

# **Bush for the birds: Biodiversity enhancement guidelines for the Saltshaker Project, Boorowa, NSW**

**by David Freudenberger**

June 2001

A report commissioned by  
Greening Australia ACT & SE NSW, Inc.



**CSIRO**

SUSTAINABLE  
ECOSYSTEMS

Freudenberger, D. (2001). *Bush for the Birds: Biodiversity Enhancement Guidelines for the Saltshaker Project, Boorowa, NSW*.  
Consultancy report to Greening Australia ACT & SE NSW, Inc.  
CSIRO Sustainable Ecosystems, Canberra.

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Printing and binding:  
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## ACKNOWLEDGMENTS

This project was funded by the Natural Heritage Trust through Greening Australia ACT & SE NSW, Inc. Bird surveys were conducted by Alex Drew and Mark Clayton (CSIRO), and Libby Elliot and Julian Reid helped with site selection. Lachlan Newham (ANU) gave initial GIS assistance and provided the roading layer to the GIS. Dr Nick Nicholls did the statistical modelling. Members of the Saltshaker Steering Committee provided the essential review of the study design, results and interpretation. We thank the landholders of the Boorowa River catchment for access to their properties during the bird surveys. Ann Milligan (Science Text Processors Canberra) edited and laid out the text; Eileen Dallwitz (TechType) refined the map's file characteristics; Peter Freudenberger generated the graphs for Appendix 4. We thank Greening Australia for the opportunity to contribute to the Saltshaker catchment enhancement project.

## SUMMARY

CSIRO Sustainable Ecosystems was contracted by Greening Australia to assist in the development of revegetation guidelines for the Saltshaker Project in the Boorowa River catchment. The project aims to improve the conservation of biodiversity, reduce the risk of dryland salinity and increase water quality by enhancing remnant vegetation and revegetating 2–3% of the catchment.

The ‘focal species approach’ was used to identify bird species that are sensitive to loss of habitat area, simplification of habitat structure and increase in habitat isolation. Bird surveys were conducted in 54 discrete patches of woodland that varied in size, structural complexity and isolation. A total of 115 species of birds were detected during three 30-minute surveys at each remnant during March 2001. The minimum was 16 woodland bird species, found in the smallest and most simplified remnant, while up to 41 species were found in large and structurally complex remnants. No bird species was sensitive to just one threatening process. Many woodland bird species were sensitive to at least three threatening processes: habitat loss, habitat simplification, and habitat isolation.

The Eastern Yellow Robin was selected as the focal species for this catchment. It generally occurred in woodland patches larger than 10 ha that were no more than 1.5 km from other patches at least 10 ha in size. The woodland patches had at least a moderate structural complexity, made up of a healthy overstorey of Eucalypts with an understorey of regenerating trees, shrubs, tussock grasses and fallen timber.

This focal species analysis identified the landscape configurations and structural compositions of woodland patches that should, as a minimum, provide occupiable habitat for the majority of woodland birds that are known to be declining throughout the region. It is assumed that these minima will also provide habitat suitable for a wide range of other native species of plants and animals that have similar or less demanding habitat needs than the focal woodland bird. The analysis was used to derive

the following guidelines for the Saltshaker Project.

1. As soon as possible, protect existing woodland remnants from continuous grazing, by fencing them off. Give priority to those remnants at least 10 ha in size, or those that are within at least 1.5 km of existing remnants at least 10 ha in size, or those that still have a structurally complex understorey.
2. Where regeneration of native understorey (tussock grasses and/or shrubs), or regeneration of trees is unlikely within fenced remnants, then take steps to establish local-provenance understorey grass or shrub species or trees.
3. Enlarge (enhance) existing remnants to at least 10 ha.
4. Create linkages between protected and enhanced remnants that are over 1.5 km away from other remnants at least 10 ha in size. At minimum, the linkages should consist of linear plantings at least 25 m wide (5 rows), or ‘stepping stones’ of block plantings at least 10 ha in size, or, ideally, a combination of both.
5. Create linkages at least 25 m wide between protected remnants less than 1.5 km away from other remnants at least 10 ha in size.
6. Create linkages at least 25 m wide between unprotected (e.g. unfenced) remnants at least 10 ha in size.

Implementation of these guidelines should provide useful habitat for a wide range of biota that cannot otherwise persist in the existing matrix of isolated trees, intensively grazed pastures and crops that dominates the landscapes of the Boorowa catchment. The Steering Committee of the Saltshaker Project has integrated these biodiversity enhancement guidelines into a transparent procedure for assessing a wide range of benefits that on-ground works can generate for reducing dryland salinity, improving water quality, increasing community participation, and conserving biodiversity.

## INTRODUCTION

Greening Australia ACT & SE NSW, Inc., received Natural Heritage Trust funding for the ‘Saltshaker’ revegetation project in the Boorowa River catchment. This project aims to improve the conservation of biodiversity, reduce the risk of dryland salinity and improve water quality by enhancing remnant vegetation and by revegetating 2–3% of the catchment in a highly targeted fashion. Greening Australia contracted CSIRO Sustainable Ecosystems to help develop guidelines for revegetation and remnant enhancement for the project, based on the focal species framework of Lambeck (1997).

Specifically, CSIRO Sustainable Ecosystems was contracted to provide the following services:

1. conduct bird and habitat surveys in at least 50 remnants within the Boorowa River catchment;
2. analyse the data within a focal species framework;
3. recommend guidelines to improve the conservation of native biodiversity through efficient enhancement of remnant vegetation;
4. communicate the survey results and recommendations to the Saltshaker Technical Steering Committee and to the Boorowa community; and
5. participate in the development and implementation of a procedure to assess proposals for on-ground works.

This report discusses parts or all of these services. The consultancy has been constrained by its short duration (six months) and by having to deliver recommendations in time to assess proposals for on-ground works planned for spring 2001.

### The focal species approach

Fauna and flora species are being lost from landscapes in which their habitats are being cleared, fragmented and simplified. To prevent further losses, it is necessary to determine the

composition, quantity and configuration of habitats that meet the needs of those species that are still present. Lambeck (1997) presented an approach for defining the landscape attributes required to meet the needs of biota, and also the management regimes that should be applied to maintain them.

Lambeck’s approach identifies a suite of sensitive fauna species, each of which is used to define the configuration and composition of habitats that must be present in the landscape for that species to thrive. The species that is identified as being most sensitive to a threat in the landscape is termed the ‘focal’ species. For example, the most area-limited species<sup>1</sup> is used to define the minimum areas required for various habitat patches, and the most dispersal-limited species<sup>2</sup> defines the configuration of patches and the characteristics of connecting vegetation. It is assumed that because the most demanding species are selected, a landscape designed and managed to meet their needs will encompass the requirements of all other species similarly threatened.

Lambeck (1999) used this approach to define minimum areas for revegetation and the need for increased connectivity in various regions of the Western Australian wheat–sheep zone. This general approach has also been used for deriving revegetation guidelines for the Greening Australia Vegetation Investment Project (Freudenberger 1999, Watson et al. 2001), the Holbrook Landcare Group Rebirding Project (Collard pers. comm.) and projects in the central Lachlan (Freudenberger and Drew 2001, Seddon et al. 2001), and is being used by Birds Australia for a landscape enhancement project in the Liverpool Plains, NSW (Ekert 2001).

<sup>1</sup> the species that is found only in patches larger than a certain size (area)

<sup>2</sup> the species that is found only in patches separated by a certain minimum distance

## Threats in the landscape

The CSIRO consultancy has focused on these threats:

- habitat loss,
- habitat isolation, and
- simplification of patches of remnant woodland and dry sclerophyll forest.

This focus is consistent with the fact that the Boorowa River catchment has less than 7% woodland or forest cover remaining, and much of this cover is in separate patches (remnants) and affected by long-term continuous grazing which can lead to habitat simplification such as loss of understorey shrubs and tussock grasses.

The three major threats were analysed by identifying the birds found in remnants of woodland or forest. The surveyed remnants were chosen from a large number that varied widely in size, condition (habitat complexity) and isolation from other remnants.

## The use of birds

Lambeck (1999) and others (e.g. Watson et al. 2001) have found birds to be useful focal species for some threatening processes. Birds are mobile — they move across and use patches of vegetation at the planning scale: that is, their ranges are paddock-size (hectares) and property-size (kilometres). Birds are useful because they are relatively easy to survey, being abundant and visible during the day.

In comparison to birds, small marsupials are exposed to similar landscape threats, but often their population densities are low or they are difficult to survey (e.g. nocturnal arboreals). Bats could be focal species because they range across the landscape at scales similar to those of birds (Lumsden et al. 1995), but they are technically more difficult and costly to sample (e.g. harp traps and acoustic detectors are needed). Reptiles and invertebrates are potential focal species for identifying finer-scale threats caused by loss of micro-habitats such as logs or bark. Plant species are less

amenable to analysis of area loss and isolation, because little is known about the minimum viable space or maximum isolation that plants can tolerate, though recent advances in molecular genetics and demography are providing useful insights (e.g. Young and Clarke 2000). Plants are particularly useful when the management required for habitat patches must be determined, e.g. for control of grazing or the use of fire.

Birds are also useful focal species because they are placed well to the top of food chains. Many woodland birds feed on a wide variety of insects (Ford 1986), which in turn eat a diverse mixture of plant species. Thus, it is assumed that the habitats required by focal species of birds will also satisfy the needs of a wide range of other biota. Some of these assumptions of the focal species approach are being analysed through the SAND Farmscapes Project in the Riverina of New South Wales, funded by the Natural Heritage Trust (Freudenberger unpublished data).

Woodland birds have been chosen because it is well known that many of them are affected when their habitats are cleared entirely or partially (producing woodland patches separated by cleared land), or degraded (e.g. Barrett et al. 1994, Reid 1999). Many of the woodland birds identified as declining throughout the wheat–sheep zone of New South Wales (Reid 1999) occur, or once occurred, within the Boorowa River catchment. Of these declining woodland birds found in the catchment, the Hooded Robin, Brown Treecreeper, Black-chinned Honeyeater, Diamond Firetail, Grey-crowned Babbler and Speckled Warbler have been provisionally listed as Vulnerable Species under the New South Wales *Threatened Species Conservation Act 1995*. The Superb Parrot has already been formally listed as Vulnerable. All these species are threatened by the clearance and modification of the native forest and woodlands that once were widespread across the catchment.

## METHODS

### Study area

The Boorowa River catchment covers approximately 168,000 ha on the south-west slopes of New South Wales. The Boorowa River is a major tributary of the Lachlan River downstream of Wyangala Dam. Agriculture, including wool, beef, cereal and some horticultural production, is the dominant landuse. Most of the catchment is within the Boorowa Shire. Average annual rainfall in the catchment ranges from 570 mm to 770 mm. Rainfall generally increases with altitude within the catchment, and is slightly greater and less variable during winter months (Hird 1991).

The native vegetation of the catchment consists of three broad types:

- dry sclerophyll forest,
- box woodlands, and
- grasslands.

Remnants of dry sclerophyll forest associations are generally found on hilly country where rainfall exceeds about 650 mm. These forests are dominated by Red Stringybark (*Eucalyptus macrorhyncha*), Scribbly Gum (*E. rossii*) and Brittle Gum (*E. mannifera*). Woodlands are found on lower slopes and plains. Dominant canopy species include White Box (*E. albens*), Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*) (Hird 1991). Small areas of grassland occur naturally either as an understorey to open box woodland, or within cold-air drainages.

The catchment has been extensively cleared and only about 7% of it remains under woodland or forest cover. Numerous outbreaks of dryland salinity have been mapped within the catchment, with 1372 ha of salt-affected areas identified within an 83,000 ha mapped area in 1995 (Hayman 1996).

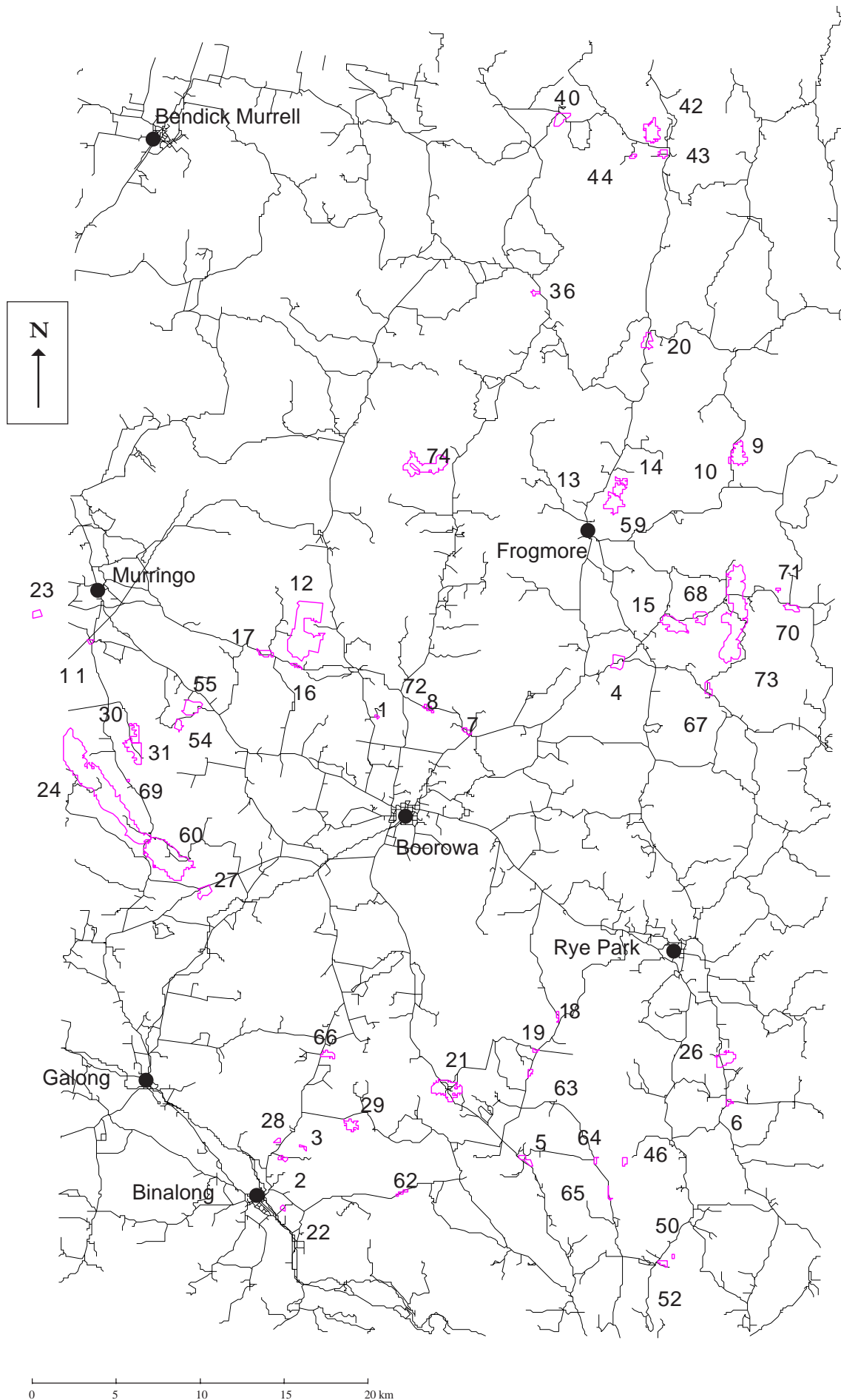
### Bird surveys

Occurrence and relative abundance data were collected from 54 sites in the Boorowa River catchment (Figure 1, see page 4). Three 30-minute

surveys were conducted at each site by Mark Clayton and Alex Drew, both experienced field ornithologists from CSIRO Sustainable Ecosystems. Each person visited each site at least once so that the effects of any operator error or bias were reduced. The occurrence and abundance of all birds were recorded within a single plot, 500 m x 100 m, within each site (patch of woodland). Survey duration and plot size were the same as those adopted by Julian Reid (CSIRO Sustainable Ecosystems) who previously surveyed 31 of the sites during spring 2000. Birds flying overhead were noted but not included in the data set. Surveys began shortly after sunrise and ceased before midday. All surveys were conducted during March 2001. Surveys were not conducted on rainy or very windy days.

Survey sites were discrete patches of woodland that had an even range of sizes on a logarithmic scale. Hence, there were fewer large sites and more small sites (Figure 2, see page 6). Within each size class of woodland sites (1–10, 11–100, >100 ha), approximately half the surveyed sites had a relatively complex structure, and the other half had a simple structure (habitat structure is defined below). The woodland sites did not have uniform composition. The large sites (>100 ha) tended to be dominated by dry sclerophyll forest and were found on shallow soils within the upper reaches of the catchment. Smaller sites (<100 ha) consisted of a range of woodland types, either dominated by dry sclerophyll species, or box woodlands on relatively deep and fertile soils. Patches of planted native vegetation were not sampled because they are part of another Greening Australia and CSIRO project (Birdwatch, Taws 2000).

Survey sites were mostly on privately held land, though a few sites were on Travelling-Stock Reserves or roadsides. Verbal permission was obtained from landholders before the surveys were conducted. Bird species lists for each site were given to each landholder within a month of the surveys being completed.



**Figure 1.** Locations of bird survey sites (coloured outlines and numbers) in the Boorowa River catchment

## Habitat complexity

The distribution and abundance of birds depend on landscape variables such as the size of a habitat patch and its composition. The structural diversity of a patch — its canopy cover, its density of shrubs, and the amounts of litter and ground cover — has been shown to strongly influence the diversity of bird species in an area (Wiens 1989).

Structural diversity was measured using a rapid appraisal method first developed by Newsome and Catling (1979) to explain the diversity of mammals found in a wide range of habitats. At each site, a habitat complexity score, modified from one described by Catling and Burt (1995) was derived on the basis of six features:

- tree canopy cover,
  - tall shrub or young tree cover (2–4 m),
  - short shrub cover (0.5–2 m),
  - ground herbage cover,
  - relative amounts of logs and/or rocks, and
  - the relative amount of ground litter;
- see Appendix 2 for a sample data sheet.

Each feature was rated on a scale of 0–3, and the scores for the six features were totalled to give an overall score. For this study, a score of 6 or below represented a woodland with poor structure, having no understorey shrubs and few logs on the ground though often a complete cover of pasture (good seasonal conditions). A score of 7–12 represented a grassy or shrubby woodland with moderate structure comprising >20% shrubs and 10–50% cover of ground herbage, logs and litter. A score greater than 12 described a structurally complex woodland. The dominant tree species at each site and any signs of recent disturbance (e.g. fire) were recorded.

