Scientific criteria and guidelines for Ecological Linkages

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Ecological linkages for birds - management guidelines

Introduction

The objective of this document is to provide guidelines, supported by the scientific literature, for the creation and retention of ecological linkages through the region in order to reduce the negative impacts for populations left isolated in these native vegetation remnants.

Composition of the Matrix

There are some clear recommendations regarding the importance of landscape context. Which lead to the following principles:

1) *A heterogeneous matrix is better for birds than a homogenous one.*

Fischer *et al*. (2008) found a positive relationship between landscape texture and the abundance of small birds (i.e. complex landscapes are good for the diversity and abundance of smaller bird species), whilst conversely, homogenous landscapes supported larger-bodied species. This research concluded that overall landscape heterogeneity was good for all species and that land-use intensification is a threat to small species as it homogenizes landscape texture (Fischer *et al.* 2008).

Ecological Linkages

2) *Corridors have value for bird populations. They are often characterized by an abundance of generalist and introduced species. The value of a corridor depends on the habitats it contains and the ecology of the bird species of interest.*

Corridors have been identified as a useful and imperative way to restore the connectivity of fragmented landscapes. There is a vast literature on corridors and diverse reasons for creating or retaining corridors. One author (Andrews 1993), describes the primary objectives of a corridor as being to:

1) Permit colonization of news sites as they become suitable
2) Allow wildlife to move out of sites as they become unsuitable
3) Permit recolonization of extinct populations
4) Allow species to move between different areas as required in their life cycle
5) Increase the overall extent of habitat within an area.

A wealth of literature has debated the merits of corridors with the general consensus that corridors do provide a useful function in connecting fragmented populations, for some species and tend to increase the diversity and abundance of species in connected patches (Arnold and Weeldenburg 1998; Drinnan 2005; Haas 1995).
However, linear strips of vegetation (traditional corridors) also have a number of negative aspects. Rates of nest predation from native bird predators are higher in linear remnants as opposed to large remnants (Major *et al.* 1999b). The abundance and density of birds is often also higher in large, non-linear remnants as opposed to narrow corridors (Major *et al.* 1999a). However some studies have found that linear corridors are used extensively by bushland-dependent migrants (Bentley and Catterall 1997).

It is important to note that corridors provide both habitat for resident birds as well as a conduit for movement. Bentley and Catterall (1997) emphasize that few studies have proven that corridors are necessary for dispersal as opposed to being used as habitat, and little is known of the types of species that use corridors and what their requirements are.

3) *Many factors influence wildlife corridor use.*

The following factors have been identified as having influences on the use of habitat corridors by wildlife (Lindenmayer and Fischer 2006):

Individual Characteristics;
- Species gender
- Aggressive interactions and territoriality
- Dispersal behaviour

Landscape characteristics;
- Corridor size and shape
- Edge effects
- Condition and nature of surrounding matrix
- Topographic location of corridor
- Size of connected patches
- Number of corridors connecting to patches
- Barriers to movement
- Corridor vegetation characteristics
- Food/resource availability

It is essential to consider the purpose of the corridor and what species it is aiming to benefit.

4) *Corridors can function as regional level landscape linkages or smaller local scale connections and if properly designed, can allow (a)* a complete range of community and ecosystem processes and (b) the movement of organisms between areas, over generations.

The role and function of a corridor needs to be decided prior to its design. While all corridors increase the habitat values of an area, narrow corridors may only be suitable for rapid movements, whereas a large corridor allows for a complete range of community and ecosystem processes and enables movement of organisms between areas, over generations (Hess and Fischer 2001). These wide corridors are often termed landscape linkages and provide regional connectivity (Hess and Fischer 2001).

5) *Wide corridors are better than narrow corridors -500 m is a preferable minimum width.*

Research has indicated that incorrect design including narrow corridors, can lead to corridors acting as sinks and actually decreasing the viability of local populations.

This is because high edge effects lead to increased predation, competition and altered habitats from factors such as weed invasion (Henein and Merriam 1990). Henein and Merriam (1990) found that populations connected by high quality corridors all had larger population sizes than those connected by low quality corridors, and that adding a low quality corridor connected to a low quality patch, had a negative impact on the larger source population.

