Chapter 9.

Final discussion

As an overall conclusion, the Regent Honeyeater in northern New South Wales occurs in small flocks each year, breeds successfully in some years, but does not breed in the region in others, and shows an ecological repertoire that is typical of other honeyeaters that have not declined to the same extent as Regent Honeyeaters. This thesis provides detailed baseline data on the population size, habitat and resource selection, breeding success, and nest site selection of Regent Honeyeaters in northern New South Wales upon which management and recovery of the species can be based (see Appendix 9). Further ecological research to refine these conservation objectives should be considered.

Population size

Regent Honeyeaters were usually found in small breeding aggregations of up to 20 birds, although they sometimes occurred as solitary breeding pairs (Chapter 8), and occasionally in non-breeding flocks of between two and 24 birds. In 1994 the two largest non-breeding flocks recorded for several decades congregated on the abundant lerp and honeydew resources at Howes Valley (151 birds) and the Warrumbungle National Park (47 birds). There was little indication whether these flocks were due to population increases or just concentrations of birds in a small area where resources were abundant during drought.

Regent Honeyeaters are hard to locate, and a flexible survey approach, incorporating standardised bi-monthly counts at many sites, as well as opportunistic searches elsewhere during the breeding season was used in this study. Using this approach, the minimum population for the Bundarra-Barraba region is estimated at 100 birds. This is higher than the previous estimate of 30 birds by Ley and Williams (1994). The number of birds fluctuated between years, from as few as four birds in 1994/95, to 101 birds in the 1995/96 breeding season.

The mean density of Regent Honeyeaters in their preferred Mugga Ironbark woodland was 0.13 birds per hectare (Chapter 2). About 4200 ha of this habitat remains in the region, therefore, a maximum of 520 birds could occur in this type of habitat. However, this figure is inflated, because

most unsurveyed Mugga Ironbark remnants are smaller and more degraded than known Regent Honeyeater sites.

The relatively short survey period (two years), and the high levels of variance in the survey data, provided no indication whether the Bundarra-Barraba population is increasing, stable, or declining. Furthermore, the small number of birds scattered across a large region, combined with high annual fluctuations of bird numbers at known Regent Honeyeater sites, makes population monitoring difficult, compared to sedentary species. To produce a Regent Honeyeater population viability model, the information gathered in this study on population size, and breeding success and output needs to be supplemented with data on adult and juvenile survivorship. This can be achieved by catching birds just before the beginning of the breeding season, to look at the age structure of the population. By knowing the proportion of adult and juvenile birds in a flock, the survivorship of juveniles in their first year of life can be estimated. Radio-telemetry studies may provide information about adult survivorship between breeding seasons, provided that the transmitters had sufficient battery life to last for twelve months.

Regent Honeyeaters use habitats that support the highest abundance and species richness of other birds, and hence they could be considered as a high *S* species, which is a species only found in communities with large numbers of taxa (Diamond 1975a, Chapter 2). Therefore, the protection and management of Regent Honeyeater habitats has important benefits for the conservation of regional avian biodiversity. Bird surveys should be continued in the Bundarra-Barraba region, not only to gain further understanding of the long-term variability in Regent Honeyeater numbers, but to also examine changes in the populations of potentially threatened woodland bird species. This is akin to Mac Nally's (1997) suggestion that ornithologists should provide 'benchmark' woodland bird population densities, against which changes can be measured at later dates.

Habitat selection

Landscape attributes

Regent Honeyeaters were found only on Crown, leasehold, and freehold land in the Bundarra-Barraba region, and usually in small to medium-sized patches. They were not found in the two large (> 1000 ha) NPWS reserves which were in unproductive woodland that supported low densities of nectarivorous birds (Chapter 2). Off-reserve habitat conservation is, therefore,

essential to protect Regent Honeyeaters from regional extinction. This needs to tackle the wide variation in landholder attitudes to management of remnant native vegetation. Effective extension programs are needed in the Bundarra-Barraba region to foster the role of landholder stewardship (Binning 1997, Curtis 1997), and to promote the economic value of retaining remnant vegetation. Where there is an economic cost, some form of assistance may be necessary.

Habitat type

Box/Ironbark woodland was the habitat most often used by Regent Honeyeaters in the Bundarra-Barraba region, and this study provides strong support to the notion that Mugga Ironbarks are the most important resource for Regent Honeyeaters, as foraging and nesting trees (Webster and Menkhorst 1992). The affinity that Regent Honeyeaters show for Mugga Ironbark may be one of the main reasons for their decline, because Mugga Ironbarks have been preferentially removed for timber in the Bundarra-Barraba region, as it has in most of southeastern Australia (Robinson and Traill 1996). Only four percent of the remaining tree cover in the Bundarra-Barraba region is Mugga Ironbark woodland (NSW NPWS North West Slopes and Northern Tablelands Database 1995). Therefore, for Regent Honeyeaters to survive, the conservation and management of this scarce woodland type from further degradation has to be addressed. This will require a reduction in timber removal, improved management on Crown Reserves, fencing to permit regeneration, and replanting in suitable areas.

Despite their preference for Box/Ironbark woodland, Regent Honeyeaters are more generalised in their habitat requirements than reported by Webster and Menkhorst (1992). In addition to Box/Ironbark woodland, they also use woodland habitats such as Box/Gum, Box/Stringybark, and dry plateau complex woodland (Chapter 2). Riparian gallery forest was used by Regent Honeyeaters as foraging and breeding habitat in some years (Chapter 8). Furthermore, it supported the highest abundance and species richness for all bird species (Chapter 2). The importance of riparian gallery forest to Regent Honeyeaters and general avian diversity was not appreciated before this study, and augments the growing body of research on riparian biodiversity and conservation (e.g., Fisher and Goldney 1997).

Further research needs to be carried out on riparian gallery forest in the Bundarra-Barraba region, which supports threatened bird species such as the Barking Owl *Ninox connivens*. The impacts of grazing and streambed sand extraction have to be reduced within substantial stands of riparian

forest, such as the Gwydir River breeding site at Torryburn, to allow regeneration of River Sheoaks and riparian eucalypts. Fencing of the narrow and highly fragmented bands of riparian vegetation along the Gwydir and Namoi catchments, will allow natural tree regeneration, and with replanting will, improve habitat connectivity. More continuous riparian vegetation provides resources, especially during droughts, and may assist movement of birds between breeding and non-breeding habitats. Additional benefits will be in water quality.

Tree species selection

Regent Honeyeaters mainly used Mugga Ironbarks for food and nesting sites (Chapter 5). However, thirty five other plant species provided food, nesting sites, and roosts for Regent Honeyeaters in Box/Ironbark woodland and other habitats in northern New South Wales (Oliver 1998). Regent Honeyeaters prefer to feed and build their nests in tall, rough-barked tree species with large canopies, particularly Mugga Ironbarks, Stringybarks, Angophoras, and River Sheoaks (Chapter 8). At Howes Valley non-breeding birds foraged in Grey Gums and Forest Red Gums that were more than 30 m tall (Chapter 5). Management of forest and woodland used by Regent Honeyeaters has to restrict the removal of mature trees, which was also the contention of Webster and Menkhorst (1992). This is likely to provide benefits to hollow-dwelling animals as well. Furthermore, mature trees take a long time to be replaced through natural regeneration and planting.

Land management for Regent Honeyeater conservation, and the maintenance of general woodland biodiversity, has to integrate all habitat types used by Regent Honeyeaters, as well as all tree species within these habitats. Habitat modeling revealed that Regent Honeyeater sites are showing signs of degradation, particularly from high numbers of mistletoes and low shrub cover. Given their fidelity to a small number of sites, arresting habitat degradation is imperative. At sites where mistletoes are killing important food and nesting trees, a proportion of the mistletoes may need to be removed, whilst leaving sufficient numbers for foraging and nesting opportunities for Regent Honeyeaters. Planting understorey shrubs may be another short-term management option, because tree planting and fencing of remnants will not achieve results for some time.

Resource selection

Regent Honeyeaters focus their foraging on nectar, when it is abundant in their habitat, which has been the view of previous studies (e.g., Franklin *et al.* 1989, Webster and Menkhorst 1992).

However, this study demonstrates that Regent Honeyeaters use other foods from a broad range of plants when nectar is scarce (Chapter 5). In 1994 and 1995, they mainly ate lerp, honeydew, and insects from a wide variety of plants. This has implications for the species of plants that should be protected and managed for the Regent Honeyeater. The previously held view that they only require nectar-yielding eucalypts, particularly Mugga Ironbark, Yellow Box and White Box, would be inadequate to save them, especially in times of drought, when other species of plants provide their main source of food. Furthermore, their offspring require insects, and lerp from eucalypts and shrubs that are not good nectar producers (Chapter 6). The broad range of foods and plants used by Regent Honeyeaters necessitates the broad approach to conservation outlined above under the habitat selection.

Foraging and aggressive behaviour

Regent Honeyeaters behave like other honeyeaters; they spend a similar amount of time feeding, resting, breeding and fighting as other species (Chapter 4). I found no evidence that they normally spent excessive amounts of time finding food, or that their foraging effort was affecting breeding and other activities. However, non-breeding birds did spend up to 80% of their time feeding in 1995, suggesting that food may sometimes be limiting, especially in autumn and winter when few trees are flowering, and lerp is not abundant. Further investigation into foraging behaviour in the non-breeding season should be done in conjunction with radio-telemetry studies of post-breeding birds.

Regent Honeyeaters spent less than two percent of their time in aggressive competition for food and nesting sites (Chapter 4 and 7), which concurs with the results of Webster and Menkhorst (1992), but contrasts with the high aggression levels measured from the limited studies of Davis and Recher (1993) and Ford *et al.* (1993). In the latter case, the high aggression levels were measured for two breeding pairs that nested in flowering Mugga Ironbarks, from which many large honeyeaters were taking nectar.

Regent Honeyeaters mostly chased conspecifics and other nectarivores, indicating that the species is capable of defending itself. There were only a few interactions recorded between Regent Honeyeaters and Noisy Miners, which are renowned for displacing small woodland birds from remnant vegetation in northeastern Victoria (Grey *et al.* 1997). The low aggression rates during the course of this study were probably influenced by the low flowering levels, compared to those

during Davis and Recher's (1993) observations. In "boom" flowering years, Regent Honeyeaters and other small nectarivores are probably aggressively excluded from the best nectar sources by large honeyeaters such as the Noisy Friarbird. Alternatively, smaller species simply avoid trees with the highest abundance of flowers and large honeyeaters, to reduce the likelihood of aggressive encounters. However, I found no evidence to suggest that controlling the numbers of Noisy Friarbirds, or Noisy Miners at Regent Honeyeater sites in northern New South Wales is necessary.

Reproductive biology

Regent Honeyeaters displayed breeding behaviour that is typical of other honeyeaters that have been studied. Their reproductive effort and juvenile feeding rate is equal to, or higher than, other non-operative honeyeaters that have been studied (Chapter 7). The feeding rate of juveniles by adults was high, one explanation being that food resources are scarce, and each "feed" comprises only a small amount of food. However, I found no evidence that nest failure or loss of fledglings was caused by lack of food to juveniles.

