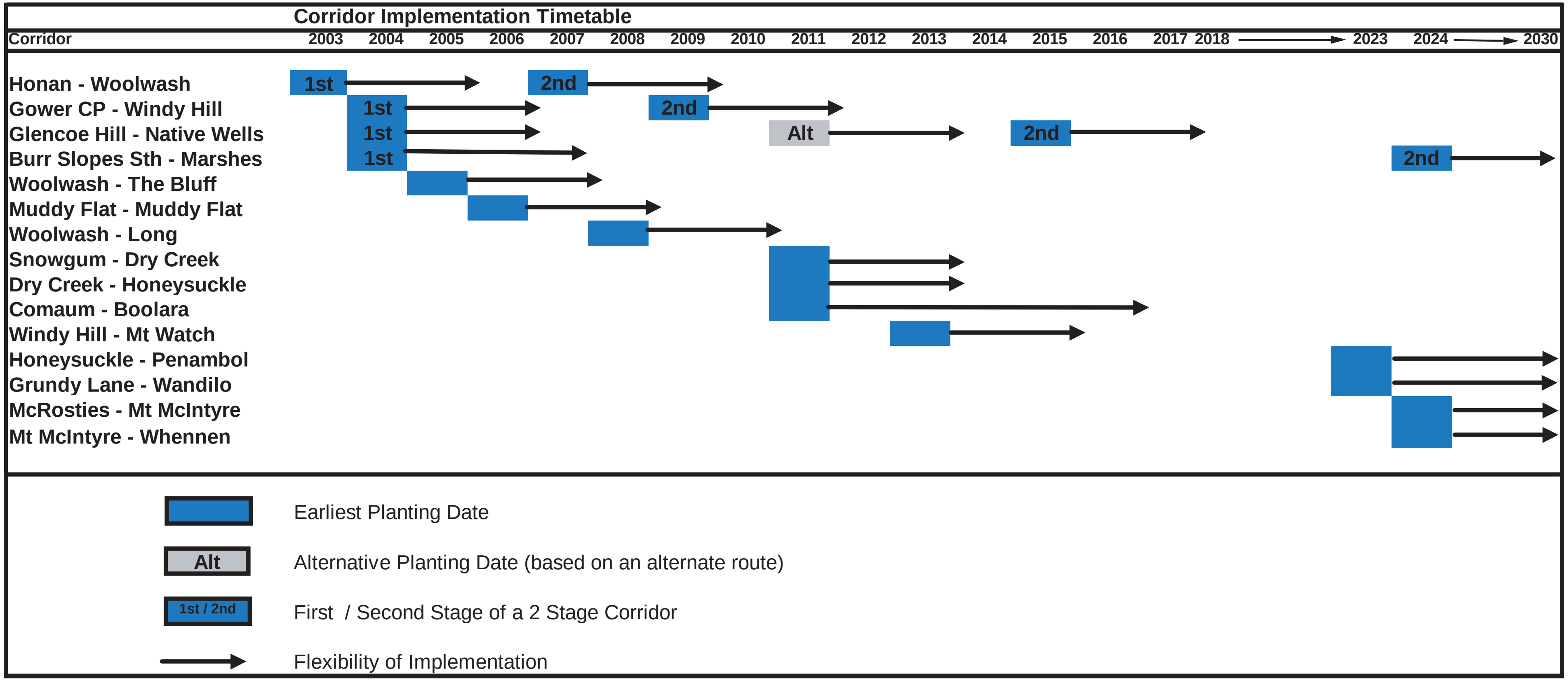
It is expected that Local Government, National Parks and Wildlife, and landowners will be approached to progress biodiversity corridor proposals. NPWSA and ForestrySA have recently signed a memorandum of understanding. Councils appear open to proposals for biodiversity corridors, as seen by the recently established corridor at The Heath NFR. Private landowners may be engaged by using existing relationships between ForestrySA’s Private Forestry section, and NPWSA’s Bushcare advisory section. Federal grants for fencing and revegetation are available as incentives to landholders considering proposals for biodiversity corridors.

Establishment of biodiversity corridors by direct seeding and hand planting, is outlined in Section 4.

6.2 Evaluation

Evaluation of the project will be undertaken regularly to ensure that objectives are being met. Photo points will be established and flora and fauna surveys will be undertaken within connected reserves and within the corridors to confirm that species diversity and abundance is increasing over time. It is expected that information will feed back into refining establishment techniques and specifications.