## Spatial data

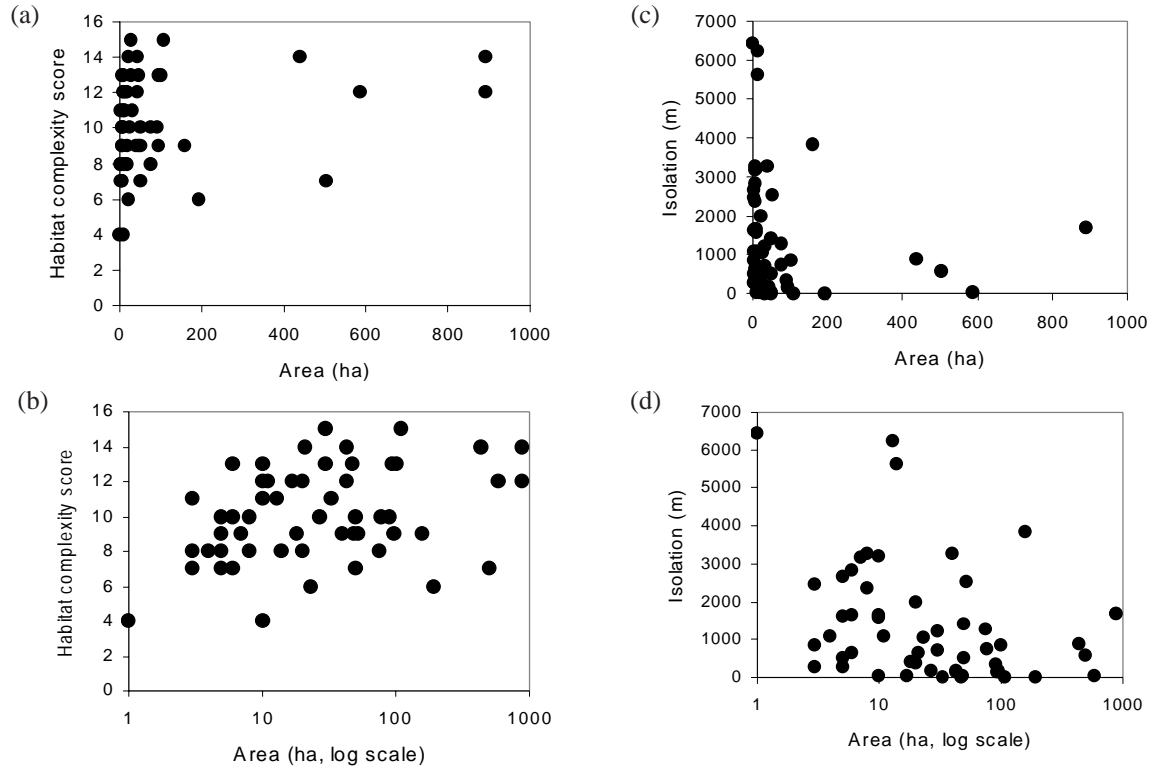
Two SPOT satellite images, held by the Boorowa Regional Catchment Committee, were used for mapping existing remnant woodland cover. These SPOT images have a resolution of 10 m x 10 m. Each survey site (discrete remnant) was measured on the image and the area of the remnant was calculated. The distance to the nearest remnant equal to or greater than 10 ha in size was measured: this measure is called the ‘patch isolation’. Remnants were delineated by eye within the GIS system, ArcView®. The patch isolation has been found to be a useful predictor of the abundance of woodland bird species within the central Lachlan river catchment (Seddon et al. 2001).

## Data analysis

All survey data were entered into a relational database<sup>1</sup>. The presence or absence of each woodland bird species of interest was graphed against the area and habitat complexity of each of the 54 sites. Presence/absence data were also graphed against area and patch isolation (Appendix 4).

Presence/absence data for woodland bird species of interest were modelled statistically to examine the relationships between the presence of a species and the size, isolation and complexity of its habitat. A binomial distribution was modelled with a logit link function in an additive fashion using GENSTAT (GENSTAT 5 Committee 1995). These regression models were then used to generate curves of each species’ probability of occurrence at a range of patch sizes, isolations and habitat complexity scores. The relationships between the number of bird species and patch size, habitat complexity and isolation were analysed by linear regressions.

<sup>1</sup> Site 1 had been revegetated and thus was not representative of remnant woodland. Data collected there were not analysed.



**Figure 2.** Distribution of survey sites by area and habitat complexity: (a) linear scale; (b) logarithmic scale. Similarly, the distribution of sites by area and isolation: (c) linear scale; (d) logarithmic scale.

## RESULTS

### Survey sites

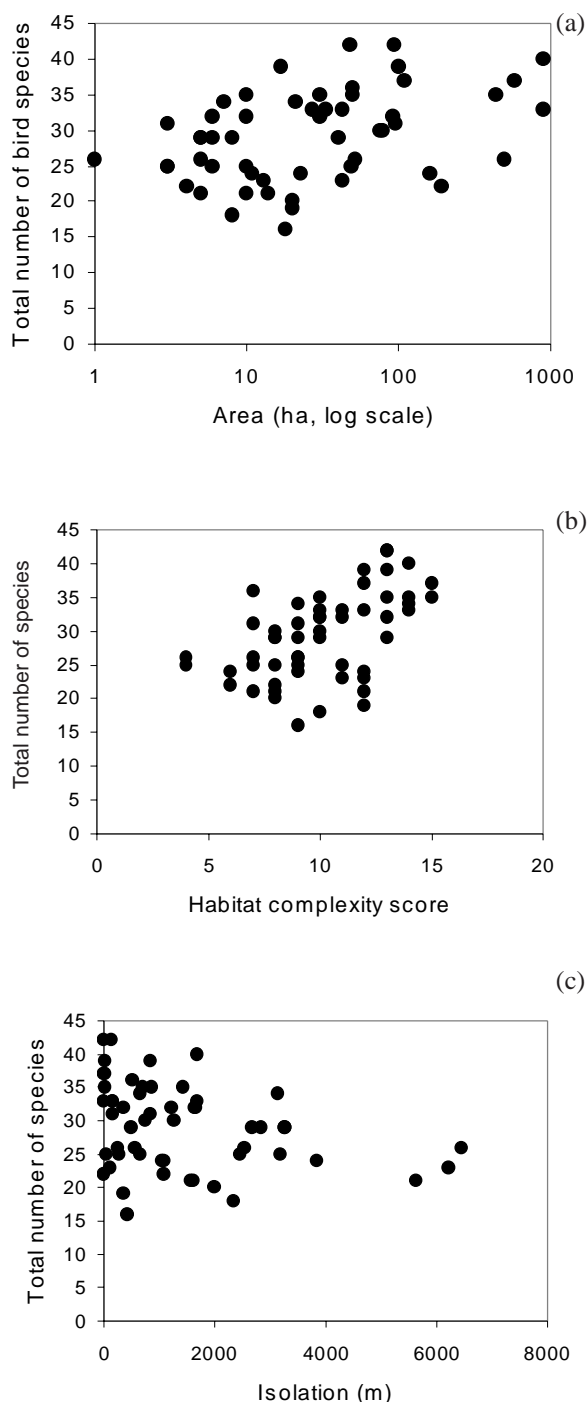
Data were obtained from survey sites that ranged in size from 1.2 ha to 892 ha, with a median size of 22 ha (Figure 2a). Distances to the nearest remnants 10 ha or larger in size ranged from 0.1 km to 6.44 km, with a median distance of 0.9 km. Habitat complexity scores for the survey sites ranged from 4 to 15, with a median score of 10 (Appendix 1).

Survey sites overall had a scatter of habitat complexity scores across the range of sizes (Figure 2b). Also, survey sites overall, whatever their size, were equally likely to be isolated from other remnants (Figure 2d). However, we only found one site larger than 100 ha that was more than 2 km away from the nearest remnant 10 ha or larger in size, whereas we were able to select 12 sites smaller than 100 ha that were more than 2 km away from the nearest 10 ha or larger remnant (Figure 2d).

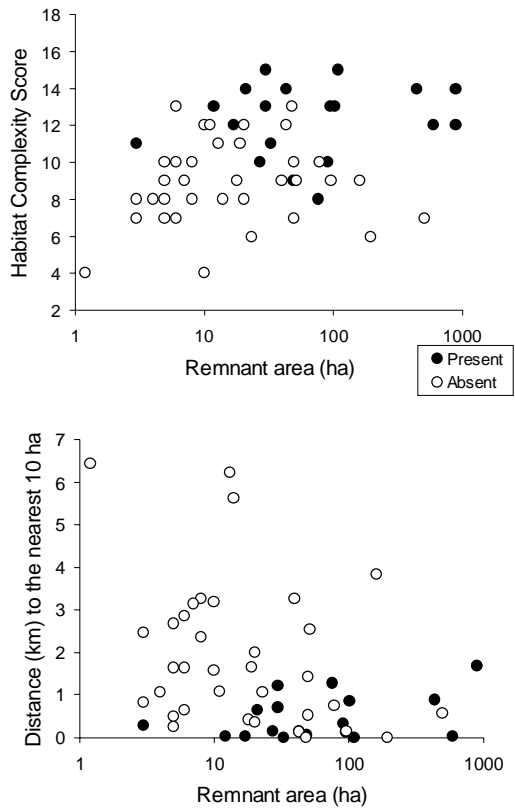
There was a weak ( $R^2 = 0.12$ ) though significant ( $P < 0.01$ ) linear relationship between the log of survey site area and habitat complexity (condition), indicating that small sites tended to have a simpler habitat structure and large sites tended to have a slightly greater habitat structure. Similarly, there was a weak ( $R^2 = 0.10$ ) though significant ( $P = 0.02$ ) linear relationship between the log of survey site area and distance to the nearest 10 ha or larger remnant, indicating that small survey sites were slightly more isolated than larger survey sites.

### Species number

A total of 115 species of birds were detected during the surveys of the 54 woodland patches within the Boorowa River catchment. Of these 115 species, 84 were woodland birds; the other 31 species were birds of prey and wetland birds. Large and structurally complex sites tended to have more species of birds than small or simple sites, though these relationships were weak (Figures 3a, b). Well connected sites (those that were a short distance from the nearest 10 ha or larger remnant) tended to have more species than isolated sites (Figure 3c). There were a



**Figure 3.** Relationships (a) between number of bird species and area (on a logarithmic scale,  $R^2 = 0.19$ ,  $P < 0.001$ ), (b) between species number and habitat complexity ( $R^2 = 0.33$ ,  $P < 0.001$ ), and (c) between species number and isolation (distance to the nearest 10 ha or larger remnant) ( $R^2 = 0.15$ ,  $P < 0.01$ )



**Figure 4.** Eastern Yellow Robin data showing typical presence or absence in response to the habitat complexity, area and isolation of remnant woodland

minimum of 16 woodland bird species in a site, and a maximum of 41 species.

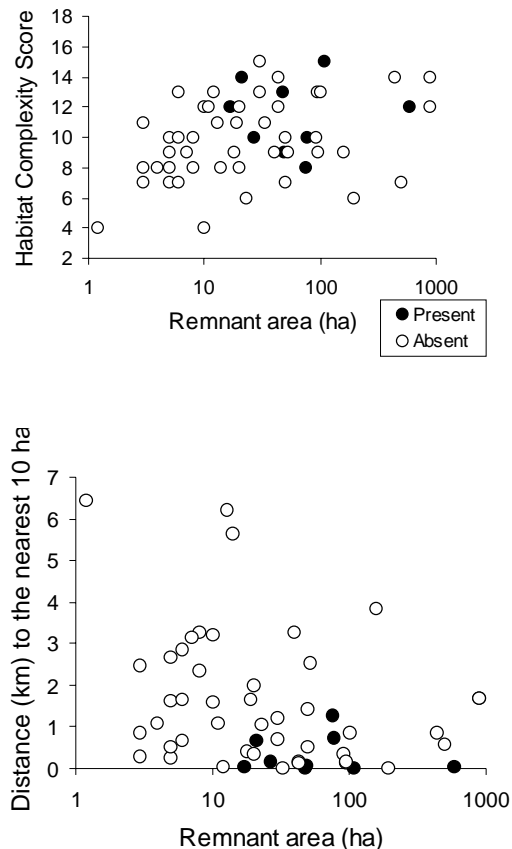
**Individual species**

Graphs of the occurrence of individual species of birds in relation to the area and habitat complexity and isolation of a surveyed remnant proved to be an informative tool for analysing the data. From these graphs, the focal species was determined. Appendix 4 contains the graphs of most of the woodland birds surveyed. Figure 4 shows a typical pattern of presence or absence for a woodland bird species sensitive to patch area, complexity, and isolation.

Those 31 woodland birds that were found in survey sites with a simple structure (little understorey) were classified as tolerant to habitat simplification (Table 1). Thirty-seven species were classified as ‘sensitive’ to habitat simplification (Table 1). Regardless of patch size, these birds occurred only in sites with understorey composed of some shrubs or logs. There was a smaller group of woodland birds that were classified as rare because they were

detected only in three or fewer sites, though few of these rare birds were recorded in structurally simple sites (Table 1). Wetland birds and birds of prey were not analysed for their sensitivity to woodland condition.

The effects of woodland patch size and isolation could not be easily separated. If a species was found in small sites (<10 ha) with habitat complexity scores greater than 6, then often the sites were also comparatively well connected (less than about 2 km from the nearest woodland patch 10 ha or larger in area). The Eastern Yellow Robin is an example (Figure 4). Even if the bird occurred in patches larger than 10 ha, these patches had a moderate to complex structure (score >6) and were well connected (<1.5 km from the nearest >10 ha patch). The Fuscous Honeyeater is another clear example of the multiple influences of habitat structure, area and isolation (Figure 5).



**Figure 5.** The Fuscous Honeyeater data show the multiple effects of habitat structure, area and isolation of surveyed remnant woodland

**Table 1.** ‘Tolerant’, ‘Sensitive’, ‘Rare and Sensitive’ and ‘Rare and Tolerant’ woodland birds recorded in the Boorowa River catchment during March 2001. Tolerant birds occurred in sites with a habitat complexity score of 6 or less. Sensitive birds were those only found in sites with a habitat score of greater than 6 and not found in sites more than 4 km from the nearest 10 ha or larger remnant. Rare and Sensitive birds occurred in three or fewer sites with a habitat score of greater than 6, and Rare and Tolerant birds occurred in three or fewer sites with a habitat score of 6 or less. Birds with an asterisk are those classified as declining in abundance throughout the wheat–sheep belt of NSW (Reid 2000).

Tolerant	Sensitive	Rare and Sensitive	Rare and Tolerant
Crested Pigeon	Common Bronzewing	Stubble Quail	Masked Lapwing
Peaceful Dove	Sacred Kingfisher	Painted Button-quail*	Pallid Cuckoo
Galah	Rainbow Bee-eater	Little Corella	Blue-faced Honeyeater
Sulphur-crested Cockatoo	White-throated Treecreeper	Fan-tailed Cuckoo	
Superb Parrot*	Brown Treecreeper*	Brush Cuckoo	
Crimson Rosella	Speckled Warbler*	Spotted Pardalote	
Eastern Rosella	White-browed Scrubwren	Chestnut-rumped Heathwren	
Laughing Kookaburra	Weebill	Southern Whiteface*	
Superb Fairy-wren	Western Gerygone	Yellow-tufted Honeyeater	
Striated Pardalote	White-throated Gerygone	White-naped Honeyeater	
White-plumed Honeyeater	Brown Thornbill	Scarlet Robin	
Noisy Miner	Buff-rumped Thornbill	Red-capped Robin*	
Little Friarbird	Yellow-rumped Thornbill	Grey Currawong	
Noisy Friarbird	Striated Thornbill	White-browed Woodswallow*	
Red Wattlebird	Yellow Thornbill	Double-barred Finch	
Grey-crowned Babbler*	Yellow-faced Honeyeater		
Grey Shrike-thrush	White-eared Honeyeater		
Willie Wagtail	Fuscous Honeyeater		
Restless Flycatcher*	Black-chinned Honeyeater		
Magpie-lark	Brown-headed Honeyeater		
Grey Butcherbird	Striped Honeyeater		
Pied Butcherbird	Eastern Spinebill		
Australian Magpie	Eastern Yellow Robin*		
Pied Currawong	Hooded Robin*		
Black-faced Cuckoo-shrike	Jacky Winter*		
Olive-backed Oriole	White-browed Babbler*		
Little Raven	Varied Sittella*		
Australian Raven	Golden Whistler		
Common Starling	Rufous Whistler*		
Welcome Swallow	Eastern Shrike-tit*		
Silvereye	Rufous Fantail		
	Grey Fantail		
	Leaden Flycatcher		
	Dusky Woodswallow*		
	White-winged Chough		
	Mistletoebird		
	Diamond Firetail*		

### Vulnerable species

Eighteen declining woodland bird species (Reid 1999), including six birds provisionally or formally listed as Vulnerable in NSW, were detected during the surveys (Table 2). All the listed birds, except the Superb Parrot and Grey-

crowned Babbler, were found only in sites with at least a moderately complex understorey (habitat score at least 7). Of the four sites at which the Superb Parrot was found, three were less than 1 km from the nearest remnant patch 10 ha or larger in area (Appendix 4).

**Table 2.** Declining woodland birds (Reid 1999) recorded in the Boorowa River catchment

Common name	Number of sites with occurrences	Minimum area (ha)	Minimum habitat complexity score	Maximum distance (km) to nearest >10 ha remnant
Southern Whiteface	2	91	9	0.4
Speckled Warbler <sup>v</sup>	12	3	9	5.5
Dusky Woodswallow	13	6	7	5.6
White-browed Woodswallow	1	109	15	0.1
Brown Treecreeper <sup>v</sup>	24	5	7	6.2
Restless Flycatcher	23	3	6	3.2
Diamond Firetail <sup>v</sup>	5	5	7	2.7
Varied Sittella	6	6	9	3.8
Eastern Shrike-tit	11	5	7	5
Rufous Whistler	37	3	7	5.4
Eastern Yellow Robin	19	3	8	1.7
Hooded Robin <sup>v</sup>	4	5	10	2.8
Jacky Winter	18	6	7	3.2
Red-capped Robin	2	3	9	5.5
Grey-crowned Babbler <sup>v</sup>	4	13	6	6.2
White-browed Babbler	10	17	12	1.7
Painted Button-quail	3	3	9	5.5
Superb Parrot <sup>v</sup>	4	1	4	6.4

<sup>v</sup> Provisionally or formally listed as Vulnerable in NSW

## DISCUSSION AND RECOMMENDATIONS

### The focal species approach

The focal species approach (Lambeck 1997) assesses landscape features and processes that are likely to threaten the persistence of native biodiversity. It identifies the species most sensitive to each threat.