The overall nest success of Regent Honeyeaters between 1993/94 and 1996/97 was in the upper range recorded for other Australian woodland birds, although there was high annual variability in breeding effort and success (Chapter 8). Parallel variability was recorded for Regent Honeyeaters at two other key breeding sites; Chiltern, Victoria (Collins and Jessup unpubl.), and Capertee Valley, New South Wales (Geering and French 1998), and for Noisy Friarbirds on the Armidale Plateau (H. Ford unpubl.). The high variability in Regent Honeyeater breeding productivity necessitates further monitoring of breeding events at key Regent Honeyeater locations, including the Bundarra-Barraba region.

Hot weather appeared to be a main cause of failure of Regent Honeyeater nests in northern New South Wales. Egg and nestling predation were other likely causes of nest failure, but I found no direct evidence of this occurring. However, nestling predation by a Pied Currawong was witnessed by Ley and Williams in the 1997/98 breeding season. Considering that Regent Honeyeaters show some fidelity for a small number of breeding sites in the Bundarra-Barraba region (Ley *et al.* 1996), the control of nest predators at these sites may need to be considered.

Regent Honeyeaters may use a 'boom or bust' approach to recruitment, whereby they invest a large breeding effort in the atypical years when resources are abundant, and a moderate to low effort in

most other years. In years when nectar is superabundant, breeding and foraging activities may be disrupted by large nectar-feeding birds that saturate the best woodland patches across the region (Davis and Recher 1993). Regent Honeyeaters may no longer be able to exploit fully these exceptional breeding conditions. Davis and Recher (1993), therefore, suggested the need for a reduction in numbers of large aggressive nectarivores in Regent Honeyeater sites. However, this is unlikely to be effective, as the resource-rich remnants would soon be saturated with new birds, once others had been culled, and may be undesirable for species such as lorikeets, which may also have declined. The long-term solution to the management of the Regent Honeyeater is to address and reverse the loss, fragmentation, and degradation of habitat.

Future research and conservation

This study has gathered valuable ecological information for the conservation and management of Regent Honeyeaters, although no clear ecological threatening process was identified (e.g., competition, predation, poor reproduction). However, the continuing loss and degradation of woodlands and forests threatens their future survival. Although the mobility of the species and annual fluctuations in numbers makes it impossible at this stage to assess the current population trend, there is no evidence to suggest that this population, or other populations have stopped declining. Therefore, further research into population dynamics, and the commencement of major land management are needed to halt the likely continued decline of Regent Honeyeaters.

Continuation of research, particularly aimed at age structure of populations, and adult survivorship will eventually provide answers about the viability of the species. The viability of the population in the future will provide a guideline whether on-ground land management objectives are achieving the desired stabilisation or improvement of the Regent Honeyeater population. The integration of research and land management in the Regent Honeyeater recovery process will provide a strong test case for other recovery plans for threatened woodland birds and communities in the future.

My research objectives were achieved in a short time scale and a modest budget, and used the resources of several dedicated local naturalists. However, it will be difficult to sustain research on Regent Honeyeaters, because of the current decline of funding from government research bodies, and a tendency for conservation agencies to neglect research in favour of on-ground action. There is also some scepticism aimed at ecological studies on single endangered species, rather than whole communities. Some ecologists argue that conserving a regionally rare species should take second

priority to saving the majority of more tolerant species (e.g., McIntyre *et al.* 1992), or that single species conservation should be matched by the preservation of national biodiversity (Verner 1986, Kitching 1994). Kitching points out that there is little evidence that preserving single indicator species will lead to assemblages of species being protected. However, the conservation of regional and national biodiversity can be achieved through the broad-scale land management needed for the Regent Honeyeater. Ecologically sensitive land management is essential for sustainable agriculture, and the future survival of the Regent Honeyeater, and the maintenance of woodland avian diversity.

Land management for the endangered "flagship" Regent Honeyeater must be carried out in a broad range of habitats and resources, and across large regional areas. If such broad-scale habitat protection and degradation reversal can be achieved to save the Regent Honeyeater, other threatened woodland biota (e.g., Swift Parrot, Painted Honeyeater, Square-tailed Kite, Turquoise Parrot *Neophema pulchella*, Squirrel Glider *Petaurus norfolcensis*) stand to benefit. Furthermore, cost-effective maintenance of total regional avian diversity can be achieved through the conservation objectives recommended in this thesis, and in the Bundarra-Barraba regional recovery plan (Appendix 9).

References

Altmann, J. (1974). Observational stucy of behaviour: sampling methods. *Behaviour* **49**, 227-267.

Ammon, E. M., and Stacey, P. B. (1997). Avian nest success in relation to past grazing regimes in a montane riparian system. *The Condor* **99**, 7-13.

Andren, H. (1994). Effects of habitat f agmentation on birds and mammals in landscapes with different proportions of suitable habitat: a review. *Oikos* **71**, 355-366.

Armstrong, D. P. (1991a). Nectar depl etion and its implications for honeyeaters in heathland near Sydney. *Australian Journal of Ecology* **16**, 99-109.

Armstrong, D. P. (1991b). Aggressiveness of breeding territorial honeyeaters corresponds to seasonal changes in nectar availability. *Behavioural Ecology and Sociobiology* **29**, 103-111.

Armstrong, D. P. (1992). Correlation between nectar supply and aggression in territorial honeyeaters: causation or coincidence? *Behavioural Ecology and Sociobiology* **30**, 95-102.

Armstrong, D. P., and Pyke, G. H. (1991). Seasonal patterns of reproduction in heathland honeyeaters are not responses to changing nectar availability. *The Auk* **108**, 99-107.

Arnold, G. W. (1988). The effects of habitat structure and floristics on the densities of bird species in Wandoo woodland. *Australian Wildlife Research* **15**, 499-510.

Ashby, E. (1917). Warty Faced Honeyeaters at Wittunga. *Emu* **16**, 193-194.

Austin, M. P. (1991). Vegetation: data collection and analysis. Pp. 37-41 in *Nature Conservation: Cost Effective Biological Surveys and Data Analysis.* Margules, C. R., and Austin, M. P. (eds). CSIRO, Australia.

Austin, M. P., Nicholls, A. O., and Margules, C. R. (1990). Measurements of the realised qualitative niche: environmental niche of five *Eucalyptus* species. *Ecological Monographs* **60**, 161-167.

Barrett, G. W. (1995). *Woodland bird assemblages on the New England Tablelands, northeastern New South Wales.* Ph.D. thesis, University of New England, Armidale N.S.W.

Barrett, G. W., Ford, H. A., and Recher, H. F. (1994). Conservation of woodland birds in a fragmented rural landscape. *Pacific Conservation Biology* **1**, 245-246.

Begon, M., Harper, J. L., and Townsend, C. R. (1990). *Ecology: Individuals, Populations and Communities.* Blackwell Scientific Publications: Melbourne.

Bell, H. L. (1985). The social organisation and foraging behaviour of three syntopic Thornbills *Acanthiza* spp.. Pp. 151-163 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H., and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Bennett, A. F. (1982). The mammals of the Woolsthorpe area, western Victoria, and the changes that have occurred since European settlement. *Victorian Naturalist* **99**, 229-240.

Bennett, A. F., and Ford, L. A. (1997). Land use, habitat change and the conservation of birds in fragmented rural environments: a landscape perspective from the Northern Plains, Victoria, Australia. *Pacific Conservation Biology* **3**, 244-261.

Bentley, J. M., and Catterall, C. P. (1997). The use of bushland, corridors, and linear remnants by birds in southeastern Queensland, Australia. *Conservation Biology* **11**, 1173-1189.

Bersier, L., and Meyer, D. R. (1995). Relationships between bird assemblages, vegetation structure, and floristic composition of mosaic patches in riparian forests. *Revue d'Ecologie; la Terre et al Vie* **50**, 15-33.

Binning, C. E. (1997). Beyond reserves: options for achieving nature conservation objectives in rural landscapes. Pp. 155-168 in *Frontiers in Ecology: Building the Links*. Klomp, N., and Lunt, I. (eds.). Elsevier Science Ltd..

Bolten, A. B., Feinsinger, P., Baker, H. G., and Baker, I. (1979). On the calculation of sugar concentration in flower nectar. *Oecologia* **41**, 301-304.

Bond, H. W., and Brown, W. L. (1979) The exploitation of floral nectar in *Eucalyptus incrassata* by honeyeaters and honeybees. *Oecologia* **44**, 105-111.

Bounds, J., Brookfield, M., and Delahoy, M. (1996). Observations of a breeding colony of Regent Honeyeaters at North Watson, Canberra in 1995-96. *Canberra Bird Notes* **21**, 41-55.

Bradley, D. W. (1985). The effects of visibility bias on time-budget estimates of niche breadth and overlap. *The Auk* **102**, 493-499.

Brigham, R. M., Debus, S. J. S., and Geiser, F. (1998). Cavity selection for roosting and nesting, and roosting ecology of forest-dwelling Australian Owlet-nightjars (*Aegotheles cristatus*). *Australian Journal of Ecology* (in press).

Bryant, D. M., and Tattner, P. (1988). Energetics of the annual cycle of Dippers *Cinclus cinclus*. *Ibis* **130**, 17-38.

Cale, P. (1990). The value of road reserves to the avifauna of the central wheatbelt of Western Australia. *Proceedings of the Ecological Society of Australia* **16**, 359-367.

Campbell, A. J. (1921). Forgotten feathers. *Emu* **20**, 144-149.

Carpenter, F. L., and MacMillen, R. E. (1976). Threshold model of feeding territoriality and test with a Hawaiian honeycreeper. *Science* **194**, 639-642.

Cassels, M. L. (1961). Field notes on the nesting of the Brown Honeyeater. *Australian Bird Watcher* **1**, 174-176.

Catterall, C. P., Green, R. J., and Jones, D. A. (1991). Habitat use by birds across a forest-suburb interface in Brisbane: implication for corridors. Pp. 247-258 in *Nature Conservation 2: The Role of Corridors*. Saunders, D. A., and Hobbs, R. J. (eds.). Surrey Beatty and Sons, Chipping Norton.

Chan, K. (1990). Habitat selection in the White-plumed Honeyeater and Fuscous Honeyeater at an area of sympatry. *Australian Journal of Ecology* **15**, 207-217.

Chapman, T. (1997). Black-chinned Honeyeater. *Nature Australia* **25(11)**, 20-21.

Christidis, L., and Boles, W. E. (1994). *The Taxonomy and Species of Birds of Australia and its Territories. Royal Australasian Ornithologists Union Monograph* **2**. RAOU: Melbourne.

Clarke, M. F. (1984). Co-operative breeding by the Australian Bell Miner *Manorina melanophrys* Latham: a test of kin selection theory. *Behavioural Ecology and Sociobiology* **14**, 137-146.

Clarke, M. F. (1988). The reproductive behaviour of the Bell Miner *Manorina melanophrys*. *Emu* **88**, 88-100.

Clarke, M. F. (1989). The pattern of helping in the Bell Miner (*Manorina melanophrys*). *Ethology* **80**, 292-306.

Clarke, M. F. (1997). A review of studies of the breeding biology of Australian birds from 1986-95: biases and consequences. *Emu* **97**, 283-289.