Table 6.1 – Implementation timetable for Biodiversity Corridors



7 Appendices

7.1 Appendix 1 - Proposal for Caroline Forest Reserve

7.1.1 Corridor selection

Potential corridor sites were identified using a Geographic Information System approach similar to that developed by Carruthers and Smith (1996). The GIS system is a non-biased way to identify areas that would be of greatest value for a biodiversity corridor, based on the proximity of one area of native vegetation to an other, and corridor length. In Fig 7.2, we can see the ecological value of the corridor, placed at a logical route.

Figure 7.3 shows the routes for biodiversity corridors chosen based on the most logical placement for an effective corridor. Factors such as plantation age, width of firebreaks, quality of the area, and significance and requirements of the target species involved were taken into account. For example, the area planned for a corridor between Snowgum NFR, and Dry Creek NFR is currently 1965 and 1966 plantation, due to be clear-fallen.

Fig 7.1 – Dry Creek Biodiversity Corridor Being Direct Seeded

Corridor Group	*Reserve*	*Reserve Area (Ha)*	*Length of Corridors Required over GF land (m)*
Caroline	Snowgum NFR	191.8	
	Dry Creek NFR	747.7	1400
	Honeysuckle NFR	266.4	860
	Pond Flat NFR	32.8	1960
	Warreanga NFR	250	
	Penambol CP	179	
Total		**1667.7**	**4220**

Table 7.1 – The Caroline Corridor Group Requirements.

Four corridors are required for the Caroline Corridor Group. One corridor is already being implemented within Dry Creek Native Forest Reserve. Three more are required for effective management of the area, and include one between Snowgum NFR and Dry Creek NFR, 1 between Dry Creek NFR and Honeysuckle NFR, and one between Honeysuckle NFR and Penambol NFR (see Table 7.1, Fig 7.2 & 7.3). This would create a net area of 1667.7 Ha, or more if we include Lower Glenelg National Park, and DC Grant native forest to the South of Dry Creek NFR.