This study has focused on habitat loss (fewer woodland patches), habitat degradation (woodland patches lose structural complexity), and on habitat fragmentation (patches become more isolated from each other). Revegetation initiatives such as the Saltshaker Project should ameliorate these threats by planting suitable species in such a way as to increase the size, connectivity (new patches or corridors) and complexity of existing remnant patches. The focal species approach can be used to devise revegetation guidelines by quantifying the requirements of the species that is most sensitive to habitat configuration and structure. It is assumed that if the habitat meets the needs of the focal species then it will satisfy the landscape and habitat requirements of all other similarly threatened species.

This consultancy focused on bird species because they use the landscape at a scale of thousands of metres — which is similar to the scale at which revegetation is usually planned — and also because they could be surveyed within the time constraints of this project. Preliminary guidelines were required within

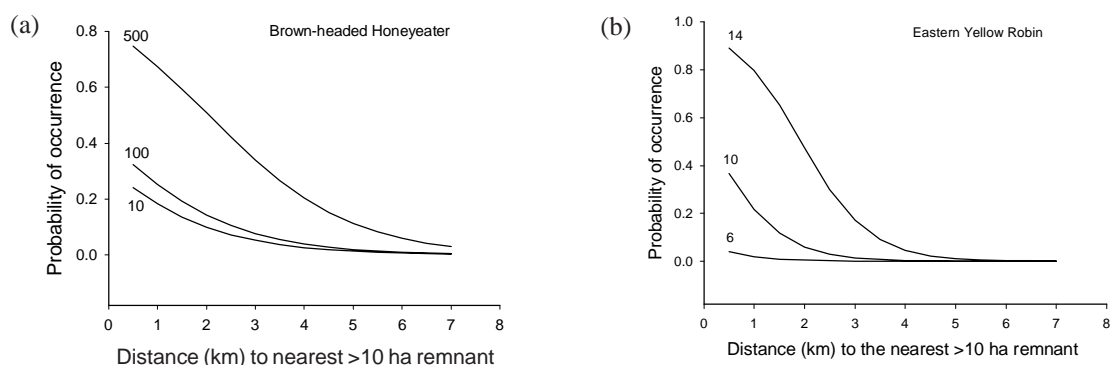
four months of the start of the study so that plantings could be prepared for spring 2001.

### Limits to application

It has been difficult to identify the most sensitive species for each of the key landscape threats (habitat loss, simplification and fragmentation). Few birds appeared to be sensitive to only one threat, or the birds appeared to respond in a compensatory fashion to these threats. Many birds were found only in sites that were relatively large *and* well connected *and* had a complex habitat structure (e.g. Eastern Yellow Robin, Figure 4). None of the species was limited to specific-size sites but not limited by habitat structure or not limited by connectivity. Similarly, no bird was found to be limited by connectivity but not patch size or structure.

The response to multiple threatening processes can also be seen in modelled probability of occurrence. For example, the Brown-headed Honeyeater had a higher probability of occurring when both patch size and connectivity were larger (Figure 6a). Similarly, the Eastern Yellow Robin had a higher probability of occurring as patch size and habitat structure increased (Figure 6b).

The other difficulty in rigorously applying the focal species approach was the lack of sufficient occurrences. I arbitrarily stipulated that



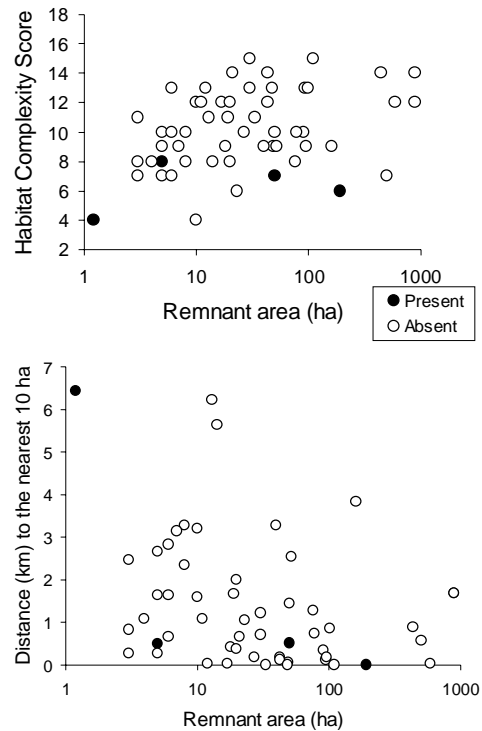
**Figure 6.** Probability of occurrence of (a) the Brown-headed Honeyeater as a function of distance and three patch sizes (10, 100, 500 ha) and (b) the Eastern Yellow Robin as a function of distance and three levels of habitat complexity score (6, 10, 14)

a bird had to occur in at least three sites to provide enough data for us to draw any sort of conclusion about its response to threatening processes. However, these relatively rare species may also be those most sensitive to a threatening process. The Double-barred Finch (Appendix 4, page 33) was only detected in the largest site (860 ha); thus, it may be the focal species (most demanding) for habitat enlargement, but there are insufficient data about the needs of this species for a revegetation recommendation to be based on it. Similarly, the Spotted Pardalote occurred only in very well connected sites (less than 160 m to the nearest 10 ha or larger remnant), but the data are insufficient (two occurrences) for us to conclude that this bird is the most sensitive to connectivity.

The only reasonably consistent response was to habitat structure. There were two broad groups of birds: those that were relatively ubiquitous, and those that did not occur in highly simplified remnants that had little understorey other than exotic pasture (Table 1). These 37 species of woodland birds required at least some understorey, made up of some combination of native tussock grasses, fallen timber, low shrubs, and/or regenerating trees or tall wattles. Few of the declining woodland birds identified by Reid (1999) (Table 2) were found in simplified sites (Table 1).

The interpretation of these results is also limited by the frequency and season of sampling. We were only able to sample during a single autumn. Studies have shown that the bird species at a site can differ markedly between seasons and between years (Recher 1988). We have only been able to provide a brief and narrow window into the dynamics of the way bird species use the Boorowa catchment.

The bird species occurring at the surveyed remnants are also likely to change as various species continue to suffer from the long history of intensive agricultural development in the catchment. The occurrence of a species in a remnant does not imply that the remnant provides viable habitat. Occurrences may be composed of dispersing juveniles or solitary males, or breeding colonies that are too small to successfully raise offspring. All that can be stated with some confidence is that many woodland species of birds have a very low probability of occurring in small, isolated and simplified woodland remnants.

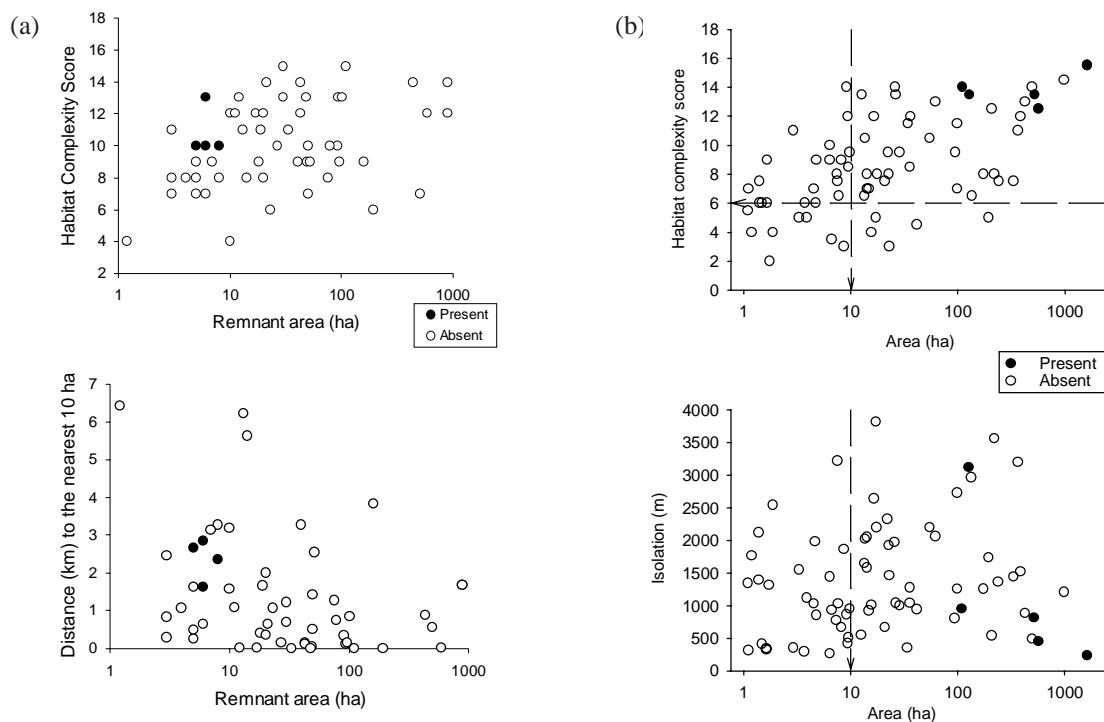


**Figure 7.** Sightings of the Superb Parrot in sites with a range of sizes, distances to next patch and habitat complexities

### The focal species

I suggest that the Eastern Yellow Robin is a useful focal species for the Boorowa River catchment. It is a small, charismatic woodland species (see front cover) that appears to respond to all three key landscape threats, i.e. habitat loss, simplification and isolation (Figure 4). It is not the most sensitive to any one of these threats, but it occurs frequently enough to potentially respond to landscape enhancement activities. It is likely to occur in sites that are enlarged to at least 10 ha, that have a complex understorey and that are at most 1.5 km from the nearest remnant 10 ha or larger in size, or connected by a corridor-planting to an existing remnant of moderate size.

The Superb Parrot is an iconic species for the Boorowa Shire, but its presence does not encapsulate all the habitat requirements of many of the 'sensitive' woodland birds listed in Table 1. The Superb Parrot is listed as Vulnerable in NSW, yet it occurs in fairly simple sites that can be quite small (Figure 7). It is probably affected by threats other than landscape simplification and patch size. For example, it may be affected by proximity to other feeding sites: of the four sites in which it



**Figure 8.** Hooded Robin data: (a) Boorowa River catchment; (b) northern ACT and bordering NSW

was detected in this study, three were less than 1 km from other patches at least 10 ha in size (Figure 7). However, note that the Superb Parrot is more likely to be seen during the spring in this catchment.

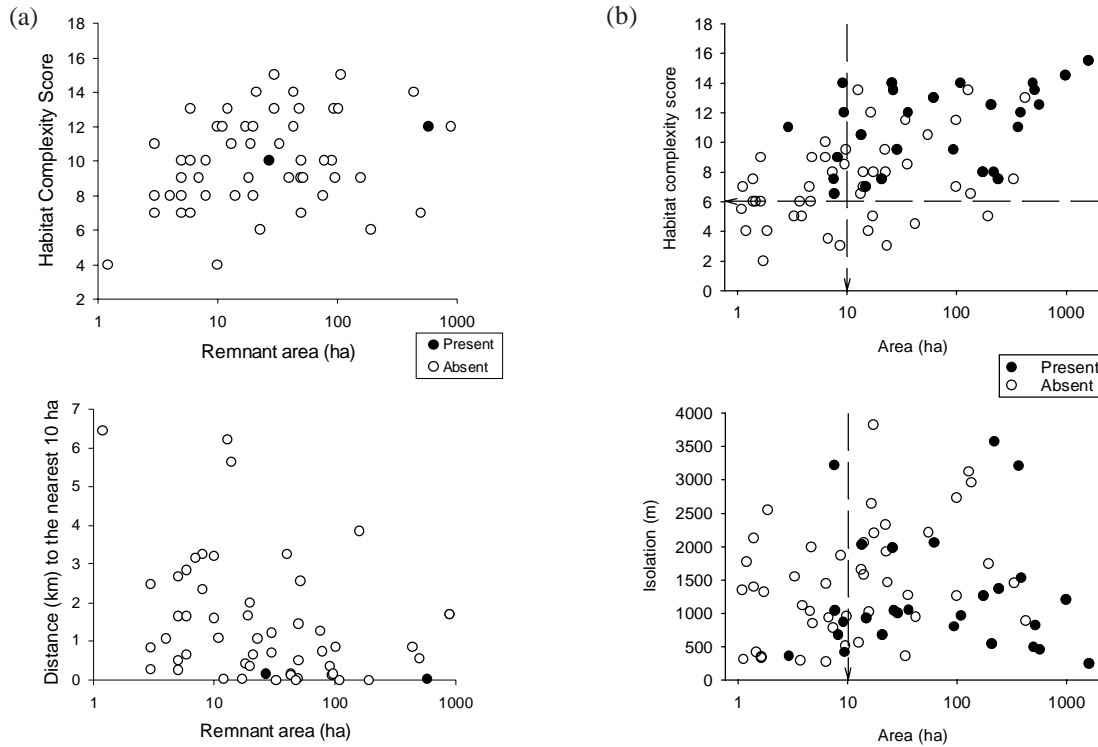
### Comparisons with other landscapes

The bird response to landscape characteristics such as remnant patch size, structure and connectivity differs between landscapes. The Hooded Robin in the northern ACT and bordering NSW only occurred in large sites (>100 ha) that were highly complex and usually well connected to other sites (Figure 8b) (Freudenberger 1999). In contrast, in the Boorowa River catchment, this bird was equally as rare but occurred in relatively small sites (<10 ha) with only moderately complex structure and connectivity (Figure 8a). The Spotted Pardalote was relatively common in the ACT and appeared unaffected by isolation, whereas this bird occurred in only two sites in the Boorowa River catchment and both of these were very near other sites at least 10 ha in size (Figures 9a, b). Other birds responded in similar fashions in both study regions. The same ubiquitous birds were found in both studies. The

Eastern Yellow Robin was more common in the Boorowa River catchment, but this bird was similarly limited by increasing isolation in both studies. The Rufous Whistler occupied small patches in the Boorowa River catchment, but it was absent from patches with little habitat structure, in both studies. The identity of the species threatened by loss of habitat extent, structure or connectivity often varies between study locations, but there are invariably groups of birds that clearly respond to these threats.

### Recommendations and guidelines for enhancing bird habitat

The Boorowa River catchment is not a biological desert. It may have only a 7% cover of remnant woodland, but 115 species of birds were recorded across a diversity of woodland types, remnant sizes and habitat structures within this catchment. This diversity of birds is feeding on a wide diversity of invertebrates, vertebrates, seeds and other plant tissues. The first priority is to try and retain this diversity, much of it supported by existing woodland remnants that are threatened by continuous grazing, intensive cultivation and dryland salinity.



**Figure 9.** Spotted Pardalote data: (a) Boorowa River catchment; (b) northern ACT and bordering NSW

**Guidelines recommended**

This study has consisted of only a relatively simple and brief analysis of the spatial and structural habitat requirements for birds in the Boorowa River catchment. It assumes that the habitats that meet the needs of birds sensitive to threats of habitat loss, simplification and isolation also meet the requirements of other non-avian taxa. If the Saltshaker Project aims to enhance the probability of retaining those species that are threatened by the current scale and intensity of landuse, the following actions are recommended, in order of priority.

1. As soon as possible, protect existing remnants from continuous grazing, by fencing them off. Give priority to those remnants at least 10 ha in size, or those that are within at least 1.5 km of existing remnants at least 10 ha in size, or those that still have a structurally complex understorey.
2. Where regeneration of native understorey (tussock grasses and/or shrubs), or regeneration of trees is unlikely within fenced remnants, then take steps to establish local provenance understorey grass or shrub species or trees.
3. Enlarge (enhance) existing remnants to at least 10 ha.

4. Create linkages between protected and enhanced remnants that are over 1.5 km away from other remnants at least 10 ha in size. At minimum, the linkages should consist of linear plantings at least 25 m wide (5 rows), or ‘stepping stones’ of block plantings at least 10 ha in size, or, ideally, a combination of both.
5. Create linkages at least 25 m wide between protected remnants less than 1.5 km away from other remnants at least 10 ha in size.
6. Create linkages at least 25 m wide between unprotected (e.g. unfenced) remnants at least 10 ha in size.

These recommendations are not exhaustive. Neither do they cover a full range of scales and detail. Rather, they are indicative of the scale and priority of actions needed. They should be combined and integrated with a range of other landscape needs and values as discussed below.

The need for linkages to be at least 25 m wide is based on research by Dr C. Kinross (Orange Agricultural College, Sydney University), which included survey sites in the Boorowa River catchment (Kinross 2000). See also Bennett et al. (2000), which summarises the key principles and scales for enhancing the value of revegetation for wildlife conservation.

This report for the Saltshaker Project has focused on providing data and insights for habitat revegetation at the scale of the individual paddock and property. The above six guidelines are also consistent with those from Birds Australia (Barrett 2000), though Barrett recommends linkage strips at least 50 m wide. These six guidelines are also consistent with those developed by Hobbs and Yates (1998).

This focal species approach does not provide catchment-wide targets such as total percent cover of woody vegetation. Analysis of regional bird data, such as those collected by Reid (2000), is one approach for defining regional targets. A range of targets is being developed by the Lachlan Catchment Board, NSW Dept of Land and Water Conservation, NSW National Parks and Wildlife Service and the Murray-Darling Basin Commission.

### **Implementation: assessment system**

Implementation of these six guidelines has already begun. The recommendations have been incorporated into an assessment scoring sheet (Appendix 3) being developed by the Saltshaker Technical Steering Committee made up of representatives from Greening Australia, CSIRO, DLWC, Boorowa Shire Council and the Boorowa Regional Catchment Committee. Ideally, this assessment sheet should have been available before the first round of applications for devolved grants from the Saltshaker Project. However, this was not possible due to the constraints of NHT funding and the need for on-ground preparation (e.g. application of herbicide; fencing before planting). This assessment sheet should provide a transparent tool for assessing existing proposals, and allow new proposals to be developed with a much greater awareness of planning criteria.

The assessment system recognises the multiple benefits of fencing and revegetation. It recognises that in some parts of the landscape the value of a proposal may be heavily weighted in favour of reducing recharge in a high salinity hazard zone, whereas in other parts of the landscape where salinity is less of a hazard the weighting may favour habitat for biodiversity. This evolving assessment system is also a starting point in the negotiation of expanded on-ground works to meet minimum criteria.

Fundamentally, the assessment system is entirely subjective — a minimum score has to

be established by consensus of the catchment community, based on actions the community is prepared to take on at this point in time. CSIRO and DLWC have provided some scientific insights, but they must be ‘meshed in’ with community expectations and values.

### **Monitoring**

The Saltshaker Project can be seen as the continuation of the long process of restoring the Boorowa River catchment. The restoration aims to create a catchment that is more sustainable, discharges less salty water and sediment, has fewer saline scalds and is composed of a biologically diverse landscape. The landscape will have healthy patches of native woodlands and corridors, and a matrix of deep-rooted perennial pastures integrated into appropriate rotations with crops.

There will be successes and failures along this long path. However, little will be learned without a monitoring and evaluation process owned and managed by the catchment community with assistance from many agencies, including Greening Australia.