Clarke, M. F., Grey, M. J., Britton, D. F.., and Loyn, R. H. (1995). 'The Noisy Miner *Manorina melanocephala* and rural diebac ; in remnant eucalypt woodlands'. RAOU Report No. 98.

Cody, M. L. (1985). An Introduction t) Habitat Selection in Birds. Pp. 3-56 in *Habitat selection in birds.* Cody, M. L. (ed.). Academic Press: New York, N.Y..

Cody, M. L. (1994). Mulga bird comm unities. I. Species composition and predictability across Australia. *Australian Journal c f Ecology* **19**, 206-219.

Collar, N. J., Crosby, M. J., and Statter: field, A.. J. (1994). *Birds to Watch 2, The World List of Threatened Birds.* BirdLife Co iservation Series No. **4**. BirdLife International, Cambridge.

Collins, B. G., and Briffa, P. (1982). Seasonal variation of abundance and foraging of three species of Australian honeyeate1 s. *Aust:ralian Wildlife Research* **9**, 557-569.

Collins, B. G., and Briffa, P. (1982). Seasonal and diurnal variations in the energetics and foraging activities of the brown ioneyeater, *Lichmera indistincta. Australian Journal of Ecology* **8**, 103-111.

Collins, B. G., Cary, G., and Packard, C. (1980). Energy assimilation, expenditure and storage by the Brown Honeyeater, *Lich nera indistincta. Journal of Comparative Physiology B* **137**, 157-163.

Collins, B. G., and Clow, H. (1978). Feeding behaviour and energetics of the Western Spinebill, *Acanthorhynchus superciliosis* (Aves: Meliphagidae). *Australian Journal of Zoology* **26**, 269-277.

Collins, B. G., Grey, J., and McNee, S. (1990). Foraging and nectar use in nectarivorous bird communities. *Studies in Avian Biology* **13**, 110-121.

Collins, B. G., Newland, C., and Briffa, P. (1984). Nectar utilisation and pollination by Australian honeyeaters and insects visiting *Calothamnus quadrifidus* (Myrtaceae). *Australian Journal of Ecology* **9**, 353-365

Collins, B. G., and Newland, C. (1986). Honeyeater population changes in relation to food availability in the Jarrah forest of Western Australia. *Australian Journal of Ecology* **11**, 63-76.

Collins, B. G., and Paton, D. C. (1989). Consequences of differences in body mass, wing length and leg morphology for nectar-feeding birds. *Australian Journal of Ecology* **14**, 269-290.

Cork, S. J, and Catling, P. C. (1996). Modelling distributions of arboreal and ground-living mammals in relation to climate, nutrients, plant chemical defences and vegetation structure in the eucalypt forests of southeastern Australia. *Forest Ecology and Management* **85**, 163-175.

Craig, J. L., Stewart, A. M., and Douglas, M. E. (1981). The foraging of New Zealand honeyeaters. *New Zealand Journal of Zoology* **8**, 87-91.

Crawley, M. J. (1993). *Methods in Ecology: GLIM for Ecologists*. Blackwell Scientific Publications, Oxford.

Crome, F. H. J. (1978). Foraging ecology of an assemblage of birds in lowland rainforest in northern Queensland. *Australian Journal of Ecology* **3**, 195-212.

Curtis, A. L. (1997). Landcare, stewardship and biodiversity conservation. Pp. 143-154 in *Frontiers in Ecology: Building the Links*. Klomp, N., and Lunt, I. (eds.). Elsevier Science Ltd..

Davidson, I. R. (1992). Regent Honeyeater feeding on mealy bug honeydew. *Australian Bird Watcher* **14**, 193-194

Davis, W. E. Jr., and Recher, H. F. (1983). Notes on the breeding biology of the Regent Honeyeater. *Corella* **17**, 1-4.

Diamond, J. M. (1975a). Assembly of Species Communities. Chapter 14, Pp. 342-444 in *Ecology and Evolution of Communities*. Cody, M. L., and Diamond, J. M. (eds.). Belknap Press, Harvard.

Diamond, J. M. (1975b). The island di emma: lessons of modern biogeographic studies for the design of natural reserves. *Biological Conservation* **7**, 129-146.

Dow, D. D. (1978). Breeding biology and development of the young of *Manorina melanocephala*, a communally breeding honeyeater. *Emu* **78**, 207-222.

Dunkerley, G. M. (1989). *The Fuscous Honeyeater: food resources and the bird community*. Ph.D. thesis, University of New England, Armidale N.S.W.

East, M. (1982). Time-budgeting by European Robins *Erithacus rubecula*: inter and intrasexual comparisons during autumn, winter and early spring. *Ornis Scandinavica* **2**, 85-93.

Eberhardt, L. L., and Thomas, J. M. (1991). Designing environmental field studies. *Ecological Monographs* **61**, 53-73.

Edwards, H. V. (1925). Birds of a New South Wales garden. *Emu* **24**, 282-286.

Er, K. B. H., Robinson, A. P., and Tidemann, C. R. (1995). Importance of sampling duration and strip width in use of the fixed-width strip transect method for estimation of bird abundance and species diversity. *Corella* **19**, 109-114.

Evans, M. C. (1996). Activity Version 1.0 [Computer Program]. Department of Ecosystem Management, University of New England, Armidale, NSW.

Ferrier, S. (1985). Habitat requiremen s of a rare species, the Rufous Scrub-bird. Pp. 241-248 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H, and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons, Sydney.

Fisher, A. M., and Goldney, D. C. (199?). Use by birds of riparian vegetation in an extensively fragmented landscape. *Pacific Conservation Biology* **3**, 275-288.

Ford, H. A. (1979). Interspecific competition in Australian honeyeaters - depletion of common resources. *Australian Journal of Ecology* **4**, 145-164.

Ford, H. A. (1981). Territorial behaviour in an Australian nectar-feeding bird. *Australian Journal of Ecology* **6**, 131-134.

Ford, H. A. (1983). Relation between number of honeyeaters and intensity of flowering near Adelaide, South Australia. *Corella* **7**, 25-31.

Ford, H. A. (1989). *The Ecology of Birds: an Australian Perspective.* Surrey Beatty and Sons, Chipping Norton.

Ford, H. A. (1993). The role of birds in ecosystems: risks from eucalypt forest fragmentation and degradation. Pp. 33-40 in *Birds and Their Habitats: Status and Conservation in Queensland.* Catterall, C. P., Driscoll, P. V., Hulsman, K., Muir, D., and Taplin, A. (eds.). Queensland Ornithological Society Inc..

Ford, H. A. (1998). Faithfulness to breeding site and birthplace in Noisy Friarbirds *Philemon corniculatus*. *Emu* (in press).

Ford, H. A., and Bell, H. (1981). Density of birds in eucalypt woodland affected to varying degrees by dieback. *Emu* **81**, 202-208.

Ford, H. A., Bridges, L., and Noske, S. (1985). Density of birds in eucalypt woodland near Armidale, north-eastern New South Wales. *Corella* **9**, 97-107.

Ford, H. A., Davis, W. E., Debus, S., Ley, A., Recher, H. F., and Williams, B. (1993). Foraging and aggressive behaviour of the Regent Honeyeater *Xanthomyza phrygia* in northern New South Wales. *Emu* **93**, 277-28 .

Ford, H. A., and Debus, S. (1994). Aggressive behaviour of Red Wattlebirds *Anthochaera carunculata* and Noisy Friarbirds *Philemon corniculatus*. *Corella* **15**, 141-147.

Ford, H. A., Huddy, L., and Bell, H. (1990). Seasonal changes in foraging behaviour of three passerines in Australian eucalypt woodland. *Studies in Avian Biology* **13**, 245-253.

Ford, H. A., Noske, S., and Bridges, L. (1986). Foraging of birds in eucalypt woodland in north-eastern New South Wales. *Emu* **86**, 168-179.

Ford, H. A., and Paton, D. C. (1977). The comparative ecology of ten species of honeyeaters in South Australia. *Australian Journal of Ecology* **2**, 399-407.

Ford, H. A., and Paton, D. C. (1982). Partitioning of nectar sources in an Australian honeyeater community. *Australian Journal of Ecology* **7**, 149-159.

Ford, H. A., and Paton, D. C. (1985). Habitat selection in Australian Honeyeaters, with special reference to nectar productivity Pp. 367-388 in *Habitat selection in birds.* Cody, M.L. (ed.). Academic Press: New York, N.Y..

Ford, H. A., and Paton, D. C. (1986). Introduction. Pp. 7-8 in *The Dynamic Partnership: Birds and Plants in Southern Australia.* Ford, H. A. and Paton, D. C. (eds.). Woolman Government Printer, South Australia.

Ford, H. A., and Pursey, J. F. (1982). Status and feeding of the Eastern Spinebill *Acanthorhynchus tenuirostris* a New England National Park, north-eastern NSW. *Emu* **82**, 203-211.

Forshaw, J. M. (1981). *Australian Parrots, 2nd edition.* Lansdowne, Melbourne.

Franklin, D. (1996). The status of the Black-eared Miner *Manorina melanotis* in New South Wales. RAOU Report No. **99**.

Franklin, D. C. (1997). The foraging behaviour of avian nectarivores in a monsoonal Australian woodland over a six-month period. *Corella* **21**, 48-54.

Franklin, D. C., and Alley, J. C. (1995). Some observations of foraging and social behaviour of the Striped Honeyeater in south-western New South Wales. *Australian Bird Watcher* **16**, 71-74.

Franklin, D. C., and Menkhorst, P.W. (1988a). The bare facial skin of the Regent Honeyeater. *Australian Bird Watcher* **7**, 237-238.

Franklin, D. C., and Menkhorst, P. W. (1988b). A history of the Regent Honeyeater in South Australia. *South Australian Ornithologist* **30**, 141-145.

Franklin, D. C., Menkhorst, P. W., and Robinson, J. L. (1989). Ecology of the Regent Honeyeater *Xanthomyza phrygia*. *Emu* **89**, 140-154.

Franklin, D. C., and Robinson, J. L. (1989). Territorial behaviour of a Regent Honeyeater at feeding sites. *Australian Bird Watcher* **13**, 129-132.

Franklin, D. C., Smales, I. J., Miller, M. A., and Menkhorst, P. W. (1995). The reproductive biology of the Helmeted Honeyeater *Lichenostomus melanops cassidix*. *Wildlife Research* **22**, 173-191.

Garnett, S. (ed.) (1992). *Threatened and Extinct Birds of Australia*. RAOU, Melbourne.

Garson, P. J., and Hunter, M. L. Jr. (1979). Effects of temperature and time of year on the singing behaviour of Wrens *Troglodytes troglodytes* and Great Tits *Parus major*. *Ibis* **121**, 481-487.

Gaze, P. D., and Clout, M. N. (1983). Honeydew and its importance to birds in Beech forests of South Island, New Zealand. *New Zealand Journal of Ecology* **6**, 33-37.

Geering, D. J., and French, K. (1998). Breeding biology of the Regent Honeyeater in the Capertee Valley NSW. *Emu* **98**, 104-116.

Goodman, R. D. (1973). *Honey flora of Victoria*. Department of Agriculture, Victoria: Melbourne.