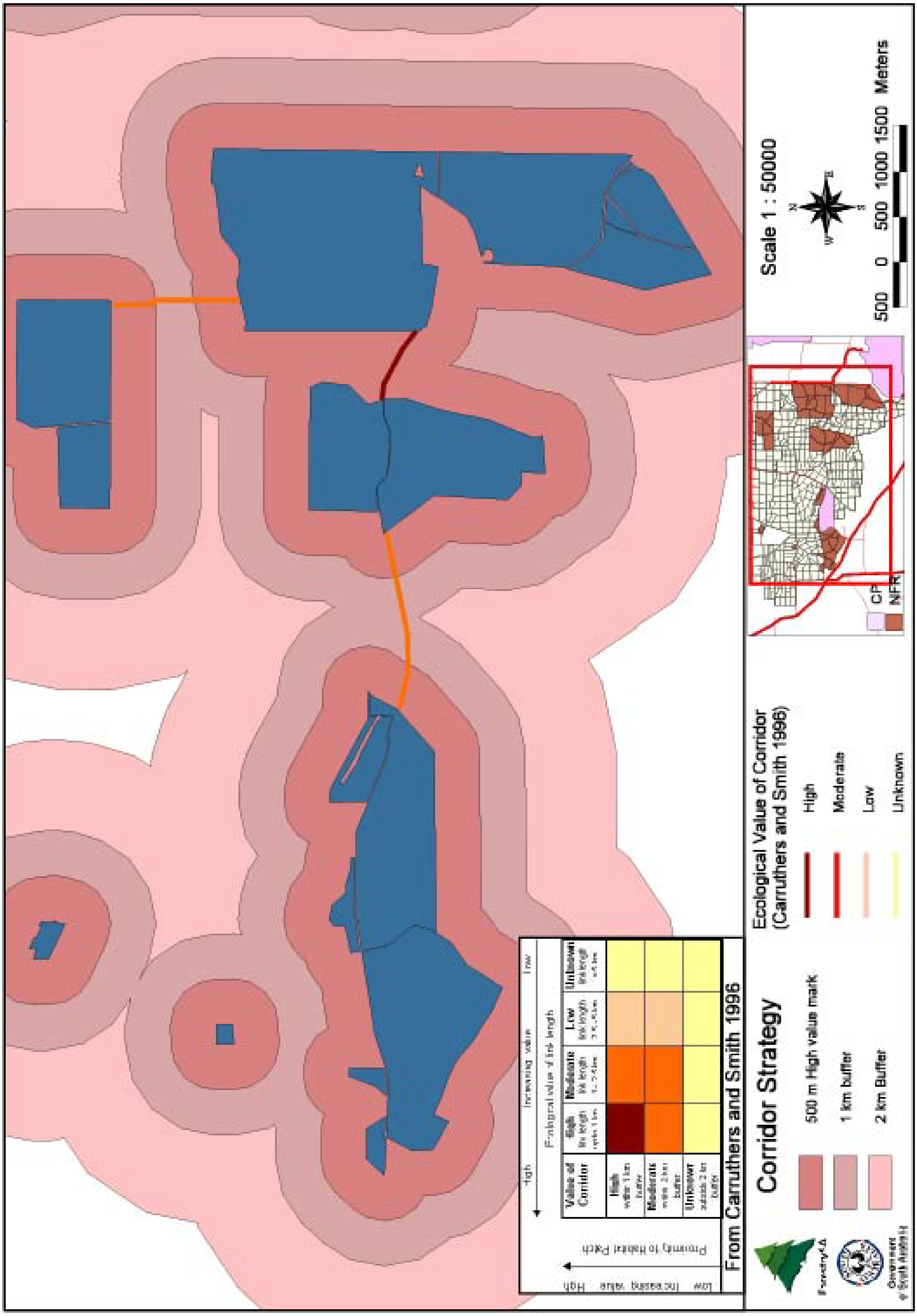


Fig 7.2 - Ecological value of Potential Biodiversity Corridors, placed at the most logical route