Corridors less than 100 m wide in North America have been found to mostly contain disturbance capitalizing species and forest-interior species were not recorded in corridors less than 50 m wide (Mason *et al.* 2007). In Mason *et al.* (2007) found most forest species only occurred in vegetation corridors over 100 m wide and some sensitive species required corridors greater than 300 m wide.

Similar results were found in another study of five sensitive bird species. Sieving *et al.* (2000) found that bird occurrence and abundance increased with increasing corridor width and that birds were rarely encountered in corridors less than 10 m wide. However, birds were always found in corridors between 25-50 m wide (Sieving *et al.* 2000).

A study of riparian corridors reported that widths of 75-175 m were required to include 90-% of the bird species recorded in the area.

6) *Roads, tracks and gaps can be barriers to mobility and have negative impacts on populations that increase with increasing barrier width, traffic noise and traffic volume. These impacts should be avoided or mitigated. The best strategies for birds would be to ensure revegetation up to the road and to soften the barrier effect of roads.*

Although there is scant research on the impact of barriers, one study found that a sedentary, insectivorous bird would cross open gaps of 20 m, but few crossed gaps greater than 80 m and were very resistant to crossing an open matrix surrounding patches (Castellon and Sieving 2006). Castellon and Sieving (2006) found that the same species would cross open shrubland for distances of up to 100 m and would disperse more than 300 m in wooded corridors.

A study of a native avifaunal community in bushland areas of Kings Park examined road-crossing events by birds (Wilcox 1999). It found that 52% of the 31 species recorded in Kings Park did not cross the 6-lane road of Thomas Street and those species that crossed could all be classed as generalist or urban-exploiting species (Wilcox 1999). Those that did not cross were generally bushland-dependent and sedentary species. This research indicated that roads have a major barrier effect on the dispersal capacity of a number of bird species.

Other research has also compared roads and natural barriers and found that birds were more resistant to crossing rivers than either roads or meadows (St Clair 2003).

This study also found that birds crossed barriers less often when the barriers were noisy (e.g. busy roads) and that the response of birds to barriers was dependent upon their ecology, with forest-dependent birds being the least likely to cross any barriers (St Clair 2003).

Roads also cause direct mortality of birds with estimates of up to 7 million birds killed by roadstrike in some countries (Forman and Alexander 1998). Traffic noise appears to be one of the main factors leading to road avoidance by birds (Forman and Alexander 1998; St Clair 2003).

It has been found that bird densities are significantly lower in bushland bordering roads with up to 60% of bird species present, experiencing lower densities for up to 930 m from the road (depending on the habitat type) (Forman and Alexander 1998). Similarly a study of grassland birds found that roads had no impacts when vehicle volumes were light, but once traffic exceeded 8000 vehicles per day, breeding success was reduced for 400 m from the road (Forman *et al.* 2002).

Between 15 000 and 30 000 vehicles per day, bird presence and breeding was reduced for 700 m from the road and over 30 000 vehicles per day reduced bird presence and breeding for 1.2 km from the road (Forman *et al.* 2002).

Clearly roads are a major barrier to bird dispersal. Forman and Alexander (1998) discuss the preferred option for mitigating the barrier effect of roads on birds, as being to soften the barrier by re-vegetating alongside and if possible, within, the road system. Although underpasses are used for ground fauna, they are unlikely to be utilized by birds, although there have been no published studies on this topic.

7) *Pine plantations do not provide suitable habitat for a full suite of avifauna and tend to favour common and generalist species. The presence and extent of native vegetation is a more important contributor to bid occurrence in pine plantations.*

There have been a number of studies on the importance of pines and other exotic plantation species, for birds in Australia and it is well established that pine plantations support few birds and are depauperate in native wildlife (Friend 1980). A study on *Pinus taeda* found that bird abundance and diversity declined rapidly from the edges of plantations for about 900 m in summer and 200 m in winter (Curry 1991). Curry (1991) concluded that food resources, especially insects, are limiting in pine plantations and that windrows containing native and exotic vegetation, helped birds to penetrate into, and use, pines as habitat. Curry suggests the use of native vegetation within pine plantations to increase its utility for native species.