Greenberg, R., Caballero, C. M., and Bichier, P. (1993). Defence of homopteran honeydew by birds in the Mexican highlands and other warm temperate forests. *Oikos* **68**, 519-524.

Grey, M. J., Clarke, M. F., and Loyn, R. H. (1997). Initial changes in the avian communities of remnant eucalypt woodlands following a reduction in the abundance of Noisy Miners, *Manorina melanocephala*. *Wildlife Research* **24**, 631-648.

Grubb, T. C. Jr., and Woodrey, M. S. (1990). Sex, age, intraspecific dominance status, and the use of food by birds wintering in temperate-deciduous and cold-coniferous woodlands: a review. *Studies in Avian Biology* **13**, 270-279.

Haskell, D. G. (1995a). A re-evaluation of the effects of forest fragmentation on rates of bird-nest predation. *Conservation Biology* **9**, 1316-1318.

Haskell, D. G. (1995b). Forest fragmentation and nest predation: are experiments with Japanese Quail eggs misleading? *The Auk* **112**, 767-770.

Haylock, J., and Lill, A. (1988). Winter ecological energetics of two passerine bird species in temperate wet forest. *Australian Wildlife Research* **15**, 319-329.

Heatwole, H., and Lowman, M. (1986). *Dieback, death of an Australian landscape*. Reed Books: Frenchs Forest, NSW.

Hertz, P. E., Remsen, J. V. Jr., and Zones, S. I. (1976). Ecological complementarity of three sympatric parids in a Californian oak woodland. *Condor* **78**, 307-316.

Hindwood, K. A. (1935). The Painted Honeyeater. *Emu* **34**, 149-157.

Holmes, R. T., Bonney, R. E. Jr., and Pacala, S. W. (1979). Guild structure of the Hubbard Brook bird community: a multivariate approach. *Ecology* **60**, 512-520.

Holmes, R. T., and Recher, H. F. (1986). Search tactics of insectivorous birds foraging in an Australian eucalypt forest. *The Auk* **103**, 515-530.

Holmes, R. T., and Robinson, S. K. (1981). Tree species preferences of foraging insectivorous birds in a northern hardwood forest. *Oecologia* **48**, 31-35.

Holmes, R. T., Sherry, T. W., and Bennett, S. E (1978). Diurnal and individual variability in the foraging behaviour of American Redstarts (*Setophaga ruticilla*). *Oecologia* **36**, 141-149.

Howe, R. W. (1984). Local dynamics of bird assemblages in small forest habitat islands in Australia and North America. *Ecology* **65**, 1585-1601.

Howe, R. W., Davis, G. J., and Mosca, V. (1991). The demographic significance of "sink" populations. *Biological Conservation* **57**, 239-255.

Hurlbert, S. H. (1984). Pseudoreplication and the design of ecological field experiments. *Ecological Monographs* **54**, 187-211.

Joesph, L. (1977) (ed.). Bird notes. *South Australian Ornithological Association Newsletter*, December 1977, 13-19.

Jongman, R. H. G., ter Braak, C. J. M., and van Tongeren, O. F. R. (eds.) (1995). *Data Analysis in Community and Landscape Ecology*. Cambridge University Press.

Kavanagh, R., P., Shields, J. M., Rechei, H. F., and Rohan-Jones, W. G. (1985). Bird populations of a logged and unlogged forest mosaic at Eden, New South Wales. Pp. 273-281 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. A., Ford, H., and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Keast, A. J. (1968). Seasonal movements in the Australian Honeyeaters (Meliphagidae) and their ecological significance. *Emu* **67**, 159-210.

Keast, A. J. (1976). The origins of adaptive zone utilisations and adaptive radiations, as illustrated by the Australian Meliphagidae. Pp. 71-82 in *Proceedings 16th International Ornithological Congress.*

Kitching, R. L. (1994). Biodiversity - political responsibilities and agendas for research and conservation. *Pacific Conservation Biology* **1**, 279-283.

Knopf, F. L., and Samson, F. B. (1994). Scale perspectives on avian diversity in western riparian ecosystems. *Conservation Biology* **8**, 669-676.

Landsberg, J., Morse, J., and Khanna, P. (1990). Tree dieback and insect dynamics in remnants of native woodlands on farms. *Proceedings of the Ecological Society of Australia* **16**, 149-165.

Lea, A. H., and Gray, J. T. (1936). The food of Australian birds: an analysis of the stomach contents. *Emu* **35**, 251-265.

Ley, A. J. (1990). Notes on the Regent Honeyeater *Xanthomyza phrygia*. *Australian Bird Watcher* **13**, 171-173.

Ley, A. J., Oliver, D. L., and Williams, B. (1996). Observations on colour-banded Regent Honeyeaters *Xanthomyza phrygia*. *Corella* **20**, 88-92.

Ley, A. J., Oliver, D. L., and Williams, M. (1997). Theft of nesting material involving honeyeaters (Meliphagidae). *Corella* **21**, 119-123.

Ley, A. J., and Williams, M. B. (1992). The conservation status of the Regent Honeyeater near Armidale, New South Wales. *Australian Bird Watcher* **14**, 277-281.

Ley, A. J., and Williams, M. B. (1994). Breeding behaviour and morphology of the Regent Honeyeater *Xanthomyza phrygia*. *Australian Bird Watcher* **15**, 366-376.

Lill, A. (1991). Behavioural energetics of overwintering in the Rifleman, *Acanthisitta chloris*. *Australian Journal of Zoology* **39**, 643-654.

Lindenmayer, D. B., Cunningham, R. B., Tanton, M. T., Smith, A. P., and Nix, H. A. (1990). The conservation of arboreal marsupials in the montane ash forests of the Central Highlands of Victoria, south-east Australia: I. Factors influencing the occupancy of tress with hollows. *Biological Conservation* **54**, 111-131.

Longmore, W. (1991). *Honeyeaters and Their Allies of Australia*. National Photographic Index of Australian Wildlife, Harper Collins Publishers, Australia.

Loyn, R. H. (1985). Ecology, distribution and density of birds in Victorian forests. Pp. 33-46 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management*. Keast, A., Recher, H. F., Ford, H, and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Loyn, R. H. (1986). The 20 minute search - a simple method for counting forest birds. *Corella* **10**, 58-60.

Loyn, R. H. (1987). Effects of patch area and habitat on bird abundances, species numbers and tree health in fragmented Victorian forests. Pp. 65-77 in *Nature Conservation: The Role of Remnants of Native Vegetation*. Saunders, D. A., Arnold, G. W., Burbidge, A. A., and Hopkins, A. J. M. (eds. . Surrey Beatty and Sons: Sydney.

Lunney, D., Curtin, A. L., Fisher, D., Ayers, D., and Dickman, C. R. (1997). Ecological attributes of the threatened fauna of New South Wales. *Pacific Conservation Biology* **3**, 13-26.

MacArthur, R. W., and MacArthur, J. W. (1961). On bird species diversity. *Ecology* **42**, 594-598.

MacArthur, R. W., and Pianka, E. R. (1966). On optimal use of a patchy environment. *American Naturalist* **100**, 603-609.

MacArthur, R. W. and Wilson, E. O. (1967). *The Theory of Island Biogeography*. Princeton University Press, Princeton, New Jersey.

Mac Nally, R. C. (1990). The roles of floristics and physiognomy in avian community composition. *Australian Journal of Ecology* **15**, 321-327.

Mac Nally, R. C. (1996). A winters' tale: among-year variation in bird community structure in a south-eastern Australian forest. *Australian Journal of Ecology* **21**, 280-291.

Mac Nally, R. (1997). Population densities in a bird community of a wet sclerophyllous Victorian forest. *Emu* **97**, 253-258.

Mac Nally, R., and McGoldrick, J. M. (1997). Landscape dynamics of bird communities in relation to mass flowering in some eucalypt forests of central Victoria, Australia. *Journal of Avian Biology* **28**, 171-183.

Maher, W. J. (1996). Nestling food and feeding frequencies of the Brown-backed Honeyeater *Ramsayornis modestus* and the Yellow-bellied Sunbird *Nectarinia jugularis* in northern Queensland. *Emu* **96**, 17-22.

Majer, J. D., Recher, H. F., Perriman, W. S., and Achuthan, N. (1990). Spatial variation of invertebrate abundance within the canopies of two Australian eucalypt forests. *Studies in Avian Biology* **13**, 65-72.

Majer, J. D., Recher, H. F., and Postle, A. C. (1994). Comparison of arthropod species richness in New South Wales and Western Australian canopies: a contribution to the species number debate. *Memoirs of the Queensland Museum* **36**, 121-131.

Majer, J. D., Recher, H. F., and Keals, N. (in prep.). Canopy arthropod faunas in fragmented agricultural landscapes.

Major, R. E. (1991). Breeding biology of the White-fronted Chat *Ephthianura albifrons* in a saltmarsh near Melbourne. *Emu* **91**, 236-249.

Mangel, M. (1991). Adaptive walks on behavioural landscapes and the evolution of optimal behaviour by natural selection. *Evolutionary Ecology* **5**, 30-39.

Marchant, S. (1980). Incubation and nestling periods of some Australian birds. *Corella* **4**, 30-32.

Marini, M. A., Robinson, S. K., and Heske, E. J. (1995). Edge effects on nest predation in the Shawnee National Forest, southern Illinois. *Biological Conservation* **74**, 203-213.

Martin, T. E. (1993). Nest predation among vegetation layers and habitat types: revising the dogmas. *The American Naturalist* **141**, 897-913.

Maxson, S. J., and Oring, L. W. (1980) Breeding season time and energy budgets of the polyandrous Spotted Sandpiper *Behaviour* **74**, 200-263.

Mayfield, H. F. (1975). Suggestions for calculating nest success. *The Wilson Bulletin* **87**, 456-466.

McCullagh, P., and Nelder, J. A. (1983). *Generalised Linear Modelling*. Chapman and Hall, London.

McFarland, D. C. (1986a). The organisation of a honeyeater community in an unpredictable environment. *Australian Journal of Ecology* **11**, 107-120.

McFarland, D. C. (1986b). Breeding behaviour of the New Holland Honeyeater *Phylidonyris novaehollandiae*. *Emu* **86**, 161-167.

McFarland, D. C. (1996). Aggression and nectar use in territorial non-breeding New Holland Honeyeaters *Phylidonyris novaehollandiae* in eastern Australia. *Emu* **96**, 181-188.

McFarland, D. C., and Ford, H. A. (1990). The relationship between foraging ecology and social behaviour in Australian honeyeaters. *Proceedings **20th** International Ornithological Congress* 1141-1155.

McFarland, D. C., and Sale, P. F. (1986). Behaviour and ecology of two species of honeyeater. *Corella* **10**, 37-45.

McIntyre, S., and Barrett, G. W. (1992). Habitat variegation, an alternative to fragmentation. *Conservation Biology* **6**, 146-147.

McIntyre, S., Barrett, G. W., Kitching, R. L. and Recher, H. F. (1992). Species triage - seeing beyond the wounded rhinos. *Conservation Biology* **6**, 604-606.

Mellor, J. W. (1919). Regent Honeyeaters - visit to the Adelaide Plains. *South Australian Ornithologist* **4**, 74-76.