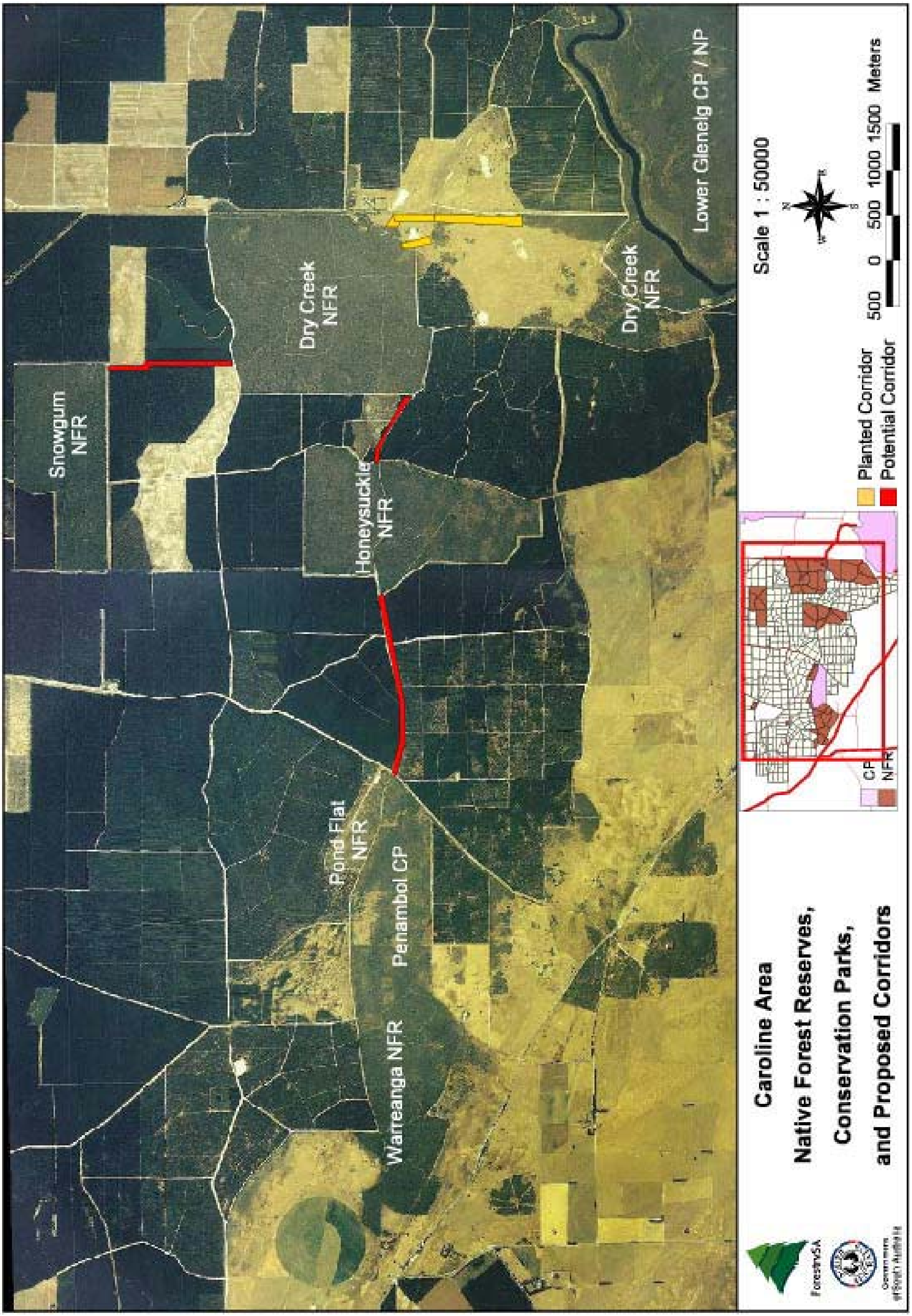


Fig 7.3 - Potential Sites for Biodiversity Corridors, based on the most logical route

7.1.2 Caroline Group: Snowgum NFR – Dry Creek NFR Corridor

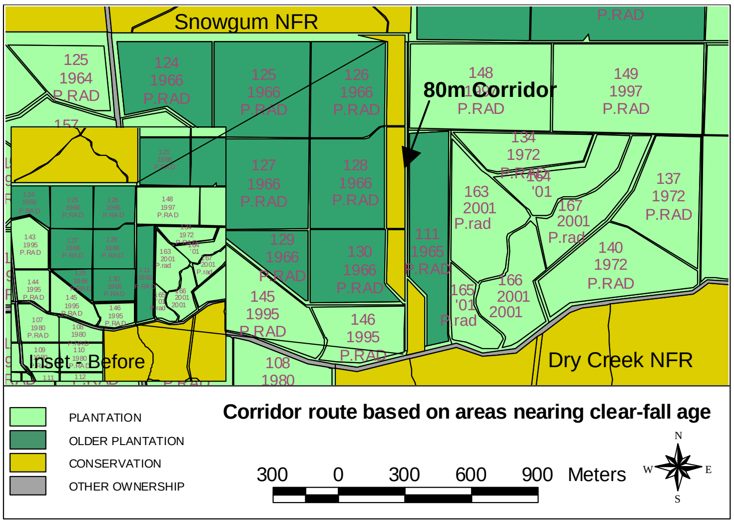


Fig 7.4 – Planned Corridor – Snowgum NFR to Dry Creek NFR

Parties involved

1. ForestrySA

Purpose

To increase the viability of the Caroline group fauna by increasing the net connected area to >1650 Ha.

Target Species

Common Name	Species	Rating	Home Range	Juvenile Dispersal	Large Range
Feathertail Glider	Acrobates pygmaeus	E	?		
Yellow-footed Antechinus	Antechinus flavipes			y >2km	
Southern Brown Bandicoot	Isoodon obesulus	V	<7ha	y	
Eastern Grey Kangaroo	Macropus giganteus	R			y
Red-necked Wallaby	Macropus rufogriseus	R			y
Yellow Bellied Glider	Petaurus australis	E	35	y	
Sugar Glider	Petaurus breviceps	R	1	y	
Common Ringtail Possum	Pseudocheirus peregrinus				
Bush Rat	Rattus fuscipes		small		
Swamp Rat	Rattus lutreolus		0.2		
Short-beaked Echidna	Tachyglossus aculeatus				y
Common Brushtail Possum	Trichosurus vulpecula				
Common Wombat	Vombatus ursinus				
Swamp Wallaby	Wallabia bicolor	V			y

Route Selection

The best option would be as Fig 7.4, using the the area of the 1965 and 1966 plantation. An 80-metre wide corridor over 1400 metres length would be required, given the wide number of species, and species of high conservation significance.