There is plenty of information in the scientific literature about monitoring, and there are many aspects of a catchment that can be monitored at a range of scales (Wakefield and Goldney 1997). The critical element of any monitoring program is an achievable set of objectives. These need to be well thought-out, simple and clearly stated.

### ***Simplicity***

The advantage of using the focal species approach for monitoring habitat health is that it allows simple predictions. For instance, I can make the simple prediction that Saltshaker plantings will provide habitat for the Eastern Yellow Robin within 5–10 years, if the plantings are each at least 10 ha and have developed a complex structure and are no more than 1.5 km from a remnant 10 ha or larger in area. Preliminary ‘Birdwatch’ data (Taws 2000) indicate that this prediction is too conservative and that occupied habitat can be created in smaller patches of revegetation. I am happy to be proved wrong. The key is that few other projects can generate such an explicit prediction and rationale for monitoring. Keeping an eye out for the Eastern Yellow Robin is much better than collecting a large amount of data for the sake of it.

### ***Community ownership***

Community ownership of a monitoring system is critical. The best monitoring is done by people passionate about what they are involved in on a regular basis. Hence, the best monitors are the residents of the Boorowa River catchment. Whether it is measuring groundwater level in a piezometer, collecting a water sample, or taking a photograph of a revegetation patch, community involvement is essential, but it will also depend on long-term institutional support.

### ***Need for coordination***

A monitoring coordinator is required, who has access to modern office infrastructure such as Geographic Information System software, databases and a colour printer. Such a person would first arrange for volunteers to help with the monitoring, and then coordinate the results (i.e. enter the data into databases and do basic tabulation) and finally communicate them back to the community. For example, an extremely valuable form of monitoring is annual photography, at permanently marked photo-points, to create a photographic record of landscape change. For this, a coordinator could make an annual mail-out of a 12-exposure colour film and return envelope to every recipient of Saltshaker funding. The coordinator would have a database system in which to store the resulting photographs as scanned images. A reporting system that rapidly processes and prints the accumulated scanned images and generates a copy for each landholder each year would be a national 'first'. The technology now exists and it is relatively inexpensive. Something as simple as regular photographs from photo-points is a powerful monitoring tool, although it is not simple to implement. It is also an excellent reason for keeping in touch with and involving landholders and other community members.

A major challenge is to find funds and staff-time or an external contractor to co-ordinate and run such a monitoring system for about six weeks once a year. If Greening Australia were to rely on just its own staff to do monitoring in the field, the monitoring could only be done on a subset of sites. Alternatively, the monitoring of birds in woodlands being done by the

Canberra Ornithologists Group, Inc. (COG) and Environment ACT is a good model. In this arrangement, COG receives a modest grant from the ACT to support a coordinator who organises COG volunteers to collect data on a range of sites.

It is relatively easy to choose robust indicators to be monitored. To get a system operational and owned by the catchment community is the real challenge. The key is to start simply — and to start now. Baseline data (i.e. information about the conditions existing before the planting or fencing) are essential. To collect them, it only takes two steel fence posts and a couple of aluminium ID tags (to mark a photo-point) and a camera.

### **Conclusions**

The Saltshaker Project in the Boorowa River catchment could have adopted the revegetation guidelines and focal species for the Greening Australia Vegetation Investment Project (VIP) (Freudenberger 1999). Some of the sites for the VIP bordered the survey sites for Saltshaker. I expected that woodland birds in the two study areas would respond similarly to landscape threats.

The results show otherwise. The Hooded Robin in the ACT region was found only in large, structurally complex and well connected remnant woodlands. Yet, in the Boorowa River catchment, the Hooded Robin was found in much smaller and less well connected remnants. There are many other examples of species of birds occurring in a strikingly different range of sites in the two study areas. The results from the Boorowa area also showed a much more complex response to patch size, structure and connectivity.

In hindsight, separate focal species surveys in the two adjacent catchments were justified. The final sets of revegetation guidelines are not very different from each other, but each catchment has its own focal or icon species that is likely to respond to landscape enhancement.

This Boorowa study has also dispelled a passing impression that the landscape is too degraded. Quite the contrary: there is much to build on. I have confidence that the revegetation activities supported by the Saltshaker Project will be a significant step in retaining the rich biodiversity that persists in this catchment.

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## APPENDIX 1

Site details for the Saltshaker bird surveys in the Boorowa River catchment. Details of the Habitat Complexity Score (HCS) are shown in Appendix 2. Isolation is the distance to the nearest remnant 10 ha or larger in size. Area is the size of the surveyed patch of woodland as delimited by eye on a SPOT satellite image. Latitudes and longitudes are GPS coordinates (1984 datum).

SiteID	Site Name	HCS	Isolation (m)	Area (ha)	Lat. (degrees)	Long. (degrees)
1	Allendale	9	5540	3	-34.22858	148.42207
2	Balgagal	12	1080	11	-34.64401	148.64772
3	Balgagal	10	1640	6	-34.6366	148.66174
4	Young RLPB	9	2540	52	-34.34606	148.86472
5	Yass RLPB	12	360	20	-34.64447	148.80592
6	Shire	12	1580	10	-34.60729	148.93816
7	Young RLPB	8	5630	14	-34.38992	148.76454
8	Young RLPB	11	6210	13	-34.37675	148.73926
9	Clonalton	9	160	96	-34.22144	148.93469
10	Clonalton	11	280	3	-34.22422	148.92934
11	Young RLPB	4	3200	10	-34.33914	148.51672
12	Forestdene	7	560	502	-34.32281	148.66315
13	Dranoel	13	10	48	-34.24696	148.85818
14	Dranoel	12	30	17	-34.24061	148.8613
15	Gentle Destiny	15	10	109	-34.32033	148.89566
16	Young RLPB	13	20	10	-34.3531	148.64842
17	Young RLPB	13	1210	30	-34.34577	148.63208
18	Shire	10	2670	5	-34.55582	148.82579
19	Young RLPB	9	3150	7	-34.57858	148.81104
20	Young RLPB	10	1430	50	-34.15201	148.87671
21	Young RLPB	9	3840	160	-34.60196	148.75375
22	Shire	8	500	5	-34.67572	148.64774
23	Young RLPB	8	2000	20	-34.32332	148.48274
24	Piney Gap	14	1690	892	-34.45227	148.54572
25	Piney Gap	12	1690	892	-34.45551	148.55457
26	Young RLPB	10	740	78	-34.58213	148.93211
27	Young RLPB	9	3270	40	-34.4842	148.59665
28	Scribble Rock	10	2350	8	-34.63686	148.6432
29	The Lagoon	12	120	43	-34.62364	148.68767
30	Willawong	14	160	43	-34.39719	148.54579
31	Willawong	10	350	91	-34.40633	148.54604
36	Shire	11	1660	10	-34.12609	148.8046
40	Young RLPB	7	510	50	-34.02452	148.81433
42	Benwerrin	13	850	101	-34.03586	148.87943
43	Midlands	14	650	21	-34.04407	148.88518
44	Benwerrin	7	650	6	-34.04766	148.86295
50	Yass RLPB	8	1070	4	-34.7009	148.90358
52	Iora	9	420	18	-34.70494	148.89676
54	West Killanear	10	160	27	-34.38898	148.57228
55	Lassan	8	1270	76	-34.37883	148.58
59	AltonDale	13	130	94	-34.25561	148.85278
60	Pine Haven	14	870	438	-34.45694	148.82364
62	Yass RLPB	13	2840	6	-34.66277	148.72879
63	Shire	8	3260	8	-34.59412	148.80704
64	Shire	9	260	5	-34.64437	148.85071
65	Shire	7	1630	5	-34.66325	148.85924
66	Young RLPB	6	1060	23	-34.58353	148.67131
67	Young RLPB	15	710	30	-34.36301	148.9189
68	AnnaLee	9	50	49	-34.31794	148.91469
69	Young RLPB	8	2470	3	-34.42284	148.54083
70	Bellanda Park	11	10	33	-34.31261	148.97206
71	Bellanda Park	7	840	3	-34.30296	148.96474
72	Linberlost	4	6440	1	-34.36805	148.72008
73	Shire	12	20	587	-34.30556	148.93262
74	Dorroughby	6	10	193	-34.23608	148.73654

## APPENDIX 2

An example of a data sheet for assessment of habitat complexity score, based on that of Catling and Burt (1995).

	<b>Score 0</b> 0–10% cover	<b>Score 1</b> 10–20% cover	<b>Score 2</b> 20–50% cover	<b>Score 3</b> >50% cover	<b>Total</b>
Tree canopy			✓		2
Tall shrub cover (2–4 m)		✓			1
Short shrub cover (0.5–2 m)		✓			1
	0–10% cover	10–40% cover	40–70% cover	>70% cover	
Ground herbage		✓			1
Logs/rocks	✓				0
Litter			✓		2
	<b>Habitat Complexity Score = 7</b>				

## APPENDIX 3

**Scoring sheet for assessing on-ground works proposals for the Greening Australia/Boorowa Regional Catchment Committee 'Saltshaker Project'. Prepared by the Saltshaker Technical Steering Committee (June 2001).**

### *1. Salinity recharge management*

Rating	Description	Score
High	2 ha block or 8+ row interception in suitable place	4
Medium	Belt of trees at least 5 rows wide	2
Low	Not of scale or location to make a difference, not on right land unit	0

*Definitions.* Salinity recharge control is one of the main aims of the Saltshaker Project. Recharge is the amount of water leaking past the root zone and entering groundwater. Recharge rates are highest under shallow-rooted annual plants and lower under deep-rooted perennial plants. Trees provide the lowest recharge rates in the climate and landscape of the Boorowa Catchment (Walker, Gilfedder and Williams 1999).

*Rationale.* Tree planting to aid recharge control relies on two things: (i) Is the scale of the planting going to make a difference? (ii) Is the planting in the appropriate spot within the landscape? Wide belts (8 rows or 35 m wide) or 2 ha blocks of vegetation will have an impact on groundwater systems. A belt of trees at least 5 rows (25 m) wide will aid in addressing recharge in a local area but will have a much smaller impact on the groundwater system as a whole.

### *2. Salinity priority area based on Ray Evans Hazard Map (Evans and Bradd 2001)*

Rating	Description	Score
Very High	Very high hazard area	4
High	High hazard area	2
Medium	Medium hazard area	1
Low	Low hazard area	0

*Definitions.* Salinity hazard is the potential for salinity to occur, based on a variety of factors such as geology, soils, and slope.

*Rationale.* The report by Evans and Bradd (2001) covers most of the area within the Saltshaker Project area. By using the classes as defined in that report, salinity issues can be addressed in a prioritised way.

### 3. Vegetation linkages

Rating	Description	Score
High	Links to enhanced (fenced) remnants 10 ha or greater	4
Medium	Links to existing remnants less than 10 ha fenced	3
Medium	Links to existing remnants less than 10 ha unfenced	2
Low	No links to other vegetation in area	0

*Definitions.* Linkages can be either ‘stepping stones’ or ‘corridors’. CSIRO research in the Boorowa River catchment has shown that an effective ‘stepping stone’ is a 10 ha or larger patch of revegetation within at least 1.5 km of an existing remnant 10 ha or larger. Research by C. Kinross (2000) in the region has shown that an effective ‘corridor’ is at least 25 m wide (minimum of 5 rows).

*Rationale.* The highest priority goes to linking large remnants (greater than 10 ha) that have been protected from uncontrolled grazing by livestock. An enhanced remnant is one that has been fenced and increased in size by plantings and/or has an understorey of shrubs established. CSIRO research in the catchment has shown that many small woodland birds are absent from remnants smaller than 10 ha and without an understorey of shrubs, native tussock grasses and fallen timber.

### 4. Remnant vegetation habitat quality

Rating	Description	Score
High	Fencing of high quality remnants 10 ha or greater	8
High	Fencing and enhancement of remnants 10 ha or greater	4
Medium	Fencing of existing remnants 10 ha to a minimum 2 ha	2
Low	Remnant vegetation protection is less than 2 ha	0

*Definitions.* A ‘high quality’ remnant is one that has a complex habitat structure made up of layers of vegetation. Layers include a healthy canopy (few signs of eucalypt dieback), a midstorey of wattles and young eucalypts, an understorey of shrubs and/or native tussock grasses, and fallen timber and/or rocks to provide additional ground cover and habitat. A ‘low quality’ remnant has a simple vegetation structure with just two layers: a sparse canopy of trees often showing signs of dieback and an understorey of weedy pasture species.

*Rationale.* CSIRO research in the catchment shows that few woodland birds are found in remnants with a simple structure lacking an understorey. Controlling grazing by fencing of existing remnants with a complex understorey is the highest priority for patches of woodland greater than 10 ha in size. Remnants smaller than 10 ha are important, but research in the catchment has shown that larger patches have a higher probability of providing suitable habitat for many woodland birds that are not found in structurally simple and small patches. A minimum of 2 ha has been established in order to maximise the benefits of recharge control (see criterion 1 above).

### 5. Fencing remnant vegetation — fencing efficiency

Rating	Description	Score
High	Large areas with minimum fencing	6
Medium	Good linkages with minimum fencing	4
Low	Small areas with minimum fencing	2
Low	Small areas with maximum fencing	1

*Definitions.* Large areas are at least 10 ha in size. Good linkages are those that create corridors or stepping stones between remnants at least 10 ha in size (see criterion 3 above). Small areas are those less than 10 ha in size.

*Rationale.* Fencing is a major cost for enhancing biodiversity, protecting stream banks and reducing recharge. The shape of proposed on-ground works affects fencing costs. For example, 10 ha fenced off as a 25 m wide corridor requires 4 km of new fencing assuming there is an existing paddock fence (2.5 ha/km fencing), whereas only 650 m of fencing is required to fence off a 10 ha square in the corner of an existing paddock (15 ha/km fencing).

### 6. Salinity discharge management

Rating	Description	Score
High	Block planting of discharge area with links to other saline reclamation works, pastures	2
Medium	Planting in discharge area	1
Low	Not of a scale to make a difference, not on right land unit	0

*Definitions.* Block planting is greater than 1 ha, or 5 rows minimum. Other saline reclamation works include:

- sowing of salt tolerant pastures,
- sowing of salt tolerant trees,
- fencing of saline areas,
- sowing of perennial pastures,
- subdivision of paddocks to allow controlled rotation grazing practices.

Plantings in a discharge area need a minimum of 5 rows to be effective.

*Rationale.* Planting of trees, and management of saline discharge areas, is important for managing salt wash-off and other related issues such as erosion and tree decline. Even though discharge management is treating the symptom of groundwater rise, it is an important part of a multi-faceted approach to salinity and land management. Many landholders are unable to fully address recharge due to some important areas being not on their land.

**7. Riparian management — erosion management — water**

<b>Rating</b>	<b>Description</b>	<b>Score</b>
High	Creek fenced 50+ m wide, specific erosion issues addressed	4
High	Flowline fenced 50+ m wide, specific erosion issues addressed	2
Medium	Flow line or gully line protected and revegetated	1
Low	Low, not of a scale to make a difference, or not related to erosion	0

*Definitions.* Creek flows all year round in most years. Flowline is a gully or low lying area that seasonally flows. Specific erosion issue — includes gully heads and gullies, stream bank erosion.

*Rationale.* Addressing riparian zones benefits water quality. Revegetation of these areas will provide stabilisation, filter strips and have an impact on potential discharge areas.

**8. Subdivision of land classes**

<b>Rating</b>	<b>Description</b>	<b>Score</b>
High	Tree planting subdivides land into uniform land unit classes and links with other similar activities	2
Medium	Tree planting defines land subdivision based on land unit classes	1
Low	No impact, negative impact	0

*Definitions.* Tree planting subdivides land into uniform land unit classes and links with other similar activities — establishment of vegetation in a way which reinforces subdivision of land types to aid appropriate management. Similar activities would include internal fencing on contours, to split land based on productivity, aspect, slope, topography. Would also include fencing out creeks or remnant vegetation. A tree planting that occurs up and down a slope or across land classes is considered to have no impact or negative impact.

**9. Past history of projects**

<b>Rating</b>	<b>Description</b>	<b>Score</b>
High	Successful completion of past projects First activity by individual; first involvement in landcare funding	4
Medium	Current projects in action (outside Saltshaker)	1
Low	Negative result past history, no past history	0

**10. Whole farm planning**

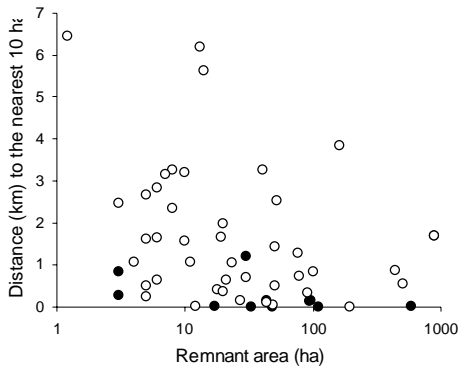
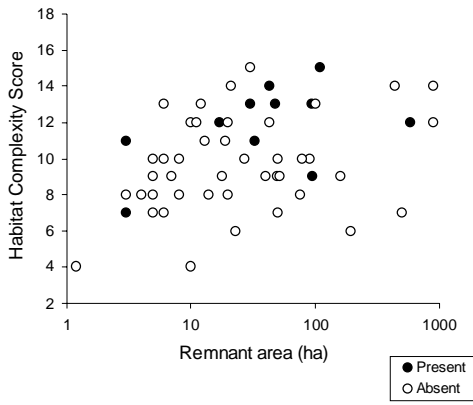
<b>Rating</b>	<b>Description</b>	<b>Score</b>
High	Part of the implementation of an existing farm plan Links to other issues and actions	2
Medium	Initiation of whole farm plan	1
Low	No farm plan	0

## APPENDIX 4

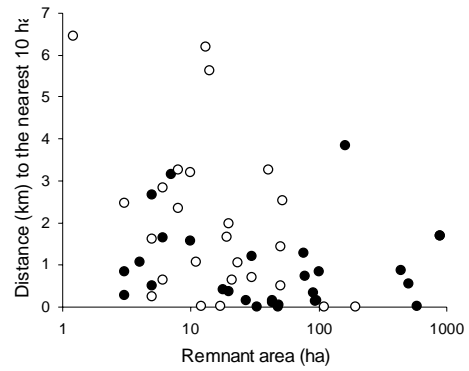
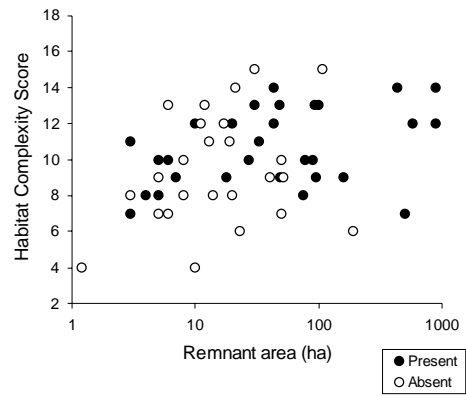
Graphs of presence or absence of woodland bird species in 54 sites surveyed in Boorowa River catchment, NSW.