Menkhorst, P. (1997). *Regent Honeyeater Recovery Plan 1994-1998*. Department of Natural Resources and Environment in conjunction with the Regent Honeyeater Recovery Team.

Milledge, D. R., and Recher, H. F. (1985). A comparison of forest bird communities on the New South Wales south and mid-north coasts. Pp. 47-52 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management*. Keast, A., Recher, H. F., Ford, H., and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Moore, K. M. (1972). Observations on some Australian forest insects. 29. Effects of clear-felling of trees associated with insect attack. *Australian Zoologist* **17**, 49-58.

Moreno, J., and Hillstrom, L. (1992). Variation in time and energy budgets of breeding Wheatears. *Behaviour* **120**, 11-39.

Morrison, M. L. (1984). Influence of sample size and sampling design on analysis of avian foraging behavior. *Condor* **8(**, 146-150.

Morrison, M. L., Ralph, C. J., and Ve ner, J. (1990). Introduction. *Studies in Avian Biology* **13**, 1-2.

Morton, S. R. (1990). The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. *Proceedings of the Ecological Society of Australia* **16**, 201-213.

Nicholls, A. O. (1989). How to make biological surveys go further with generalised linear models. *Biological Conserva ion* **50**, 51-75.

Norton, D. A., Hobbs, R. J., and Atkii s, L. (1995). Fragmentation, disturbance, and plant distribution: mistletoes in wooilland remnants in the Western Australian wheatbelt. *Conservation Biology* **9**, 426-438.

Noske, R. A. (1983). Communal beh ıviour of Brown-headed Honeyeaters. *Emu* **83**, 38-41.

Noske, R. A. (1985). Huddle-roostin ; behaviour of the Varied Sittella *Daephoenositta chrysoptera* in relation to soci l status. *Emu* **85**, 188-194.

Noske, R. A. (1996). Abundance, zoı ation and foraging ecology of birds in mangroves of Darwin Harbour, Northern Teı ritory. *Wildlife Research* **23**, 443-474.

Oliver, D. L. (1998). Roosting of nor -breeding Regent Honeyeaters *Xanthomyza phrygia*. *Emu* **98**, 65-69.

Oliver, D. L., Quin, B. R., Quin. D. G , Walpole, R. M., and Walpole, S. C. (in prep). Observations of nectar and insect feeding by Painted Honeyeaters *Grantiella picta*.

Osborne, W. S., and Green, K. (1992). Seasonal changes in composition, abundance and foraging behaviour of birds in the Snowy Mountains. *Emu* **92**, 93-105.

Paton, D. C. (1979). *The behaviour and feeding ecology of the New Holland Honeyeater, Phylidonyris novaehollandiae, in Victoria.* Ph.D. thesis: Monash University, Melbourne, Victoria.

Paton, D. C. (1980). The importance of manna, honeydew and lerp in the diets of honeyeaters. *Emu* **80**, 213-226.

Paton, D. C (1982). The diet of the New Holland Honeyeater, *Phylidonyris novaehollandiae*. *Australian Journal of Ecology* **7**, 279-298.

Paton, D. C. (1985a). Do New Holland Honeyeaters *Phylidonyris novaehollandiae* breed regularly in spring and autumn? *Emu* **85**, 130-133.

Paton, D. C. (1985b). Food supply, population structure, and behaviour of New Holland Honeyeaters *Phylidonyris novae hollandiae* in woodland near Horsham, Victoria. Pp. 219-230 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H, and Saunders, D.(eds.). RAOU and Surrey Beatty and Sons: Sydney.

Paton, D. C. (1986a). Interdependence of Australian honeyeaters (Meliphagidae) and nectar-producing plants. *Proceedings 19th International Ornithological Congress* 549-559.

Paton, D. C. (1986b). Honeyeaters and their plants in south-eastern Australia. Pp. 9-19 in *The Dynamic Partnership: Birds and Plants in Southern Australia.* Ford, H. A., and Paton, D. C. (eds.). Woolman, Government Printer, South Australia.

Paton, D. C. (1993). Honeybees in the Australian environment. Does *Apis mellifera* disrupt or benefit the native biota? *Bioscience* **43**, 95-103.

Paton, D. C., and Collins, B. G. (1989). Bills and tongues of nectar-feeding birds: A review of morphology, function and perfo mance, with intercontinental comparisons. *Australian Journal of Ecology* **14**, 473-506.

Pearce, J. L., Burgman, M. A., and Frar klin, D. C. (1994). Habitat selection by Helmeted Honeyeaters. *Wildlife Researc.* **21**, 53-63.

Pearce, J. L., Menkhorst, P., and Burgn an, M. A. (1995). Niche overlap and competition for habitat between the Helmeted H oneyeater and the Bell Miner. *Wildlife Research* **22**, 633-646.

Peters, D. E. (1979). Some evidence f r a dec ine in the population status of the Regent Honeyeater. *Australian Bird Watcher* **8**, 117-123.

Petit, L. J, Petit, D. R., Petit, K. E., and Fleming, W. J. (1990). Annual variation in foraging ecology of prothonotary warble s during the breeding season. *The Auk* **107**, 146-152.

Pleasants, J. M., and Zimmerman, M. (979). Patchiness in the dispersion of nectar resources: evidence for hot and cold spots. *Oecologia* **41**, 283-288.

Poiani, A. (1993a). Social structure an d the development of helping behaviour in the Bell Miner (*Manorina melanop rys*, Meliphagidae). *Ethology* **93**, 62-80.

Poiani, A. (1993b). Bell Miners: what kind of 'farmers' are they? *Emu* **93**, 188-194.

Poiani, A. (1997). Prey delivered to B ll Miner nestlings: is there division of labour among nest attendants? *Emu* **97**, 87-90.

Powers, D. R., and McKee, T. (1994). The effect of food availability on time and energy expenditures of territorial and n on-territorial hummingbirds. *The Condor* **96**, 1064-1075.

Pyke, G. H. (1980). The foraging beh viour of Australian honeyeaters: a review and some comparisons with hummingbird s. *Australian Journal of Ecology* **5**, 343-369.

Pyke, G. H. (1983). Seasonal patterns of abundance of honeyeaters and their resources in heathland areas near Sydney. *Australian Journal of Ecology* **8**, 217-233.

Pyke, G. H. (1985). The relationships between abundances of honeyeaters and their food resources in open forest areas near Sydney. Pp. 65-77 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F, Ford, H, and Saunders, D (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Pyke, G. H. (1989). Effects of flower removal on abundance and behaviour of honeyeaters in heathland near Sydney. *Australian Journal of Ecology* **14**, 415-421.

Pyke, G. H., Christy, M., and Major, R. E. (1996). Territoriality in honeyeaters: reviewing the concept and evaluating available information. *Australian Journal of Zoology* **44**, 297-317.

Pyke, G. H., Pulliam, H. R., and Charnov, E. L. (1977). Optimal foraging: a selective review of theory and tests. *The Quarterly Review of Biology* **52**, 137-154.

Pyke, G. H., and Recher, H. F. (1984). Censusing Australian Birds: a summary of procedures and a scheme for standardisation of data presentation and storage. Pp. 55-63 in *Methods of Censusing Birds in Australia* Davies, S.J.J.F. (ed.). R.A.O.U. Report **7**.

Pyke, G. H., and Recher, H. F. (1986). Relationships between nectar production and seasonal patterns of density and nesting of resident honeyeaters in heathland near Sydney. *Australian Journal of Ecology* **11**, 195-200.

Ramsay, E. P. (1866). The oology of Australia. *Transactions of the Philosophical Society of Australia* **1**, 309-329.

RAOU (1901). Second Day. *Emu* **1**, 47.

Recher, H. F. (1969). Bird species diversity and habitat diversity in Australia and North America. *The American Naturalist* **103**, 75-80.

Recher, H. F. (1971). Sharing of habitat by three congeneric honeyeaters. *Emu* **71**, 147-152.

Recher, H. F. (1977). Ecology of co-existing White-cheeked and New Holland Honeyeaters. *Emu* **77**, 136-142.

Recher, H. F. (1985). Synthesis: a model of forest and woodland bird communities. Pp. 129-135 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H., and Saunders, D.(eds.). RAOU and Surrey Beatty and Sons: Sydney.

Recher, H. F. (1988). Counting terrestrial birds: use and application of census procedures in Australia. *Australian Zoological Review* **1**, 25-45

Recher, H. F. (1989). Foraging segregation of Australian warblers (Acanthizidae) in open forest near Sydney, New South Wales *Emu* **89**, 204-215.

Recher, H. F. (1996). Will Australia's birds survive in the 21st century? *Island* **65**, 82-90.

Recher, H. F. (1998). Costing the environment: agriculture and community responsibility. *Proceedings of the W.A. Landcare Conference 1997* (in press).

Recher, H. F., and Abbott, I. J. (1970). The possible ecological significance of hawking by honeyeaters and its relation to nectar feeding. *Emu* **70**, 90.

Recher, H. F., and Davis, W. E. Jr. (1997). Foraging ecology of a Mulga bird community. *Wildlife Research* **24**, 27-43.

Recher, H. F., and Gebski, V. (1990). Analysis of foraging ecology of eucalypt forest birds: sequential versus single-point observations. *Studies in Avian Biology* **13**, 174-180.

Recher, H. F., and Holmes, R. T. (1985). Foraging ecology and seasonal patterns of abundance in a forest avifauna. Pp. 79-96 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H., and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Recher, H. F., Holmes, R. T., Schulz, M., Shields, J., and Kavanagh, R. (1985). Foraging patterns of breeding birds in eucalypt forest and woodland of south-eastern *Australia. Australian Journal of Ecology* **10**, 399-420.

Recher, H. F, and Majer, J. D. (1994). On the selection of tree species by Acanthizidae in open-forest near Sydney, New South Wales. *Emu* **94**, 239-245.

Recher, H. F., Majer, J. D., and Ford, H. A. (1990). Temporal and spatial variation in the abundance of eucalypt canopy invertebrates: the response of forest birds. *Proceedings **20th** International Ornithological Congress*, 1568-1575.

Recher, H. F., Majer, J. D., and Ganesh, S. (1996). Eucalypts, arthropods and birds: on the relation between foliar nutrients and species richness. *Forest Ecology and Management* **85**, 177-195.

Recher, H. F., Rohan-Jones, W. and Smith, P. (1980). Effects of the Eden woodchip industry on terrestrial vertebrates with recommendations for management. *Forestry Commission of NSW Research Note No.* **42**.

Redpath, S. M. (1995). Impact of habitat fragmentation on activity and hunting behavior in the tawny owl *Strix aluco. Behavioural Ecology* **6**, 410-415.

Reid, N. (1986). Pollination and seed dispersal of mistletoes (Loranthaceae) by birds in southern Australia. Pp. 64-84 in *The Dynamic Partnership: Birds and Plants in Southern Australia.* Ford, H. A., and Paton, D. C. (eds.). Woolman Government Printer, South Australia.

Reid, N., Yan, Z., and Fittler, J. (1994). Impact of mistletoes (*Amyema miquelii*) on host (*Eucalyptus blakelyi* and *Eucalyptus melliodora*) survival and growth in temperate Australia. *Forest Ecology and Management* **70**, 55-65.