In a comprehensive study in Victoria, it was noted that pines host few bird species, particularly in younger aged stands (<5 years) and that when compared to a eucalypt woodland control site, birds in pine plantations decline in richness and abundance and species composition changes (Friend 1982). Friend (1982) found that in pine plantations the species composition favoured generalist species with life histories that included an insectivorous diet, foraging from the ground or low shrubs and the ability to nest in open areas. Canopy feeders and eucalypt specialists were absent (Friend 1982). Friend found that birds were significantly more abundant in control eucalypt woodland than in pines although older pines plantations (22 years plus) had no significant difference in bird abundance when compared to control eucalyptus forest. Birds were more abundant along the eco-tonal edges of pines than in the middle of plantations (Friend 1982).

A recent study in NSW further emphasized these trends with a lower frequency of occurrence of birds in pines compared to nearby eucalypt woodland (Lindenmayer *et al.* 2003). The study also found that the proximity to native vegetation was important with bird frequency and diversity in pines being higher where pine stands bordered native forest. Lindenmayer *et al.* (2003) found that seven native bird species had higher detection rates in pine plantations and a further 15 generalist species were more common in pine plantations than native vegetation and that a number of other species used pines as part of their foraging range, although most still required bushland for breeding, feeding or shelter. Forty birds recorded were all either species that were very sensitive to habitat modification and fragmentation or were slightly sensitive (intermediate).
Interestingly, all of these 40 species were significantly less common in pine forest than native vegetation.

Another study also showed reduced bird diversity in pines as opposed to native vegetation and reported that the area of surrounding eucalypt forest had a more important influence on the avifaunal assemblage of pines than any factors within the pine forests (Lindenmayer *et al.* 2002).

Internationally a similar result has been reported on a study of birds in Africa (Wethered and Lawes 2005), who reported that pine plantations only promoted the dispersal of generalist bird species. Furthermore, they found that no species-area relationship or isolation effects existed for patches of native vegetation within pines, that is to say that larger patches that were closer to other patches, did not necessarily have more species than smaller and isolated ones. This is likely a reflection of the selective nature of the pine matrix on birds of neighbouring bushland.

8) Revegetation is a viable strategy for establishing corridors in cleared landscapes but the structure and composition of the vegetation is important.

- *It should contain perching sites or canopy within 1 m of the ground for insectivorous birds.*
- *It should contain a diverse understorey of native species*
- *Expanding the size of existing patches is likely to be more beneficial for rarer, woodland-dependent species*
- *Close proximity to existing native vegetation is essential.*

A number of studies have shown that birds will use revegetation for both its habitat and dispersal values. In one study, revegetation contained 70% of all bird species recorded in the region (Barrett *et al.* 2008). Arnold (2003) also reported that revegetated and agroforestry sites contained most bird species recorded in his study, although at a reduced abundance compared to native vegetation sites. He also found that rarer species were generally absent from revegetated and agroforestry sites.

Understorey is also a critical component of restored habitats and studies have reported reduced species richness and abundance in sites containing no understorey (Arnold 2003). Arnold and Weeldenburg (1998) reported that understorey was essential for maximizing bird diversity and abundance and Sieving *et al*. (2000) found that the availability of dense understorey vegetation was the primary predictor of the presence of five endemic understorey birds in South America.

Arnold (2003) noted that habitat structure and the composition of revegetation were important, with insectivore abundance being highest where there were canopy or perching sites within 1 m of the ground. Nectarivorous birds were also dependent upon the presence of nectar-producing plants in the revegetation (Arnold, 2003). Barrett *et al.* (2008) examined revegetation of around 2-3 years in age, and also found that insectivores were under-represented, which he attributed to a lack of wildflower diversity and leaf-litter. Similarly, a study of eucalypt woodland revegetation found that sites containing a mix of both overstorey and understorey were best for birds and were of similar habitat value to native remnants (Kavanagh *et al.* 2007).

Landscape context and size of revegetation are also important. Larger patches and those that are closer to native remnants or other patches, are more likely to support populations of declining, woodland-dependent species (Kavanagh *et al.* 2007). Kavanagh *et al.* (2007) deemed plantings to be more successful (as measured by bird diversity and abundance) if close to existing native vegetation.
A more technical analysis for the Mount Lofty Ranges concluded that landscapes should have revegetated areas with mean patch sizes of 780 – 4010 ha (Westphal *et al.* 2007) and be close to existing remnant vegetation.

However, most studies such as those cited above, examine the habitat values of revegetation that had been undertaken for the purpose of creating novel habitat. Little research has investigated the dispersal value that revegetation has for birds.