<b>Bird name</b>	<b>Page</b>	<b>Bird name</b>	<b>Page</b>
Australian Magpie	43	Olive-backed Oriole	29
Australian Raven	44	Painted Button-quail	45
Black-chinned Honeyeater	37	Pallid Cuckoo	48
Black-faced Cuckoo-shrike	36	Peaceful Dove	41
Blue-faced Honeyeater	40	Pied Butcherbird	43
Brown Thornbill	26	Pied Currawong	43
Brown Treecreeper	31	Red Wattlebird	38
Brown-headed Honeyeater	37	Red-capped Robin	31
Brush Cuckoo	48	Restless Flycatcher	35
Buff-rumped Thornbill	26	Rufous Fantail	36
Common Bronzewing	41	Rufous Whistler	32
Crested Pigeon	41	Sacred Kingfisher	45
Crimson Rosella	47	Scarlet Robin	30
Diamond Firetail	33	Silvereye	34
Double-barred Finch	33	Southern Whiteface	28
Dusky Woodswallow	43	Speckled Warbler	28
Eastern Rosella	47	Spotted Pardalote	29
Eastern Shrike-tit	32	Striated Pardalote	29
Eastern Spinebill	37	Striated Thornbill	26
Eastern Yellow Robin	30	Striped Honeyeater	39
Fan-tailed Cuckoo	48	Stubble Quail	41
Fuscous Honeyeater	37	Sulphur-crested Cockatoo	46
Galah	46	Superb Fairy-wren	34
Golden Whistler	32	Superb Parrot	47
Grey Butcherbird	42	Varied Sittella	34
Grey Currawong	42	Weebill	27
Grey Fantail	35	Western Gerygone	27
Grey Shrike-thrush	32	White-browed Babbler	44
Grey-crowned Babbler	44	White-browed Scrubwren	28
Hooded Robin	30	White-eared Honeyeater	39
Jacky Winter	30	White-naped Honeyeater	39
Laughing Kookaburra	45	White-plumed Honeyeater	39
Leaden Flycatcher	35	White-throated Gerygone	27
Little Corella	46	White-throated Treecreeper	31
Little Friarbird	38	White-winged Chough	45
Little Raven	44	Willie Wagtail	35
Magpie-lark	36	Yellow Thornbill	26
Mistletoebird	34	Yellow-faced Honeyeater	40
Noisy Friarbird	38	Yellow-rumped Thornbill	27
Noisy Miner	38	Yellow-tufted Honeyeater	40

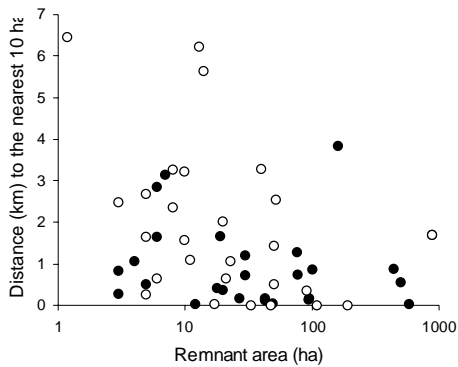
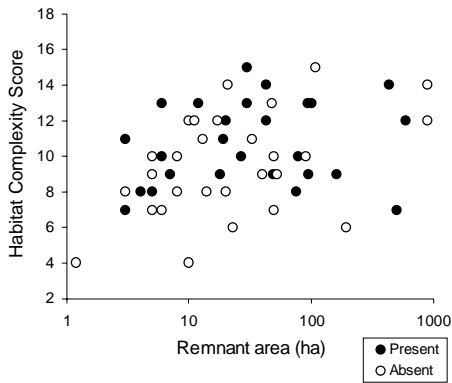
### Brown Thornbill



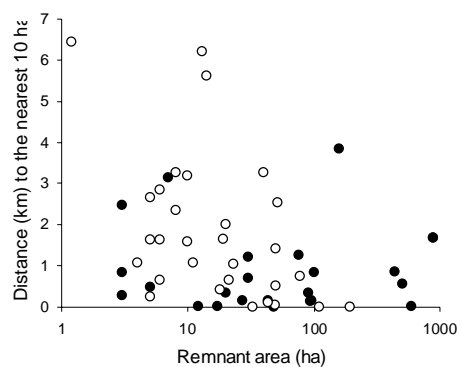
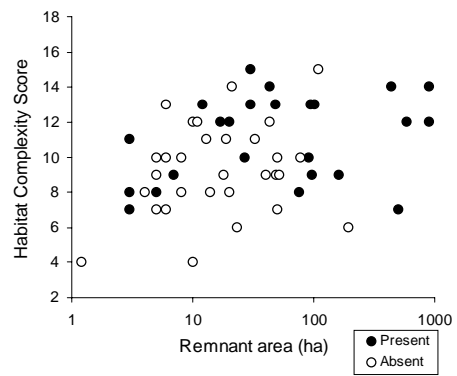
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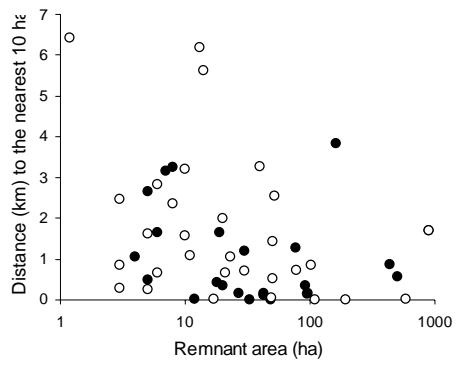
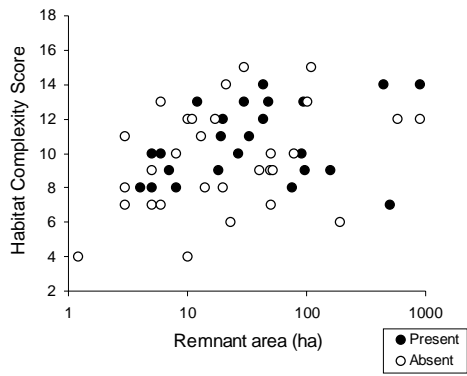
### Striated Thornbill



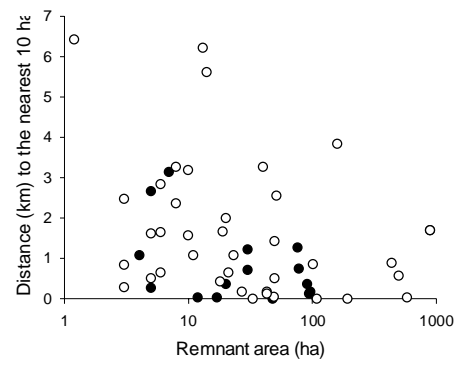
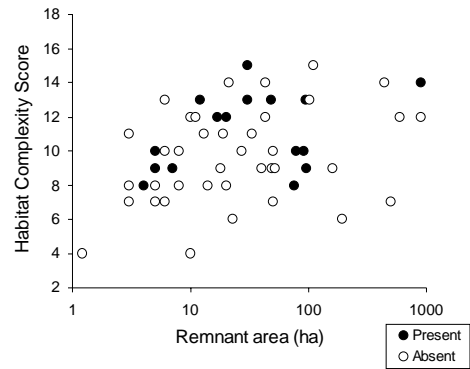
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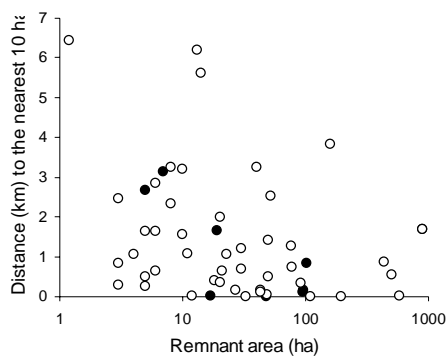
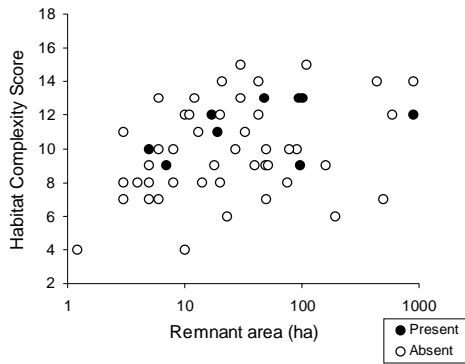
## Yellow-rumped Thornbill



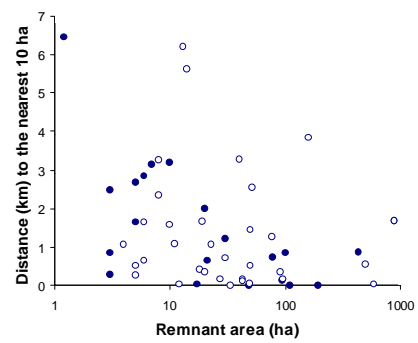
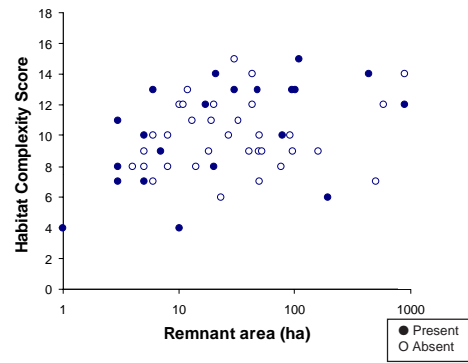
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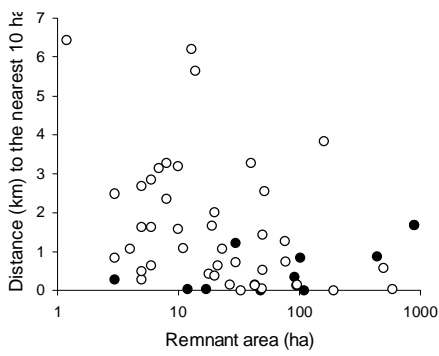
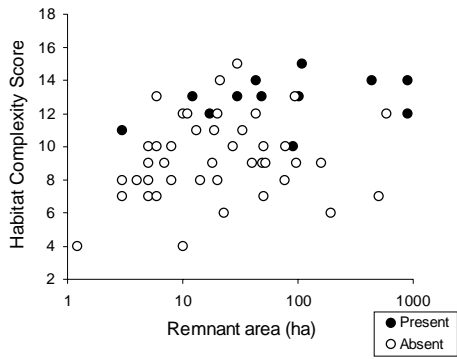
## Weebill