Robbins, C. S. (1981). Effect of time of day on bird activity. *Studies in Avian Biology* **6**, 275-286.

Robinson, D. (1991). Threatened birds in Victoria: their distributions, ecology and future. *Victorian Naturalist* **3**, 67-77.

Robinson, D. (1993). *Vale* Toolern Vale: the loss of our woodland birds. *Wingspan* **9**, 1-3, 20-21.

Robinson, D. (1994). *Research Plan for Threatened Woodland Birds of Southeastern Australia.* Arthur Rylah Institute for Environmental Research Technical Report Series No. 133. Department of Conservation and Natural Resources, Victoria

Robinson, D., and Traill, B. J. (1996). Conserving woodland birds in the wheat and sheep belts of southern Australia. R.A.O.U. Conservation Statement **10**.

Rotenberry, J. T. (1985). The role of habitat in avian community composition: physiognomy or floristics?. *Oecologia* **67**, 213-217.

Runciman, D. (1996). Activity budget of non-breeding Helmeted Honeyeaters. *Emu* **96**, 62-65.

Saunders, D. A. (1977). The effect of agricultural clearing on the breeding success of the White-tailed Black Cockatoo. *Emu* **77**, 180-184.

Saunders, D. A. (1980). Food and movements of the Short-billed form of the White-tailed Black Cockatoo. *Australian Wildlife Research* **7**, 257-269.

Saunders, D. A. (1989). Changes in the avifauna of a region, district and remnant as result of fragmentation of native vegetation: the Wheatbelt of Western Australia. *Biological Conservation* **50**, 99-135.

Saunders, D. A. (1993). The effect of habitat fragmentation on regional bird populations: lessons from the Western Australian wheatbelt. Pp. 23-32 in *Bird and Their Habitats: Status and Conservation in Queensland.* Catterall, C. P., Driscoll, P. V., Hulsman, K., Muir, D., and Taplin, A. (eds.). Queensland Ornithological Society Inc..

Saunders, D. A., and Curry, P. J. (1990). The impact of agricultural and pastoral industry on birds in the southern half of Western Australia: past, present and future. *Proceedings of the Ecological Society of Australia* **16**, 303-321.

Schodde, R. L., Mason, I. J., and Christidis, L. (1992). Regional, age and sexual differentiation in the Regent Honeyeater *Xanthonyza phrygia*. *Corella* **16**, 23-28.

Schodde, R. L., and McKean, J. L. (1976). The relations of some monotypic genera of Australian oscines. *Proceedings 16th International Ornithological Congress,* 530-541.

Shields, J. M., Kavanagh, R. P., and Roman-Jones, W. G. (1985). Forest avifauna of the Upper Hastings River. Pp. 55-64 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H, and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Shields, J. M., and Recher, H. F. (1984). Breeding birds censuses: an evaluation of four methods for use in schlerophyll forest. *Corella* **8**, 29-41.

Smith, P. (1985). Woodchip logging and birds near Bega, New South Wales. Pp. 259-271 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H., and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Smith, P., and Smith, J. (1994). Histor cal change in the bird fauna of western New South Wales: ecological patterns and c ɔnservation implications. Pp. 123-148 in *Future of the Fauna of Western New South W ıles.* Lunney, D., Hand, S., Reed, P. and Butcher, D. (eds.). Transactions of the Roy ıl Society of New South Wales, Surrey Beatty and Sons: Sydney.

Specht, R. L. (1972). *The Vegetation ıf South Australia 2nd edition.* A.B. James, Government Printer, Adelaide.

Specht, R. L. (1981). Ecophysiologica principles determining the biogeography of major vegetation formations in Australia. Pp. 299-334 in *Ecological Biogeography of Australia.* Keast, A. (ed.). Junk, the Hagı e.

Stokes, A. L. (1995). *Habitat selectio.ı and foraging behaviour by two species of sympatric treecreeper (Climacteridae).* P ı.D. thesis, University of New England, Armidale, NSW.

Straw, J. A., Wakely, J. S., and Hudgin: , J. E. (1986). A model for environmental management of diurnal habitat for American wo ɔdcock n Pennsylvania. *Journal of Wildlife Management* **50**, 378-383.

Sutton, J. (1926). A trip to Kangaroo sland. *South Australian Ornithologist* **8**, 253-272.

SYSTAT for Windows (1992). Statist cs, Version 5.E. 1992. SYSTAT Inc., Evanston. 750pp.

Szaro, R. C., Brawn, J. D., and Balda, F.. P. (1990). Yearly variation in resource-use behaviour by Ponderosa Pine forest birds. *Studies in Avian Biology* **13**, 226-236.

Terrill, S. E., and Rix, C. E. (1950). T ıe birds of South Australia - their distribution and habitat. *South Australian Ornithologist* **3**, 334-340.

Tidemann, S. C. (1986). Breeding in three species of fairy-wrens (*Malurus*): do helpers really help? *Emu* **86**, 131-138.

Verbeek, N. A. M. (1964). A time and energy budget study of the Brewer Blackbird. *The Condor* **66**, 70-74.

Verner, J. (1965). Time budget of the male Long-billed Marsh Wren during the breeding season. *The Condor* **67**, 125-139.

Verner, J. (1986). Summary: predicting effects of habitat patchiness and fragmentation - the researchers viewpoint. Pp. 327-329 in *Wildlife 2000: Modelling habitat relationships of terrestrial vertebrates*. Verner, J., Morrisson, M. J., and Ralph, C. J. (eds.). The University of Wisconsin Press, Madison, Wisconsin.

Weathers, W. W., Paton, D. C., and Seymour, R. S. (1996). Field metabolic rate and water flux of nectarivorous honeyeaters. *Australian Journal of Zoology* **44**, 445-460.

Webster, R., and Menkhorst, P. W. (1992). *The Regent Honeyeater (Xanthomyza phrygia): population status and ecology in Victoria and New South Wales*. Arthur Rylah Institute for Environmental Research Technical Report Series Number 126. Department of Conservation and Environment, Melbourne.

Wheeler, J.R. (1960). The RAOU camp out at Kangaroo Island, South Australia, 1959. *Emu* **60**, 265-280.

White, H. L. (1909). Warty-faced Honeyeaters and Friarbirds. *Emu* **9**, 93-94.

White, T. C. R. (1969). An index to measure weather-induced stress of trees associated with outbreaks of psyllids in Australia. *Ecology* **50**, 905-909.

Wiens, J. A. (1984). Resource systems, populations, and communities. Pp. 397-436 in *A New Ecology: Novel Approaches to Interactive Systems*. Price, P. W., Slobodchikoff, C. N. and Gaud, W. S. (eds.). John Wiley and Sons: New York.

Wiens, J. A., and Rotenberry, J. T. (1981). Habitat associations and community structure of birds in shrubsteppe environments. *Ecological Monographs* **51**, 21-41.

Woinarski, J. (1985). Breeding biology and life history of small insectivorous birds in Australian forests: response to a stable environment? *Proceedings of the Ecological Society of Australia* **14**, 159-168.

Woinarski, J. C. Z., and Cullen, J. M. (1984). Distribution of invertebrates on foliage in forests of south-eastern Australia. *Australian Journal of Ecology* **9**, 207-232.

Woinarski, J. C. Z., Cullen, J. M., Hull, C., and Nayudu, R. (1989). Lerp-feeding in birds: a smorgasbord experiment. *Australian Journal of Ecology* **14**, 227-234.

Woinarski, J. C. Z., and Wykes, B. J. (1983). Decline and extinction of the Helmeted Honeyeater at Cardinia Creek. *Biological Conservation* **27**, 7-21.

Wykes, B. J. (1982). *Resource partitioning and the role of competition in structuring Lichenostomus honeyeater (and Manorina melanophrys) communities in southern Victoria.* Ph.D. thesis, Monash University, Melbourne.

Wykes, B. J. (1985). The Helmeted Honeyeater and related honeyeaters of Victorian woodlands. Pp. 205-217 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management.* Keast, A., Recher, H. F., Ford, H, and Saunders, D. (eds.). RAOU and Surrey Beatty and Sons: Sydney.

Wyndham, E. (1982). Movements and breeding seasons of the Budgerigar. *Emu* **82**, 276-282.

Yahner, R. H. (1988). Changes in wildlife communities near edges. *Conservation Biology* **2**, 333-339.

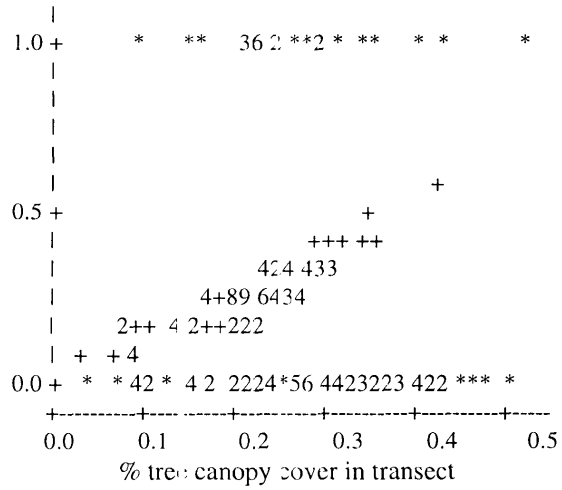
Zann, R. A., Morton, S. R., Jones, K. R., and Burley, N. T. 1995. The timing of breeding by Zebra Finches in relation to rainfall in central Australia. *Emu* **95**, 208-222.

Zar, J. H. (1984). *Biostatistical analysis - 2nd edition.* Prentice-Hall International, Inc., New Jersey.

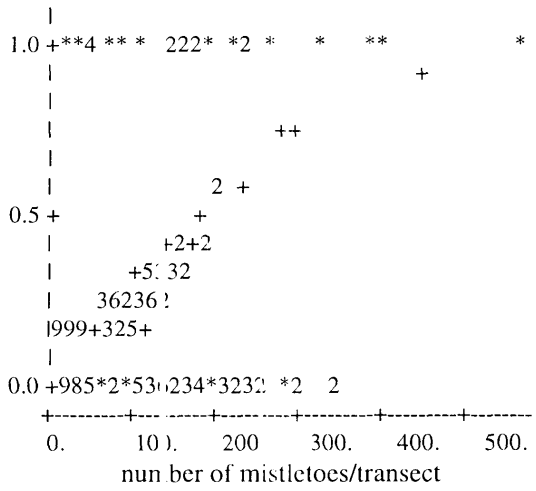
Appendices

Appendix 1. GLIM 4 (Crawley 1993) binary response curves of significant microhabitat variables from recently-occupied transect model. (* = explanatory value, + = estimated probability of Regent Honeyeater occurrence, numbers next to + or * = number of cases with the same value). Y axes of all response graphs represent the probability of RHE occurrence.