In many cases, expanding the size of existing remnants may be more beneficial in creating overall landscape connectivity, than a corridor *per se*., although Arnold and Weeldenburg (1998) suggest that corridors are required when remnants are isolated by more than 500 m.

Guiding Principles

To summarise the above information, the following rules can be formulated concerning habitat corridors:

1) A heterogeneous matrix is better for birds than a homogenous one.
   - **Try to place corridors near to or in a vegetated matrix and complex landscapes with minimal disturbance.**

2) Corridors have value for bird populations. They are often characterized by an abundance of generalist and introduced species. The value of a corridor depends on the habitats it contains and the ecology of the bird species of interest.
   - **Corridors are proven to be effective but their appeal to sedentary and bushland-dependent species is dependent on their size, shape and composition.**

3) Corridors can function as regional level landscape linkages or smaller local scale connections, allowing (a) a complete range of community and ecosystem processes and (b) enabling movement of organisms between areas, over generations.
   - **It is preferable to design large regional linkages rather than localized corridors.**

4) Wide corridors are better than narrow corridors.500 m is a preferable minimum width.
   - **Regional corridors should be 500 m in width wherever possible and a minimum of 300 m.**

5) Re-vegetation is a viable strategy for establishing corridors in cleared landscapes but the structure and composition of the vegetation is important.
   - **Create perching sites or canopy within 1 m of the ground for insectivorous birds.**
   - **Plant a diverse understorey of a range of local native species (maximise density, structure and composition)**
   - **Expand the size of existing remnant bushland patches wherever possible**
   - **Preference should be given to placing corridors in close proximity to existing native vegetation.**

6) Roads, tracks and gaps can be barriers to mobility and have negative impacts on populations that increase with increasing barrier width, traffic noise and traffic volume. These impacts should be avoided or mitigated. The best strategies for birds would be to ensure revegetation up to the road and to soften the barrier effect of roads.
   - **Aim for continuous linkages without gaps, and re-vegetate up to the edges of roads to soften their barrier effect.**

7) Pine plantations do not provide suitable habitat for a full suite of avifauna and tend to favour common and generalist species. The presence and extent of native vegetation is a more important contributor to bird occurrence in pine plantations.
   - **Native vegetation retention should be favoured over leaving remnant pine stands. Old pine stands are better than young ones.**

Available Data on sensitive species

An extensive assessment of the avifauna of the Swan Coastal Plain (Brooker *et al*., 2008) has provided an insight into the landscape requirements of 64 bird species. The requirements of the most sensitive of these groups, is presented in Table 1 and may be used as a guide to corridor design. This provides some additional information from the guidelines above, including the requirements of canopy cover, leaf litter and area for some species. Note that the requirements of these species differs from each other, and is dependent upon ecological preferences and behaviour of each species.

Table 1: Minimum requirements for proportion of native vegetation, total vegetation, area, tree cover and other features, for bird species most sensitive to urbanization and fragmentation on the Swan Coastal Plain. After Brooker *et al.* (2008).

	Threshold proportion of native vegetation cover within 2 km	**Threshold proportion of all vegetation cover within 2 km**	**Threshold size of survey site (ha)**	**Threshold size of treed area on survey site (ha)**	**Other important features**
Scarlet Robin	0.24	0.61	n/a	3.1	Wetlands Canopy cover
Grey Shrike-thrush	0.23	0.32	n/a	n/a	Logs
Common Bronzewing	0.18	0.34	22.1	n/a	
Red-capped Parrot	0.23	0.34	16.0	n/a	Logs
Inland Thornbill	0.08	0.51	n/a	n/a	Wetlands
Splendid Fairy-wren	0.08	0.25	12.9	n/a	
Western Thornbill	0.22	0.33	4.2	n/a	
Western Spinebill	0.07	0.33	n/a	12.6	
Yellow-rumped Thornbill	0.07	0.38	5.6	n/a	Wetlands
Tree Martin	n/a	n/a	9.8	n/a	Wetlands
New Holland Honeyeater	0.07	n/a	n/a	n/a	Melaleuca
Western Wattlebird	n/a	n/a	n/a	13.0	Leaf litter
White-browed Scrubwren	n/a	n/a	21.7	n/a	

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