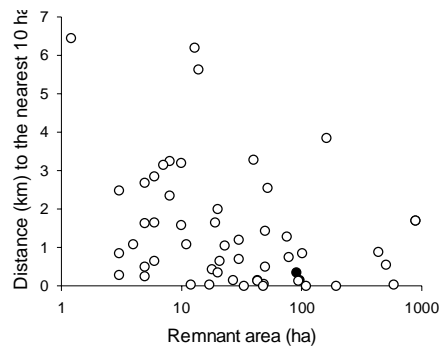
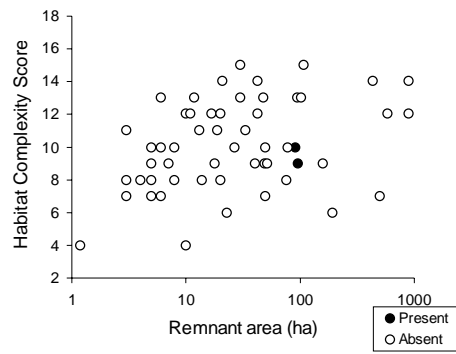
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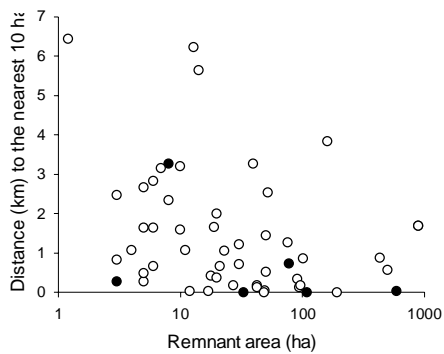
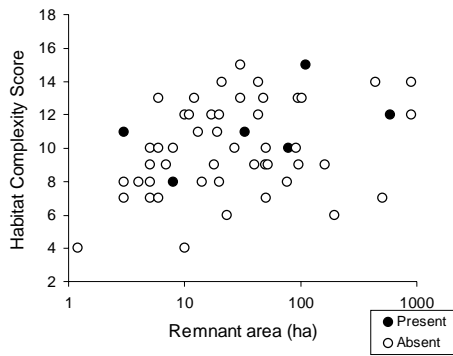
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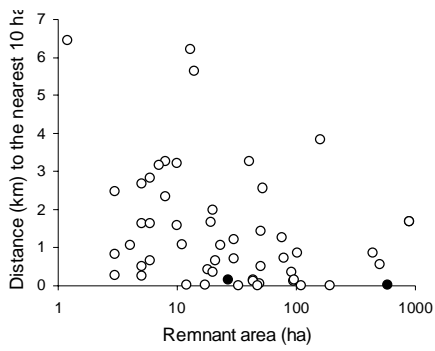
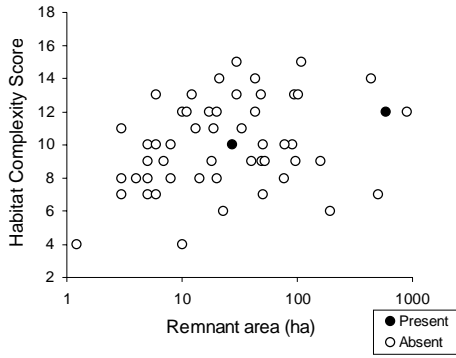
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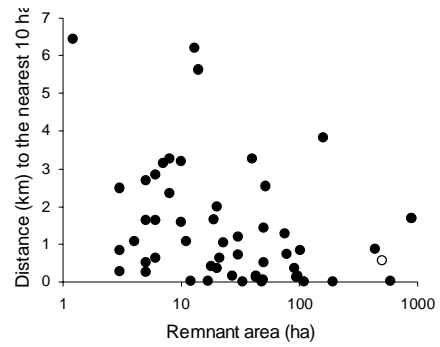
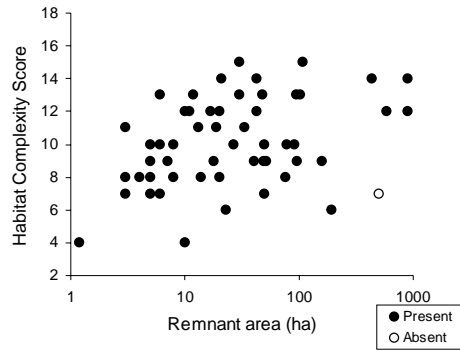
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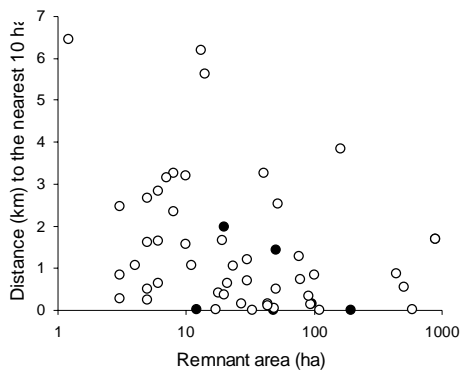
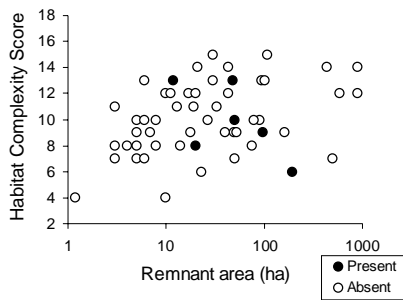
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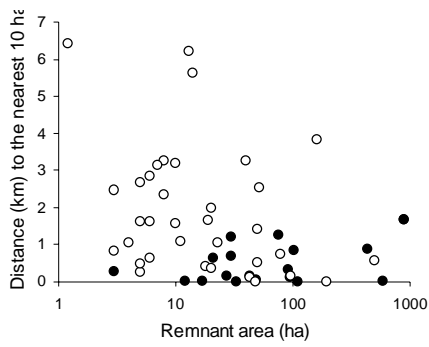
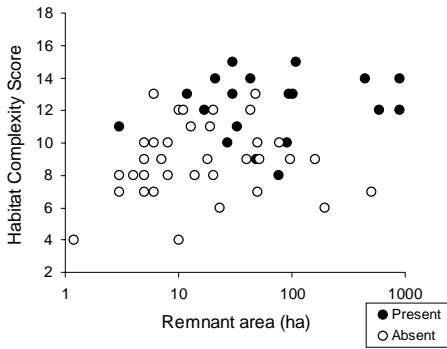
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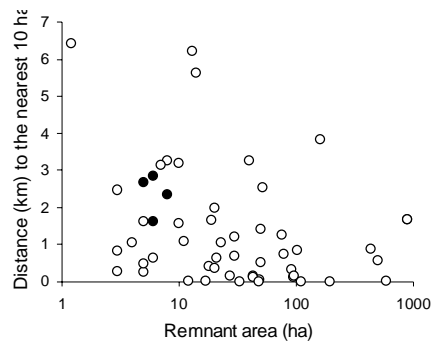
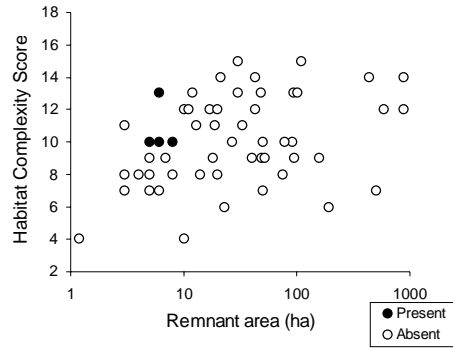
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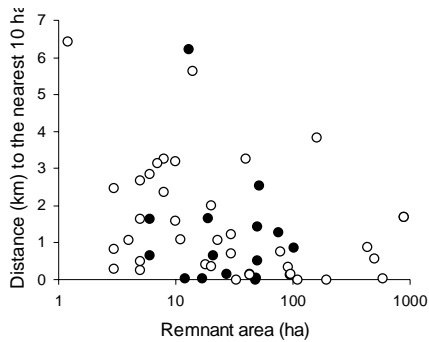
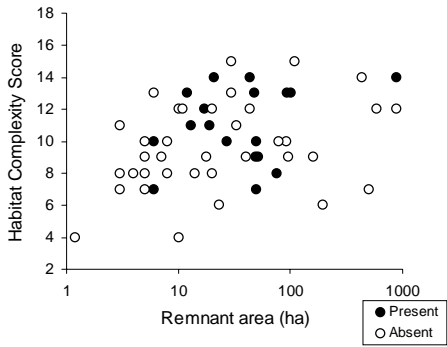
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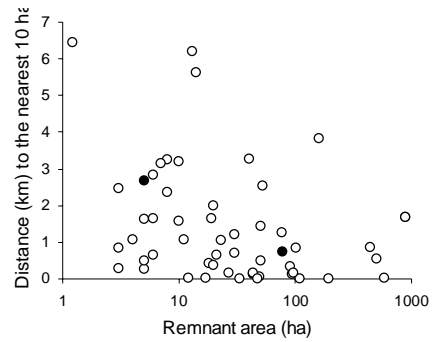
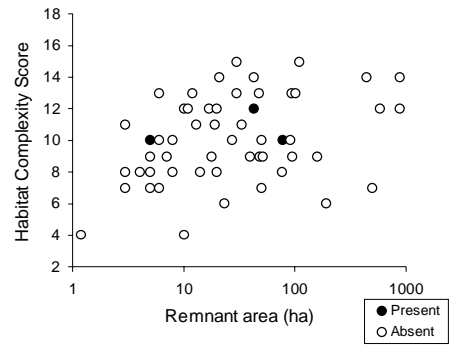
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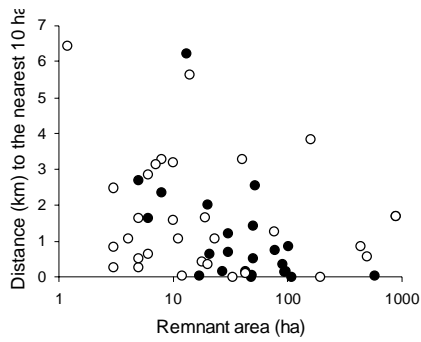
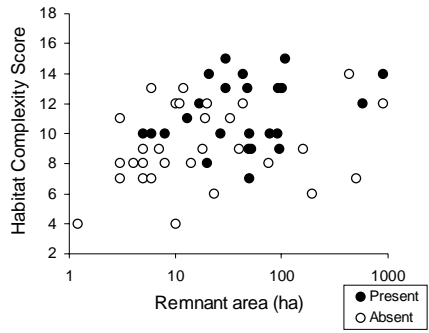
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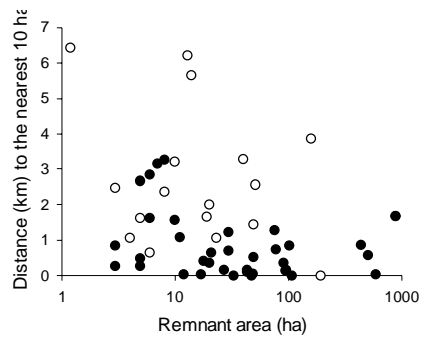
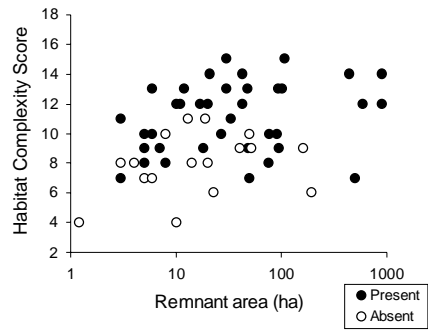
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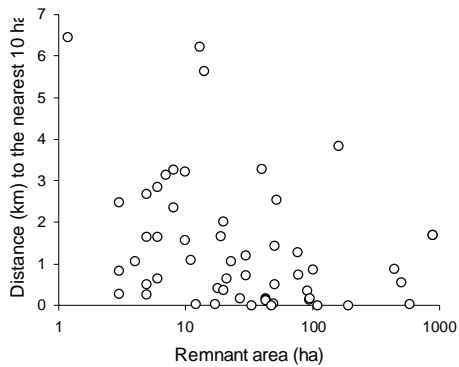
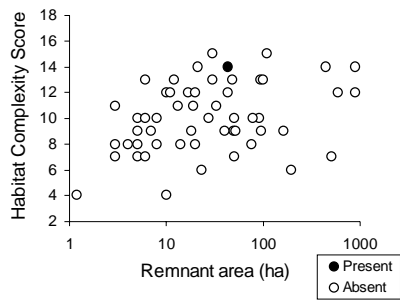
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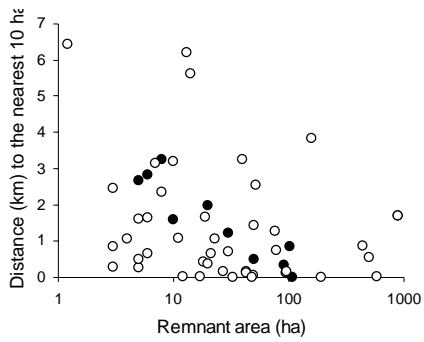
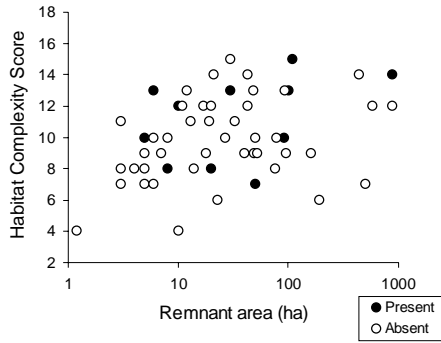
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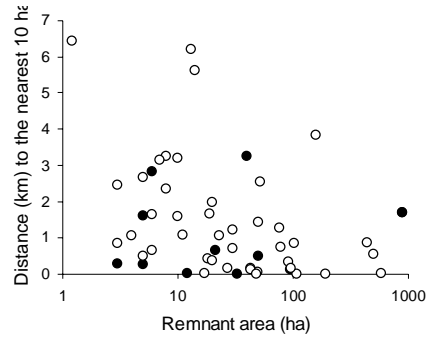
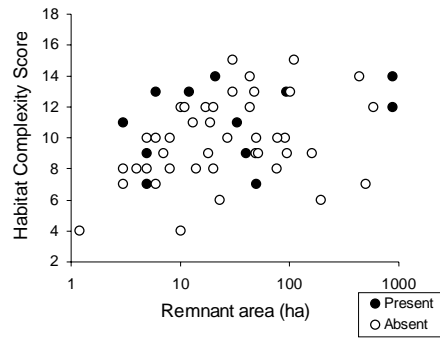
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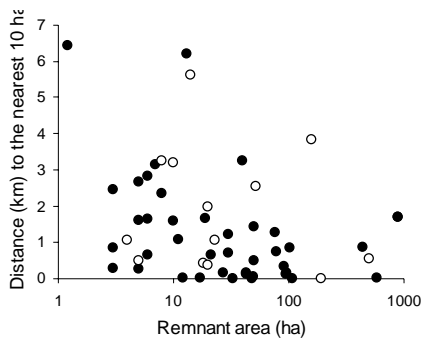
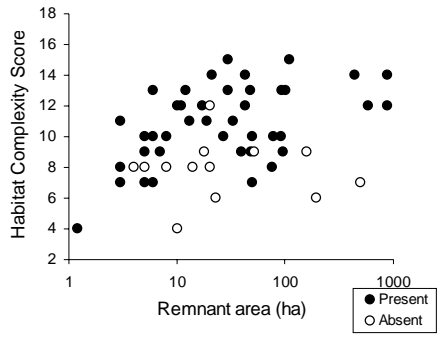
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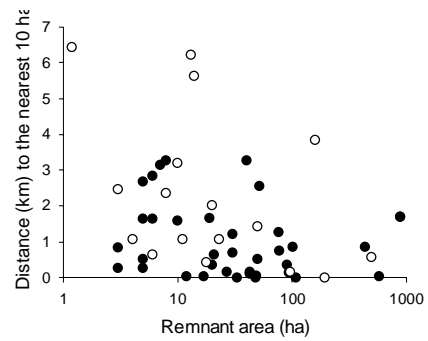
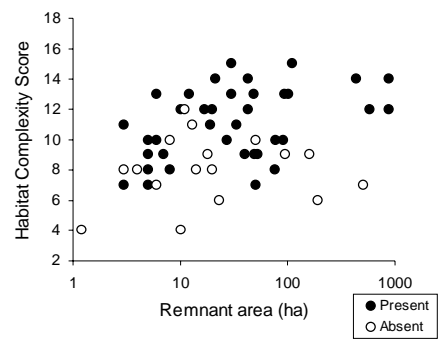
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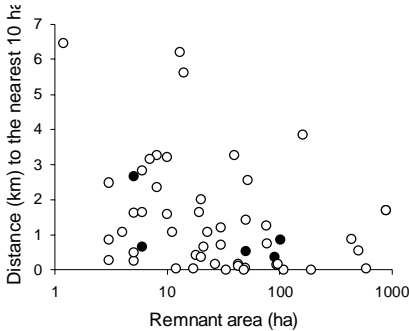
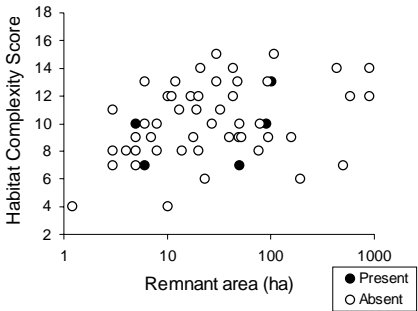
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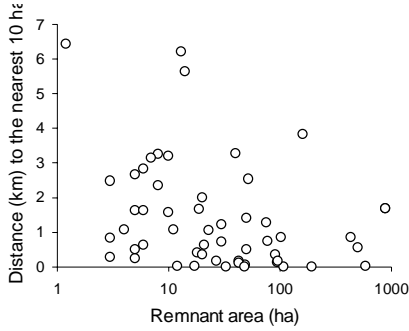
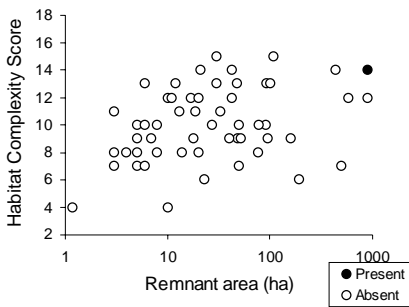
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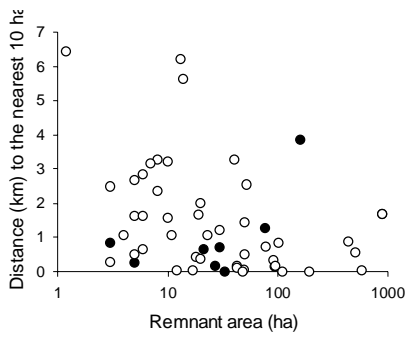
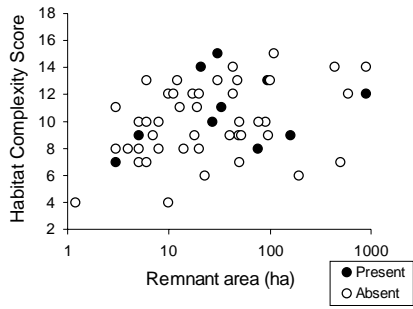
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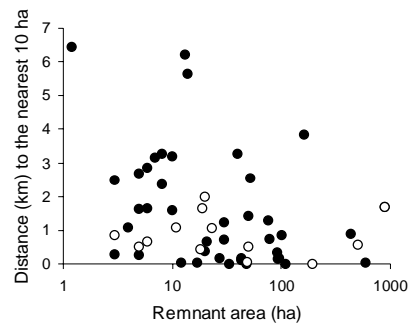
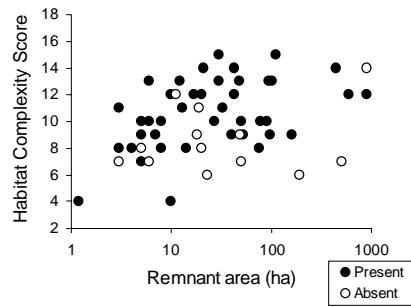
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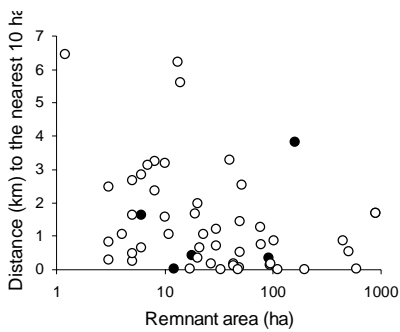
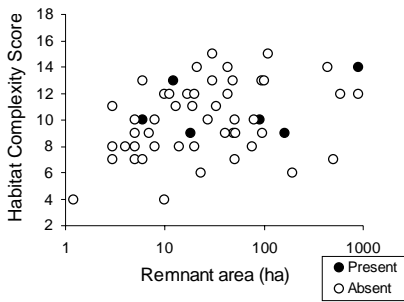
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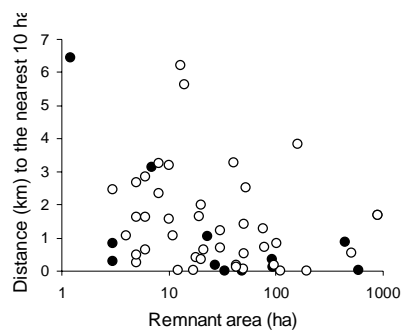
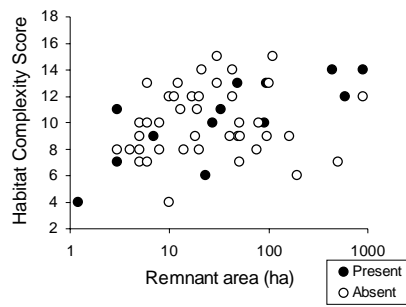
### Superb Fairy-wren



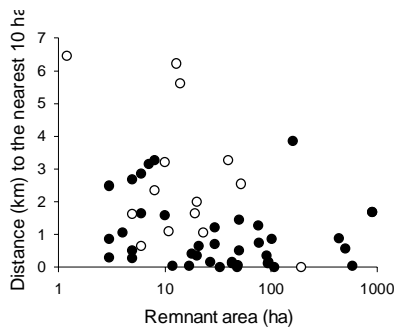
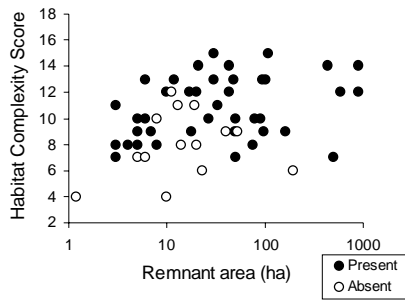
### Varied Sittella



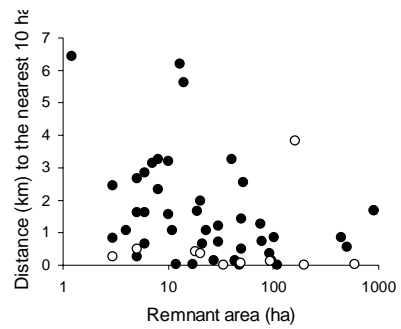
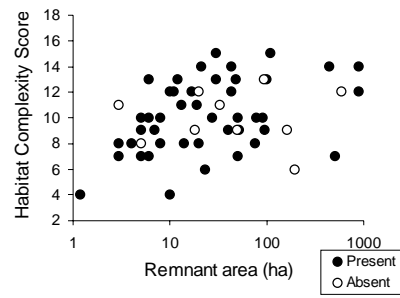
### Silvereye



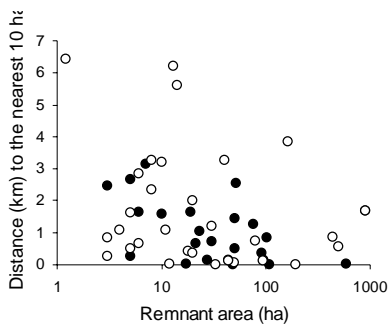
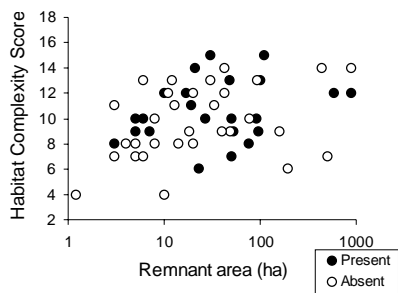
### Grey Fantail



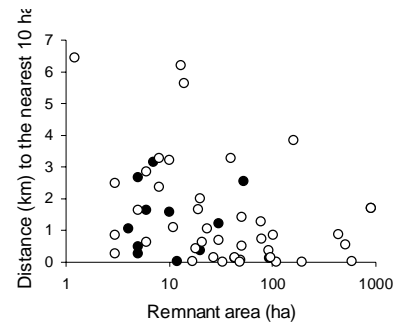
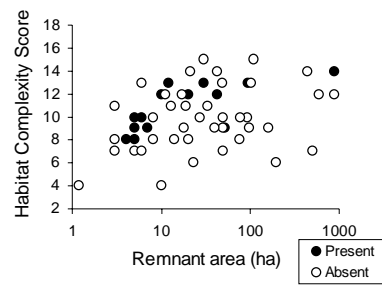
### Willie Wagtail



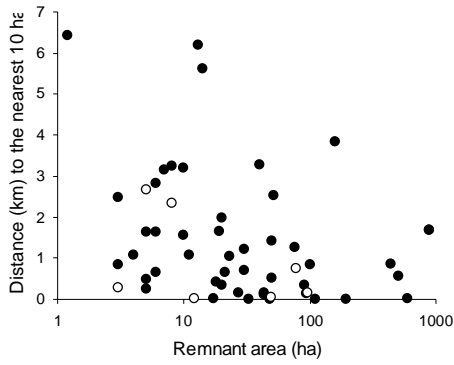
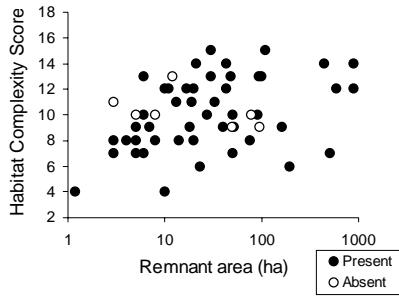
### Restless Flycatcher



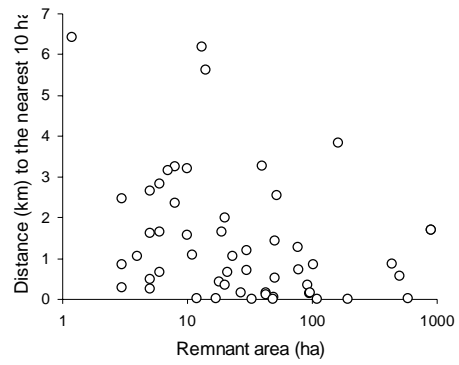
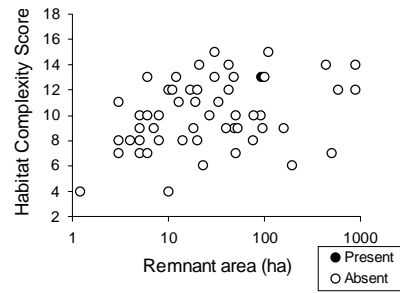
### Leaden Flycatcher