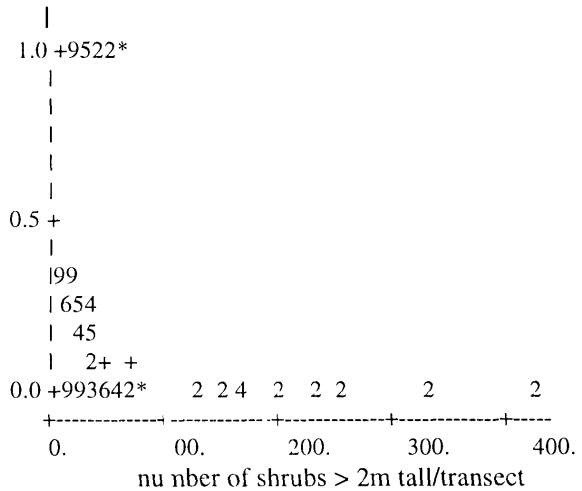
1.1 pcan (% canopy cover)



1.2 mt (no. mistletoes)

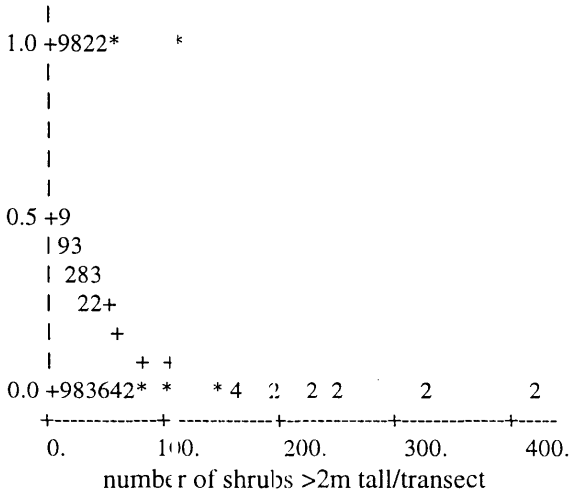


1.3 s2 (no. of shrubs >2m tall)

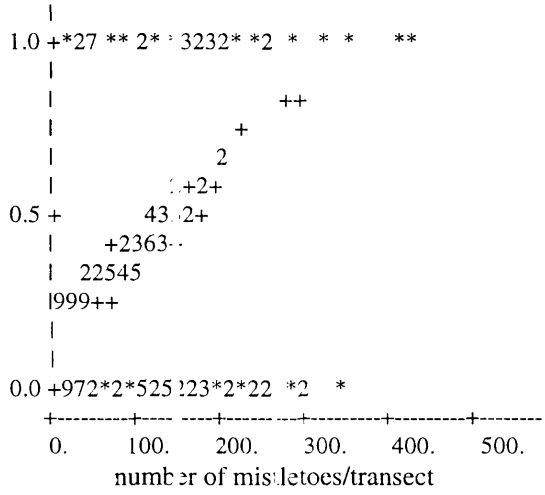


Appendix 2. Binary response curves of significant microhabitat variables from recently and historically-occupied transect model.

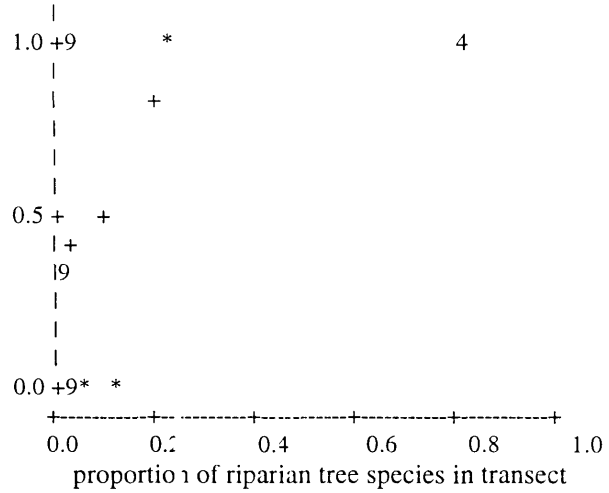
2.1 s2 (no. of shrubs >2m tall)



2.2 mt (no. of mistletoes)

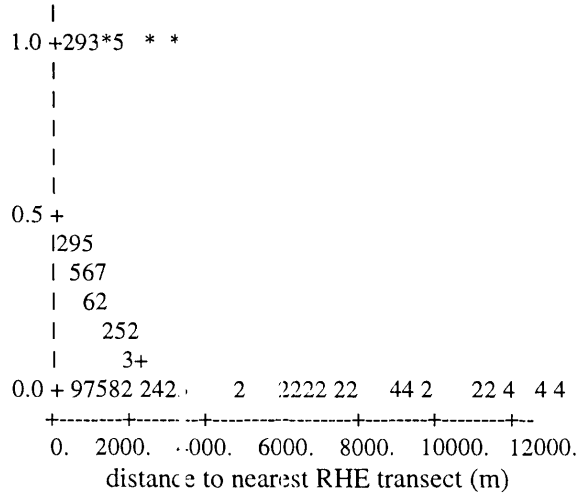


2.3 prip (proportion of riparian tree species)

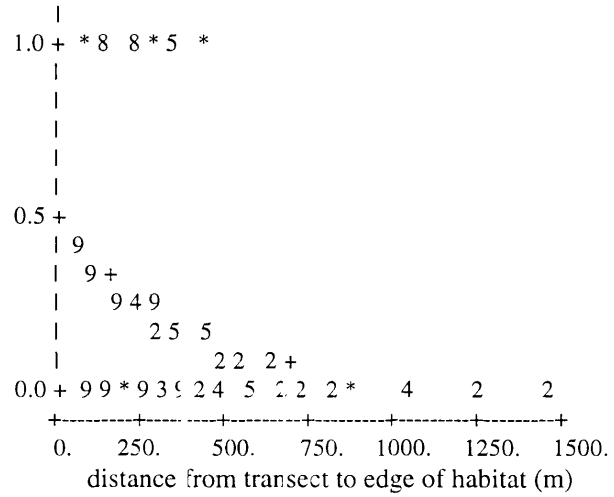


Appendix 3. Binary response curves for significant landscape variables from recently-occupied transect model

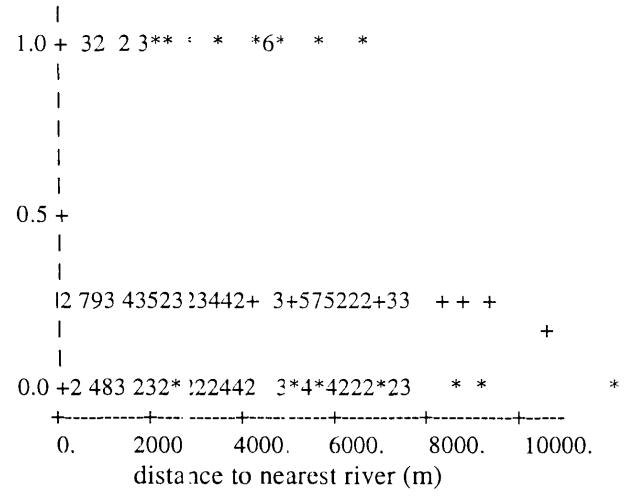
3.1 nrh (distance to nearest Regent Honeyeater transect)



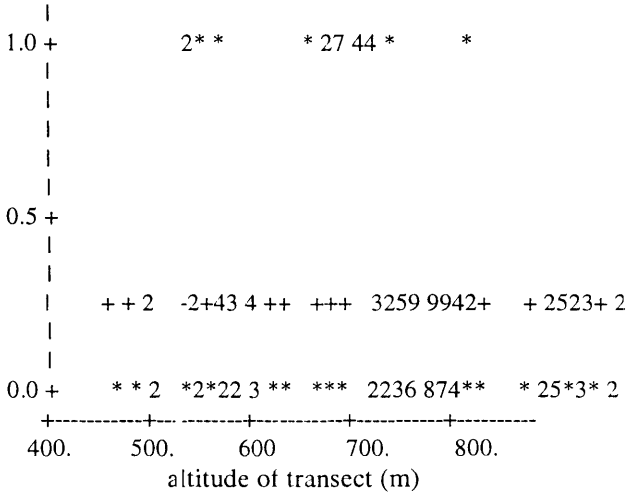
3.2 ped (distance to patch edge)



3.3 riv (distance to river)

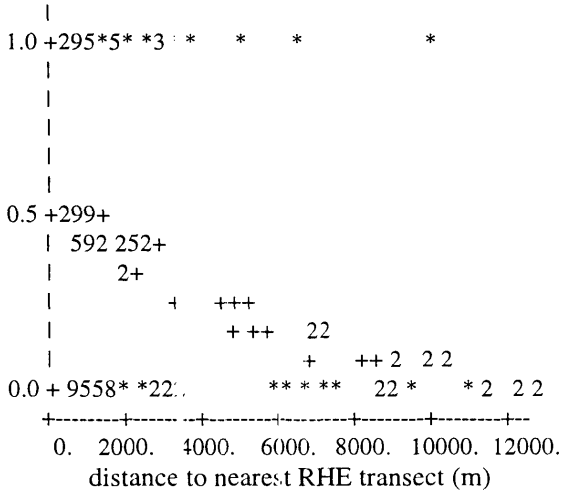


3.4 alt (altitude)

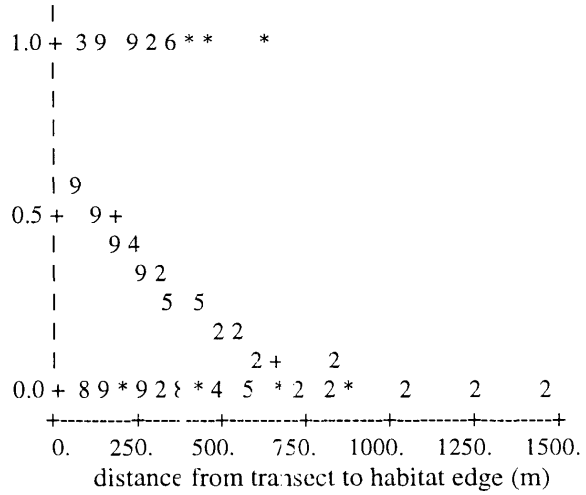


Appendix 4. Binary response curve of significant landscape variables from recently and historically-occupied transect model.