Planting recommendations

As per the recommendations in Section 4, the understorey should be thickly direct seeded and hand planted, including large *Xanthorrhoea* areas on the hills, and the overstorey should be hand planted with *Eucalyptus baxteri, Eucalyptus viminalis, Eucalyptus pauciflora, and Banksia marginata.*

7.1.3 Caroline Group: Dry Creek NFR – Honeysuckle NFR Corridor

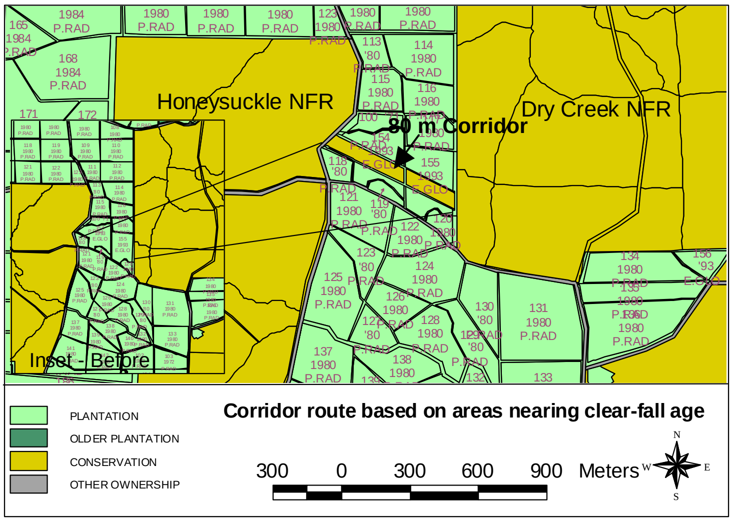


Fig 7.5 – Planned Corridor – Dry Creek NFR – Honeysuckle NFR

Parties involved

1. ForestrySA

Purpose

To increase the viability of the Caroline group fauna by increasing the net area to >1650 Ha.

Target Species

Common Name	Species	Rating	Home Range	Juvenile Dispersal	Large Range
Feathertail Glider	Acrobates pygmaeus	E	?		
Yellow-footed Antechinus	Antechinus flavipes			y >2km	
Southern Brown Bandicoot	Isoodon obesulus	V	<7ha	y	
Eastern Grey Kangaroo	Macropus giganteus	R			y
Red-necked Wallaby	Macropus rufogriseus	R			y
Yellow Bellied Glider	Petaurus australis	E	35	y	
Sugar Glider	Petaurus breviceps	R	1	y	
Common Ringtail Possum	Pseudocheirus peregrinus				
Bush Rat	Rattus fuscipes		small		
Swamp Rat	Rattus lutreolus		0.2		
Short-beaked Echidna	Tachyglossus aculeatus				y
Common Brushtail Possum	Trichosurus vulpecula				
Common Wombat	Vombatus ursinus				
Swamp Wallaby	Wallabia bicolor	V			y

Route Selection

The best option would be as Fig 7.5, using the shortest area between the two, yet still taking advantage of the fertile soil where the *Eucalyptus viminalis* can grow well. An 80- metre wide corridor over 860 metres would be required, given the wide number of species, and species of high conservation significance.

Planting recommendations

As per the recommendations in section 4, the understorey should be thickly direct seeded and hand planted, and the overstorey should be hand planted with *Eucalyptus baxteri and Eucalyptus viminalis, and Banksia marginata.*

7.1.4 Caroline Group: Penambol CP – Honeysuckle NFR Corridor

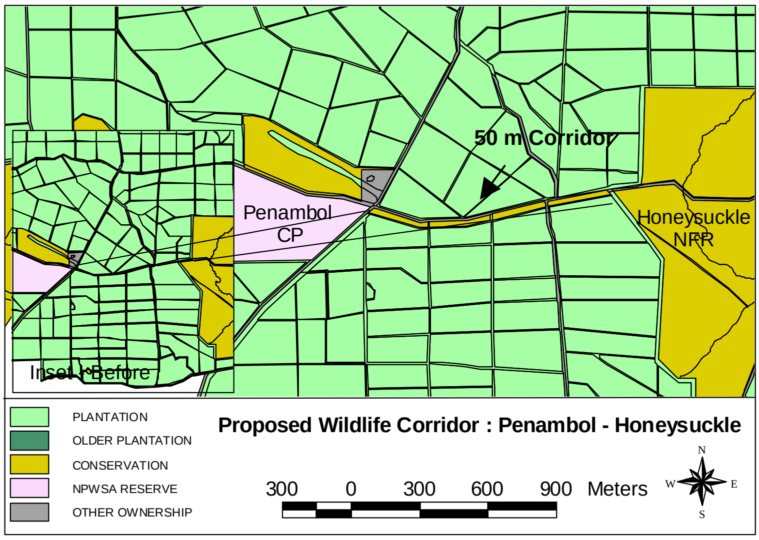


Fig 7.6 – Planned Corridor –Penambol CP – Honeysuckle NFR

Type

1. ForestrySA, 2. Other Landholder

Purpose

To increase the viability of the Caroline group fauna by increasing the net area to >1650 Ha.