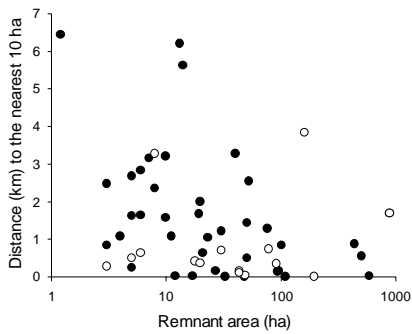
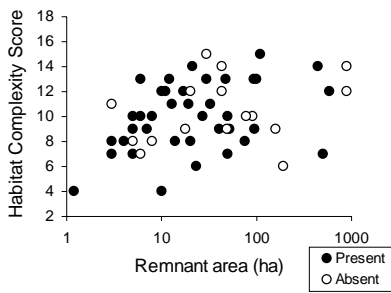
## Magpie-lark



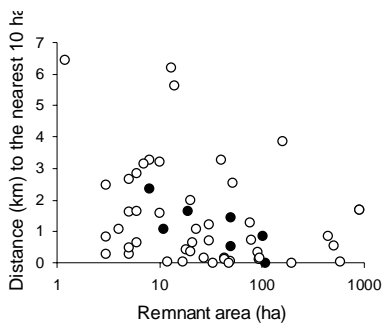
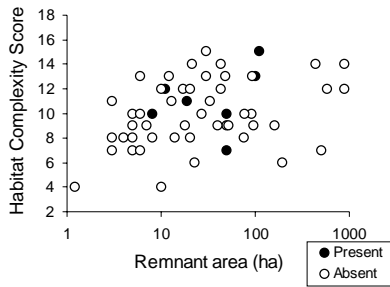
## Rufous Fantail



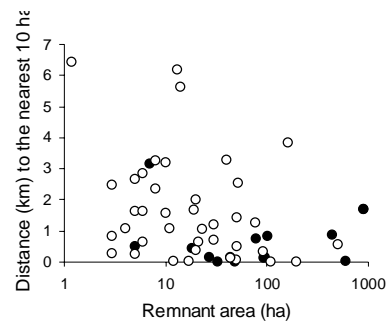
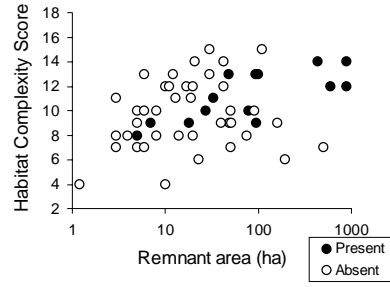
## Black-faced Cuckoo-shrike



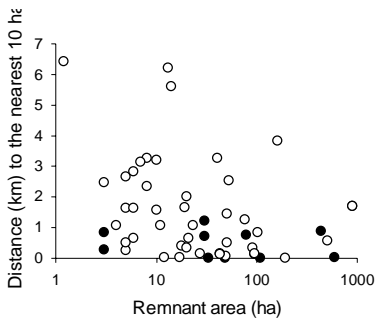
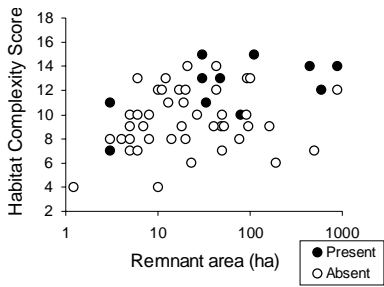
## Black-chinned Honeyeater



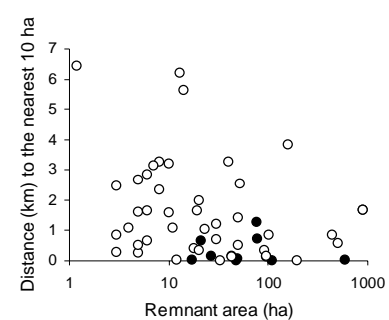
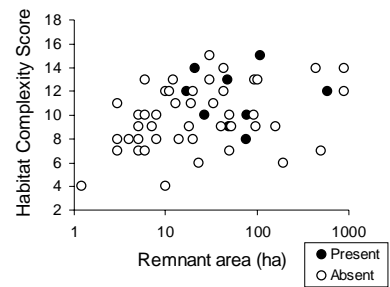
## Brown-headed Honeyeater



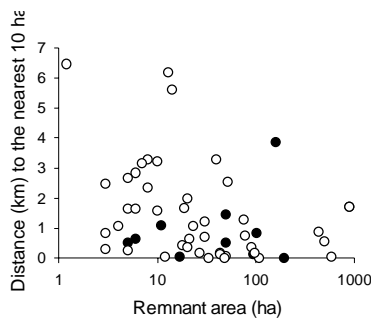
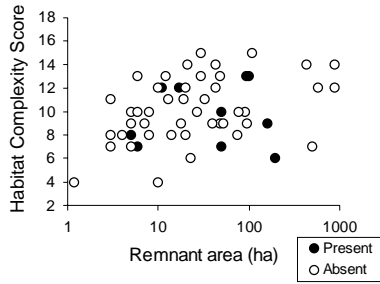
## Eastern Spinebill



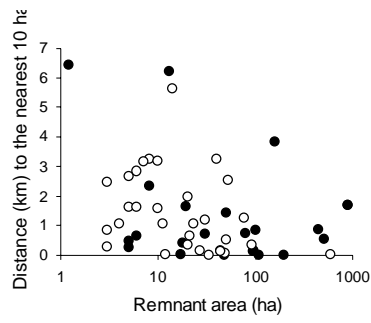
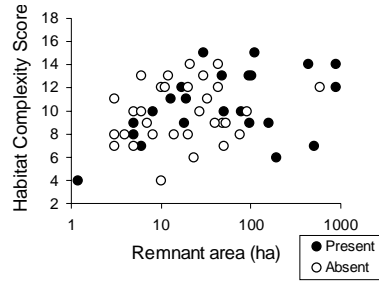
## Fuscous Honeyeater



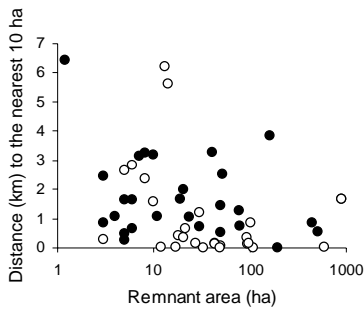
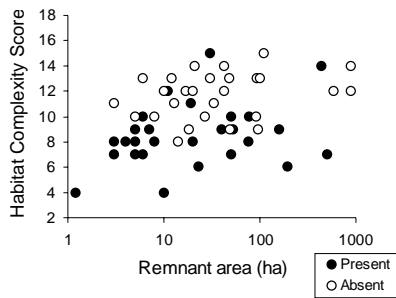
### Little Friarbird



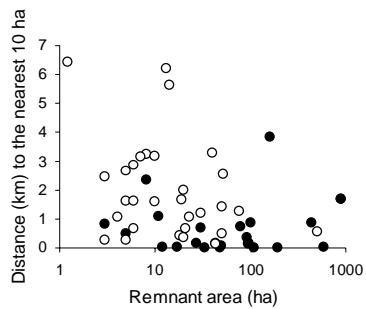
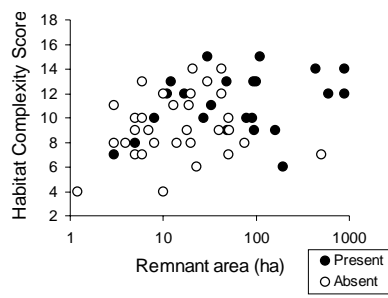
### Noisy Friarbird



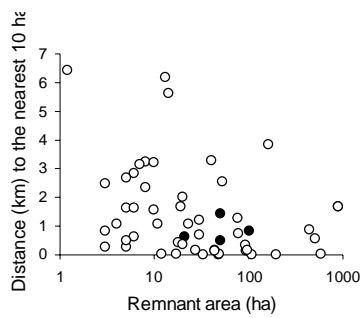
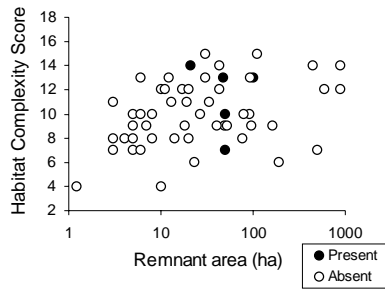
### Noisy Miner



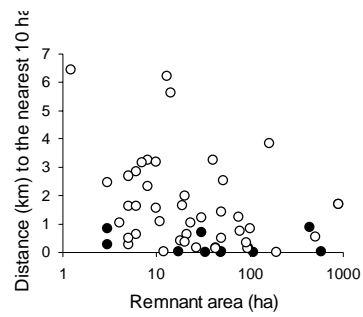
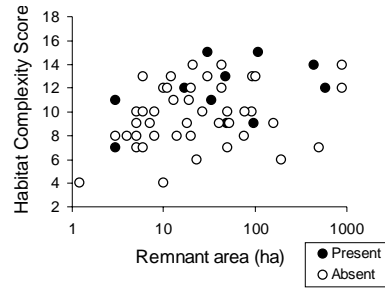
### Red Wattlebird



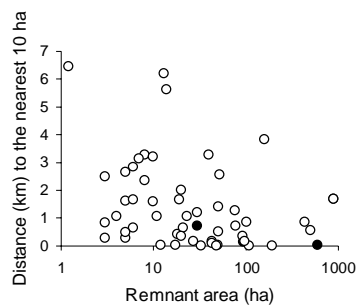
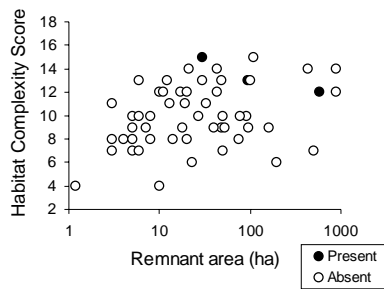
## Striped Honeyeater



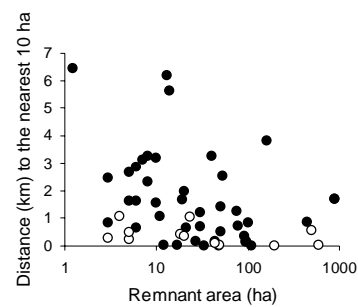
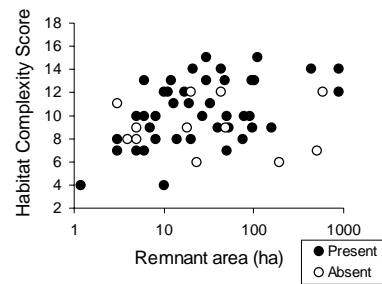
## White-eared Honeyeater



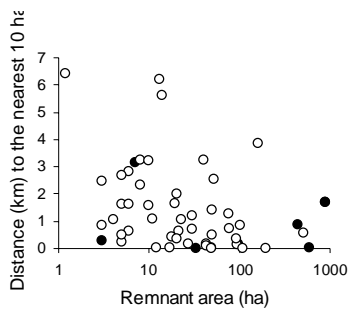
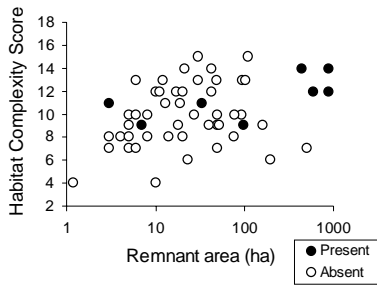
## White-naped Honeyeater



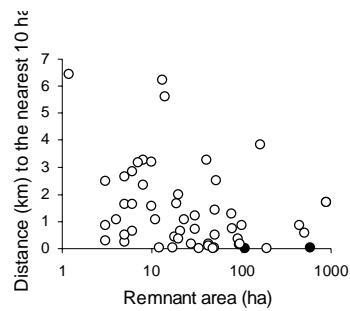
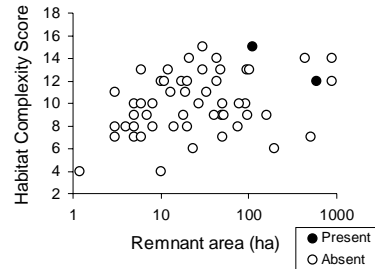
## White-plumed Honeyeater



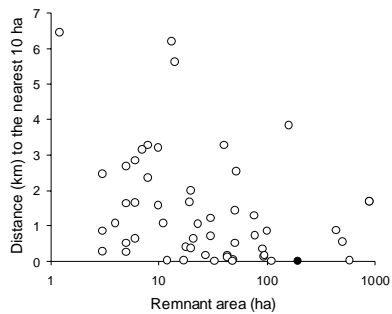
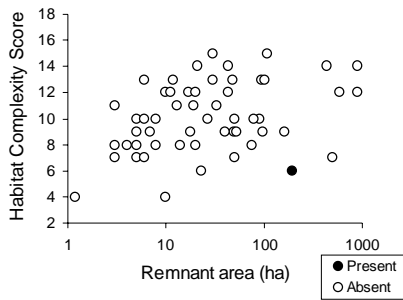
## Yellow-faced Honeyeater



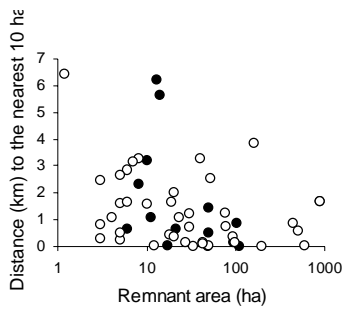
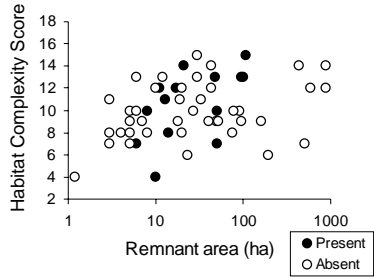
## Yellow-tufted Honeyeater



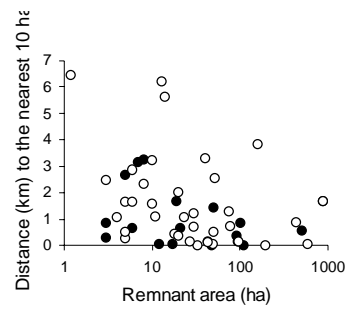
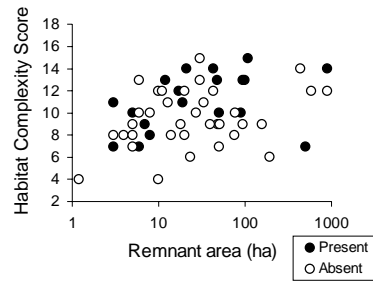
## Blue-faced Honeyeater



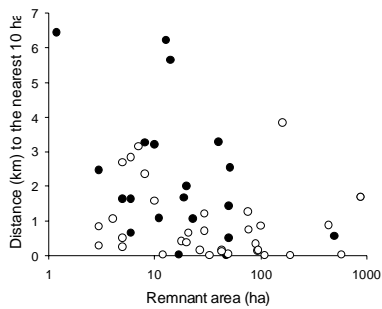
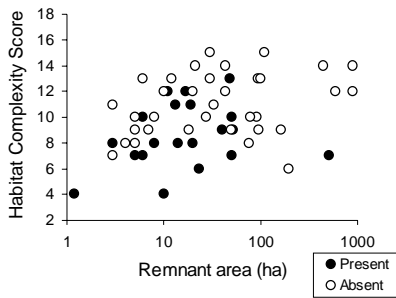
## Peaceful Dove



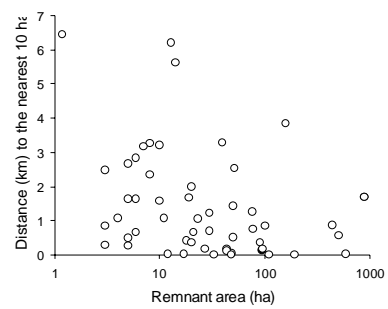
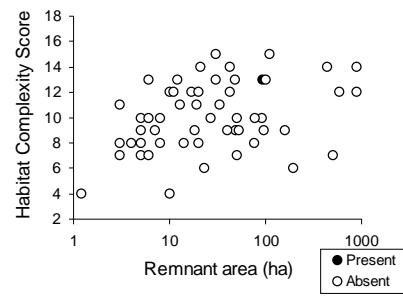
## Common Bronzewing



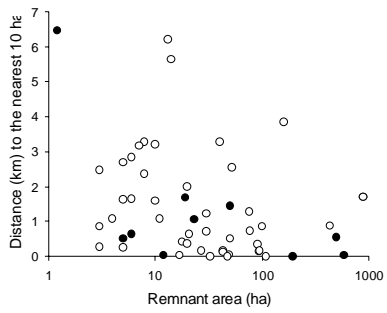
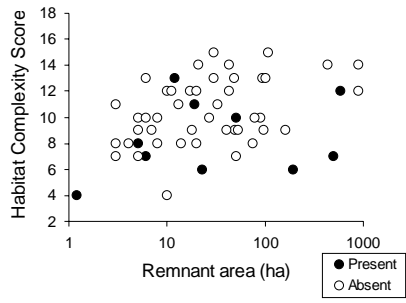
## Crested Pigeon



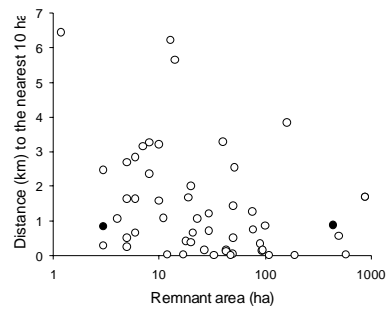
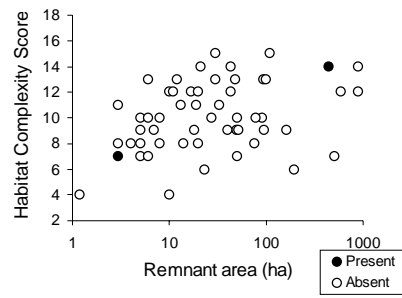
## Stubble Quail



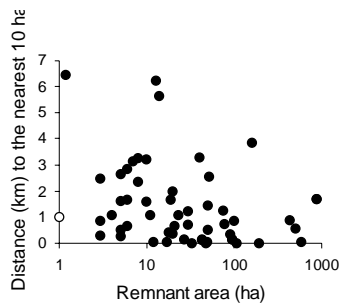
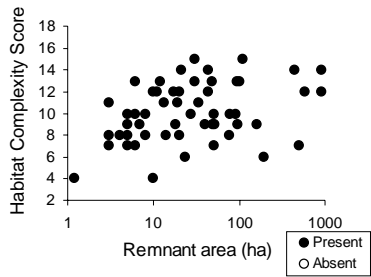
## Grey Butcherbird