Target Species

Common Name	Species	Rating	Home Range	Juvenile Dispersal	Large Range
Feathertail Glider	Acrobates pygmaeus	E	?		
Yellow-footed Antechinus	Antechinus flavipes			y >2km	
Southern Brown Bandicoot	Isoodon obesulus	V	<7ha	y	
Eastern Grey Kangaroo	Macropus giganteus	R			y
Red-necked Wallaby	Macropus rufogriseus	R			y
Yellow Bellied Glider	Petaurus australis	E	35	y	
Sugar Glider	Petaurus breviceps	R	1	y	
Common Ringtail Possum	Pseudocheirus peregrinus				
Bush Rat	Rattus fuscipes		small		
Swamp Rat	Rattus lutreolus		0.2		
Short-beaked Echidna	Tachyglossus aculeatus				y
Common Brushtail Possum	Trichosurus vulpecula				
Common Wombat	Vombatus ursinus				
Swamp Wallaby	Wallabia bicolor	V			y

Route Selection

The best option would be as Fig 7.6 along the road reserve. Approximately 10 to 20 metres of the Road Reserve and existing firebreak may be utilised, depending on the location, providing a corridor of 50 metres wide, and 1900m long.

Planting recommendations

As per the recommendations in section 4, the understorey should be thickly direct seeded and hand planted, and the overstorey should be hand planted with *Eucalyptus baxteri and Eucalyptus viminalis, and Banksia marginata.*

7.2 Appendix 2 – Biological Effects of Habitat Fragmentation

	Habitat change	*Consequences for population dynamics*
Population-level effects	Reduced connectivity, insularisation, increased interfragment distance	Directly affects dispersal and reduces the immigration rate
	Reduced fragment size, reduced total area	Directly affects population size and increases the extinction rate
Landscape or community level effects	Reduced interior-edge ratio	Indirectly affects mortality and production through increased pressure from predators, competitors, parasites, and disease
	Reduced habitat heterogeneity within fragments	Indirectly addects population size through reduced carrying capacity within the fragment
	Increased habitat heterogeneity in surrounding matrix	Indirectly affects mortality and production through increased carrying capacity of predators, competitors, etc. in the surrounding matrix
	Increased habitat heterogeneity in surrounding matrix	Indirect effect through disruption of mutualistic guilds or food webs
	Loss of keystone species for the habitat	

From Rolstad in Krebs (2001)

7.3 Appendix 3 – Advantages and Disadvantages of Biodiversity Corridors

Potential advantages	*Potential disadvantages*
1. Increase immigration rate to a reserve, which could:	1. Increase immigration rate to a reserve, which could:
a. Increase or maintain species richness and diversity (as predicted by island biodiversity theory).	a. Facilitate the spread of epidemic diseases, insect pests, exotic species, weeds, and other undesirable species into reserves and across the landscape.
b. Increase population sizes of particular species, and decrease the probability of extinction (provide a "rescue effect") or permit reestablishment of extinct local populations.	b. Decrease the level of genetic variation among populations or subpopulations, or disrupt local adaptations and coadapted gene complexes ("outbreeding depression").
c. Prevent inbreeding depression and maintain genetic variation within populations.	
2. Provide increased foraging area for wide-ranging species.	2. Facilitate the spread of fire and other abiotic disturbances ("contagious catastrophes").
3. Provide predator-escape cover for movements between patches.	3. Increas exposure of wildlife to hunters, poachers, and other predators.
4. Provide a mix of habitats and successional stages accessible to species that require a variety of habitats for different activities or stages of their life cycles.	4. Riparian strips, often recommended as corridor sites, might not enhance dispersal or survival of upland species.
5. Provide alternative refuges from large disturbances (a "fire escape").	5. High cost, and conflicts with conventional land preservation strategy for preserving endangered species habitat (when inherent quality of corridor habitat is low).
6. Provide "greenbelts" to limit urban sprawl, abate pollution, provide recreational opportunities, and enhance scenery and land values.	

From Noss in Krebs (2001)

8 Acknowledgements

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