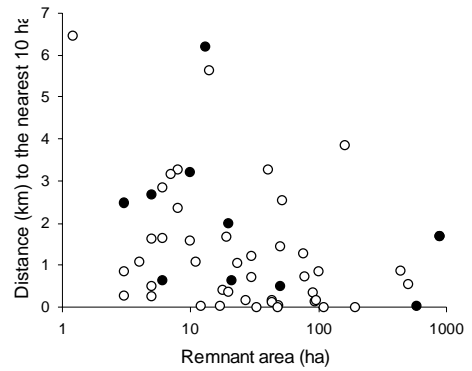
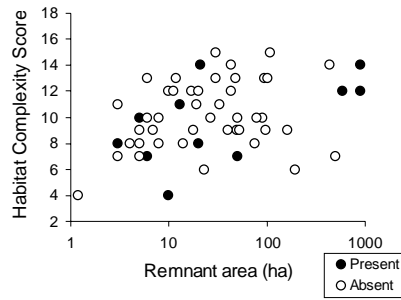
## Grey Currawong



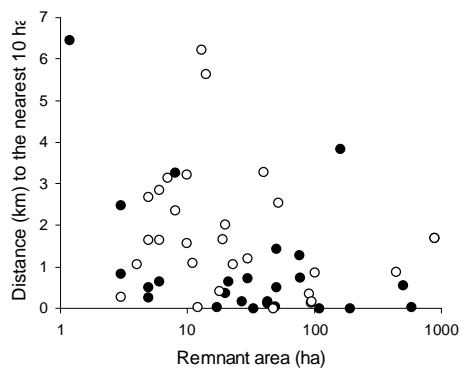
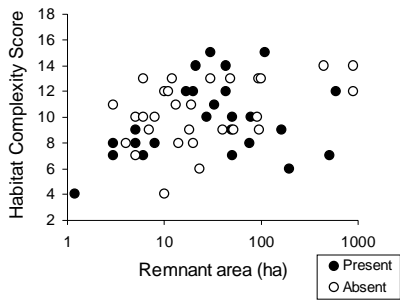
## Australian Magpie



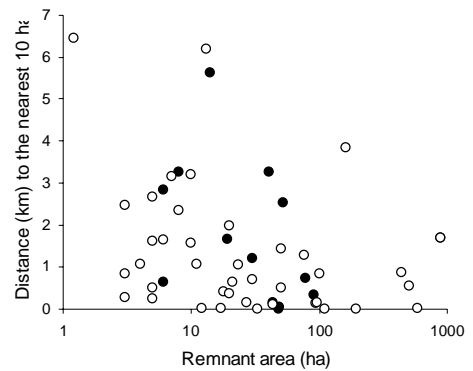
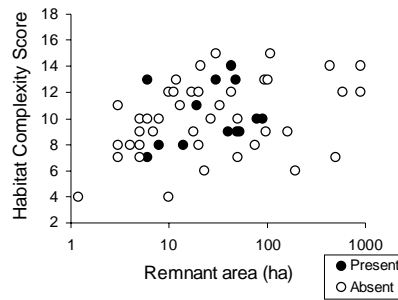
## Pied Butcherbird



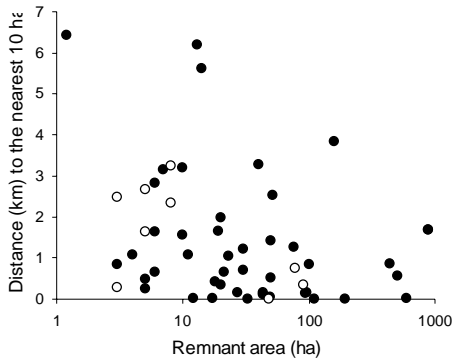
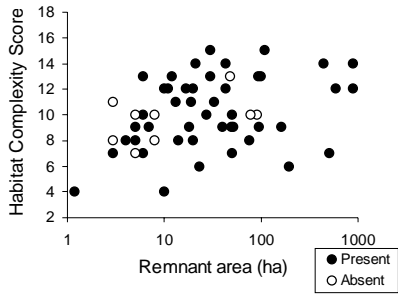
## Pied Currawong



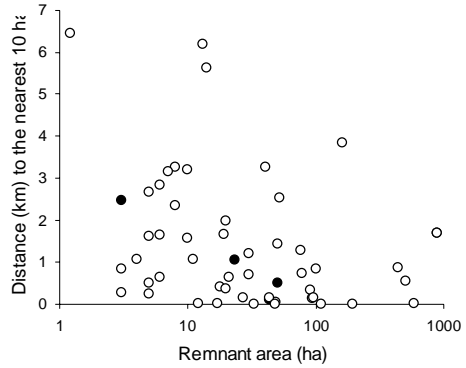
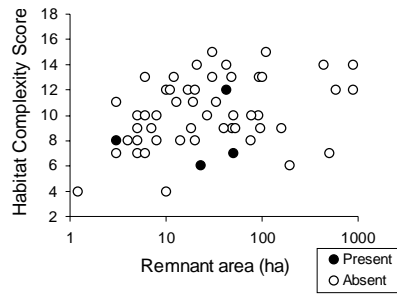
## Dusky Woodswallow



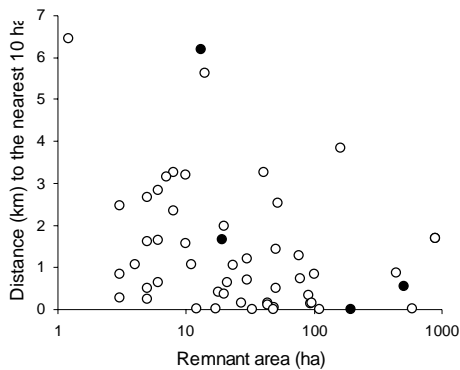
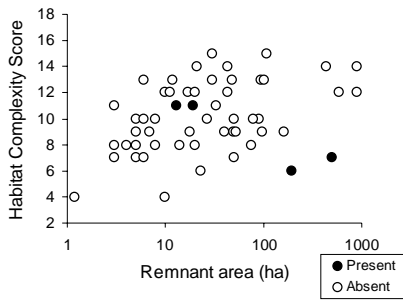
### Australian Raven



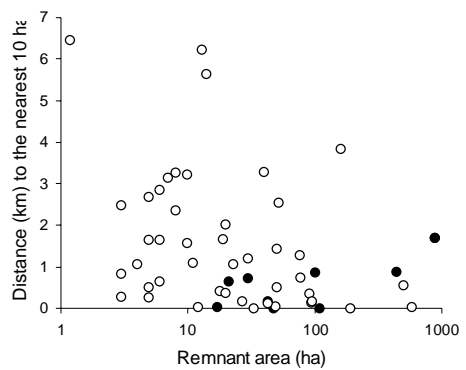
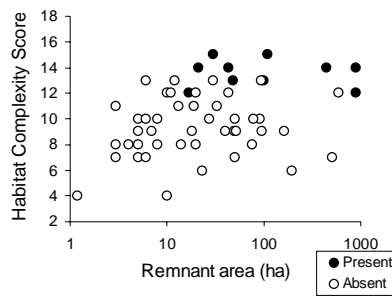
### Little Raven



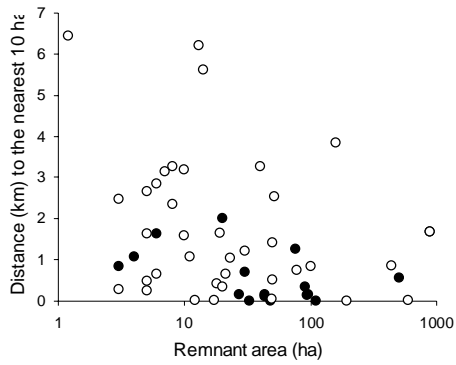
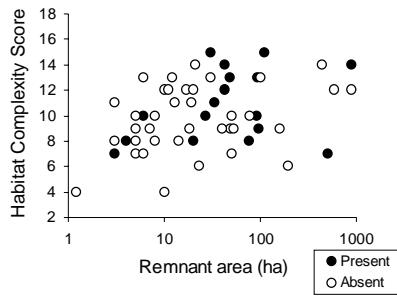
### Grey-crowned Babbler



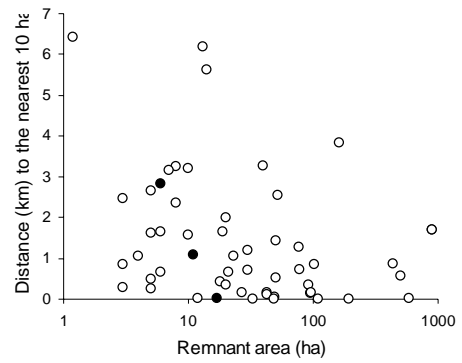
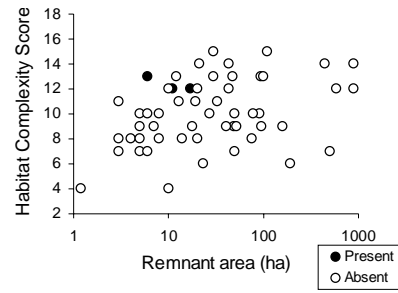
### White-browed Babbler



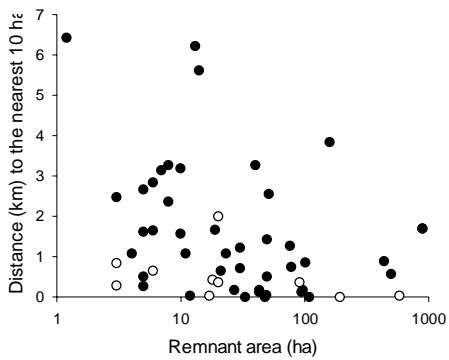
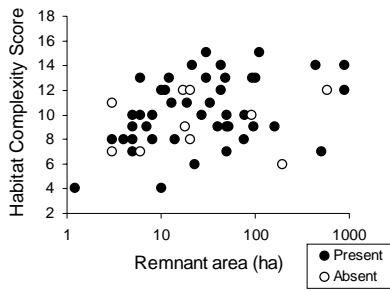
## White-winged Chough



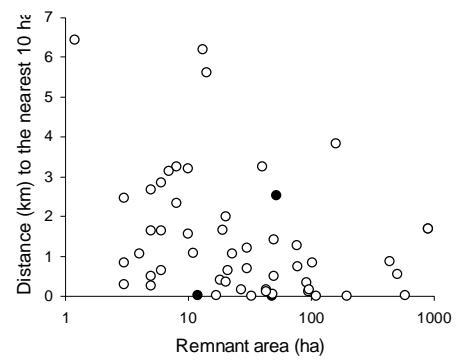
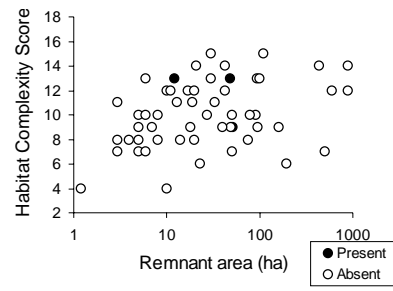
## Painted Button-quail



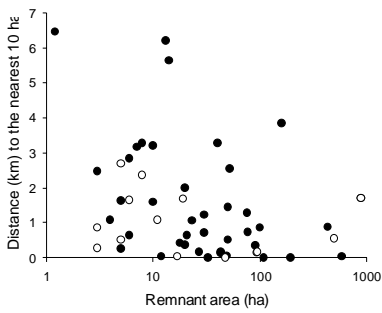
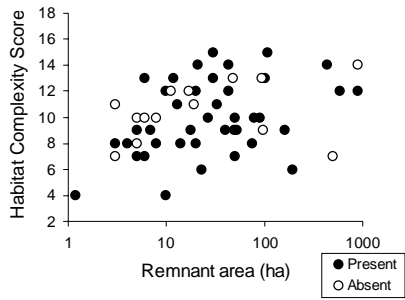
## Laughing Kookaburra



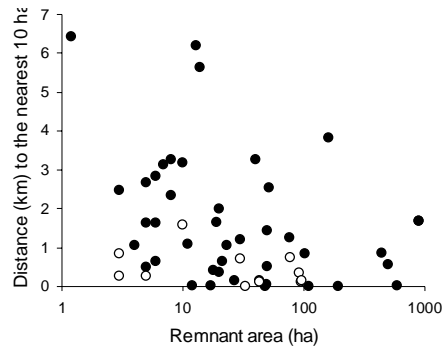
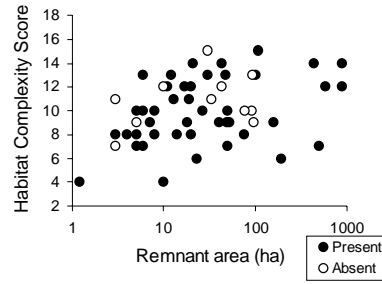
## Sacred Kingfisher



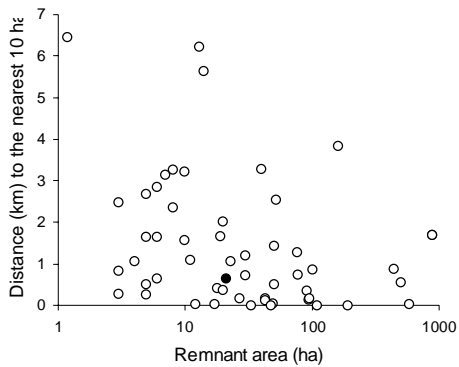
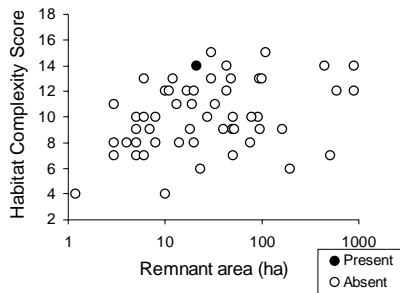
## Sulphur-crested Cockatoo



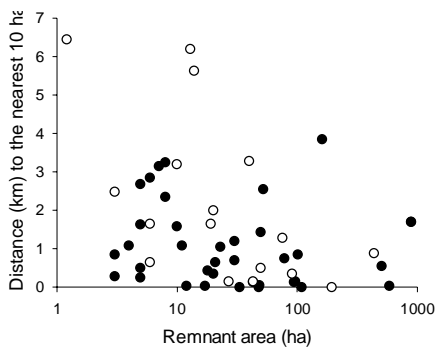
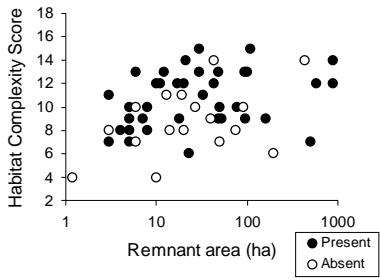
## Galah



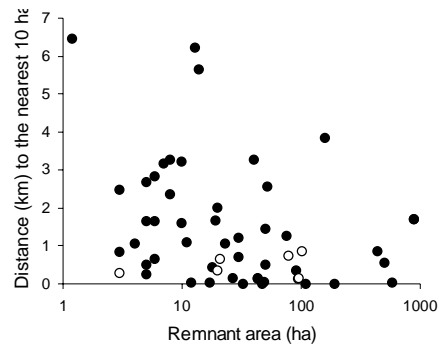
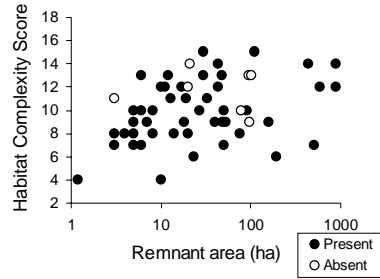
## Little Corella



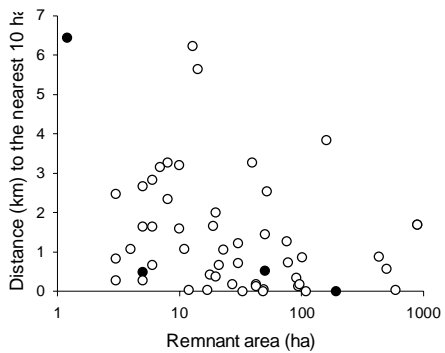
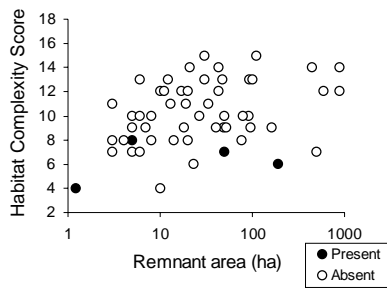
### Crimson Rosella



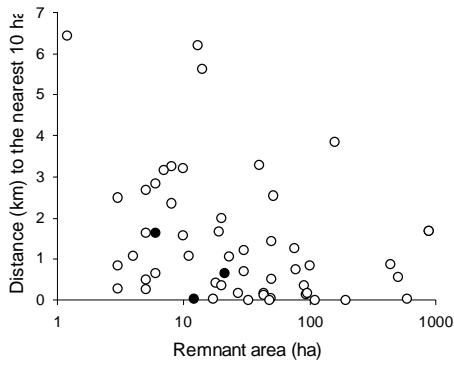
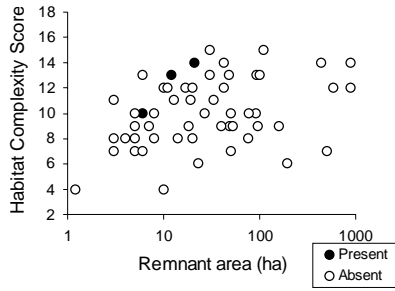
### Eastern Rosella



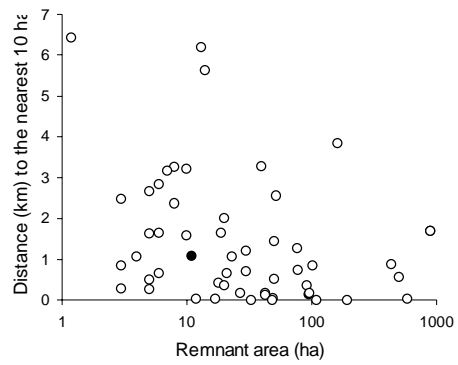
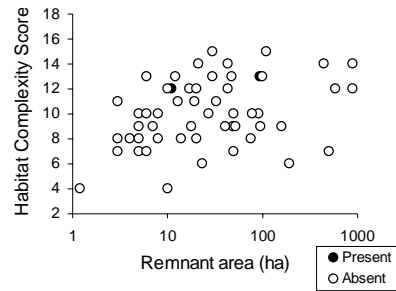
### Superb Parrot



## Fan-tailed Cuckoo



## Brush Cuckoo



## Pallid Cuckoo