4.1 nrh (distance to next Regent Honeyeater transect)

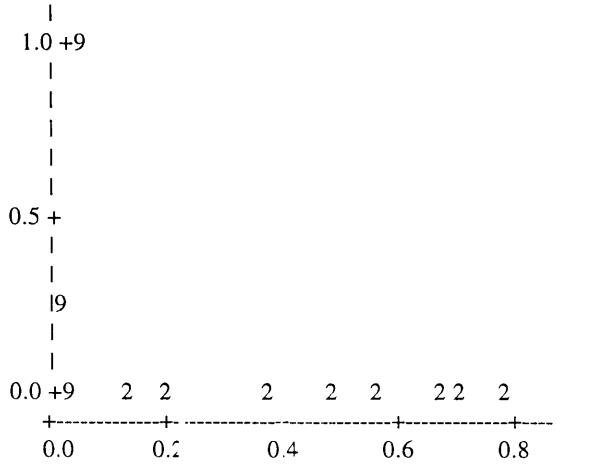


4.2 ped (distance to patch edge)

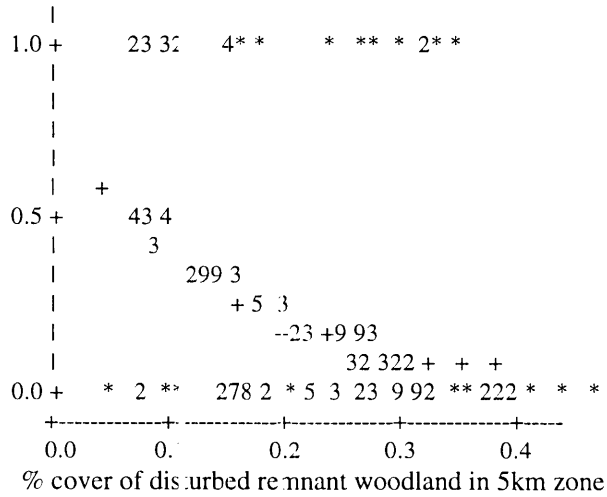


Appendix 5. Binary response curves of significant GIS landscape variables from recently-occupied transect model

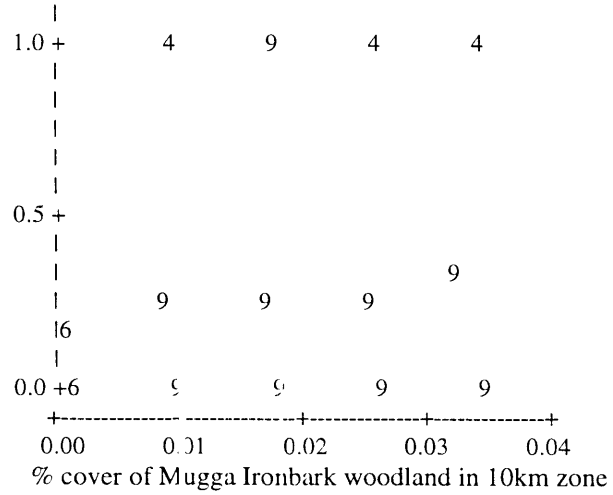
5.1 dp2 (% dry plateau complex at 2km)



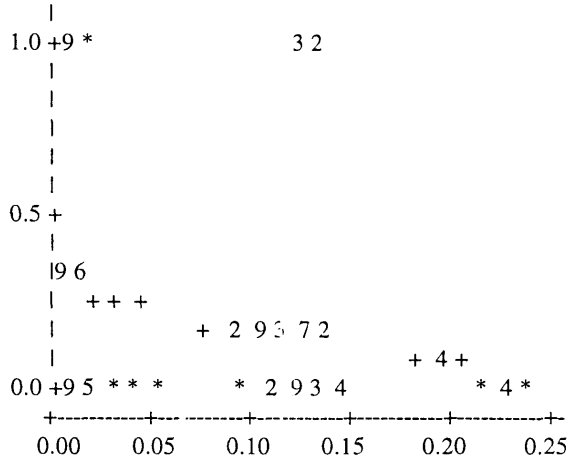
5.2 dr5 (% disturbed remnant at 5km)



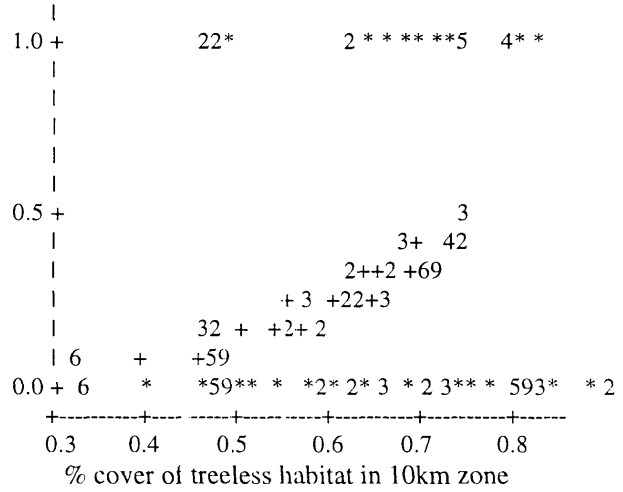
5.3 ib10 (% Ironbark at 10km)



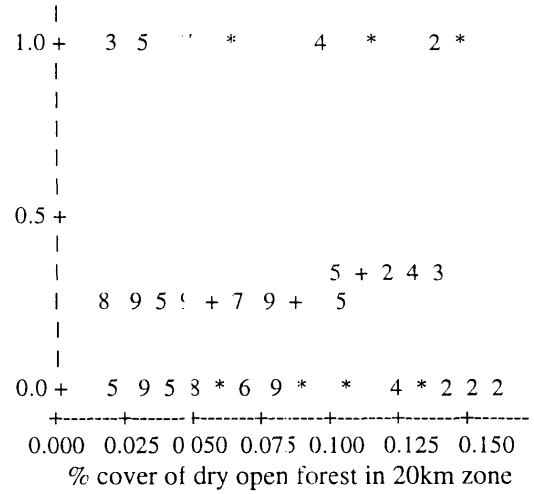
5.4 dp10 (% dry plateau complex at 10km)



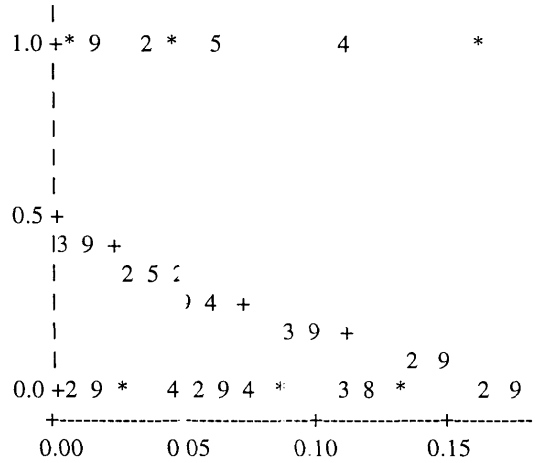
5.5 tl10 (% treeless at 10km)



5.6 do20 (% dry open forest at 20km)

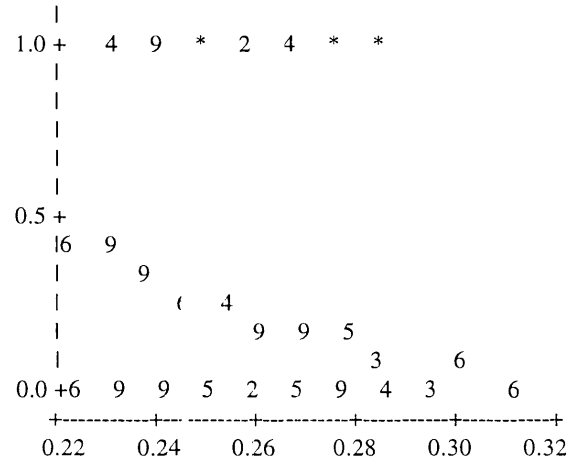


5.7 dp20 (% dry plateau complex at 20km)



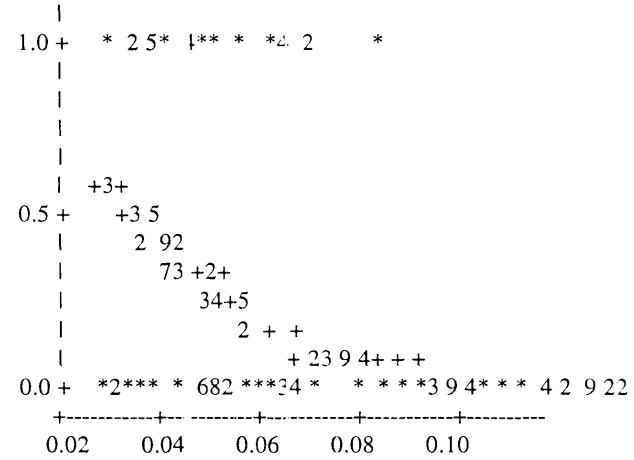
% cover of dry plateau complex woodland in 20km zone

5.8 dr20 (% disturbed remnant at 20km)



% cover of disturbed remnant woodland in 20km zone

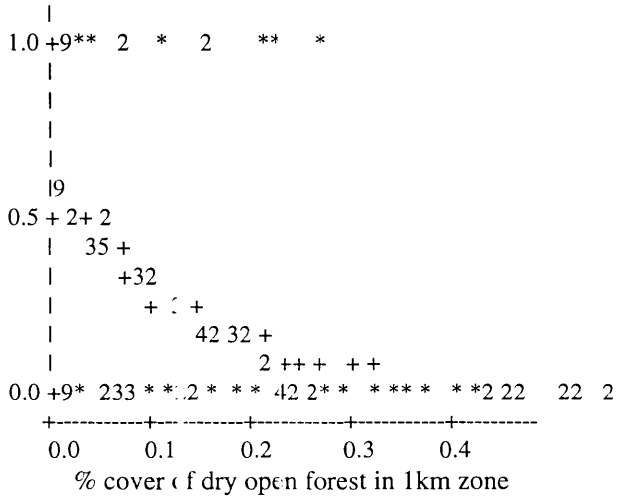
5.9 interaction term dr10 x dr20



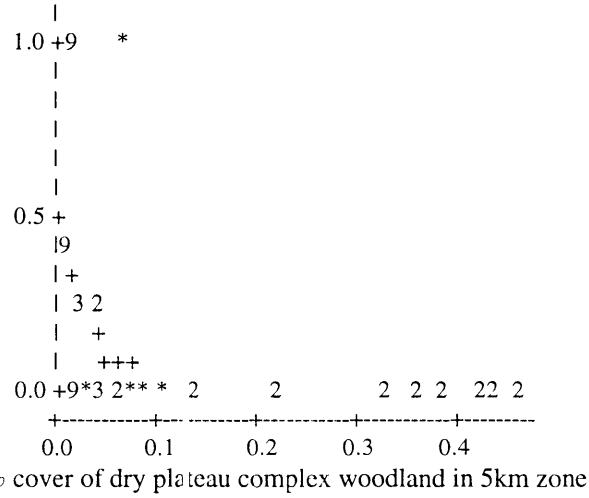
combined % cover of disturbed remnant woodland at 10km and 20km zones

Appendix 6. Binary response curves of significant GIS landscape variables from recently + historically-occupied transect model.

6.1 do1 (% dry open forest at 1km)

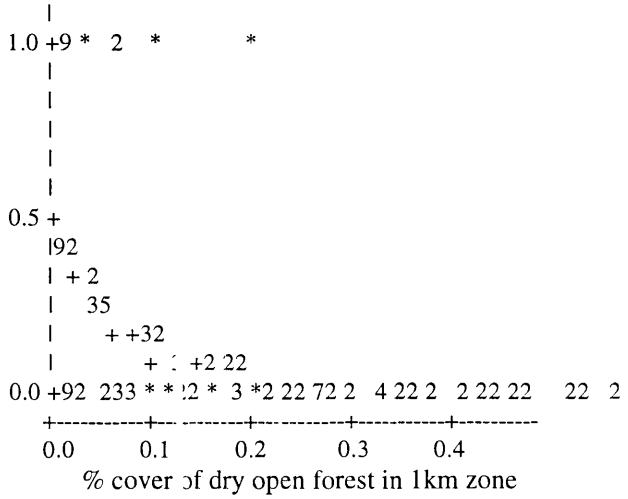


6.2 dp5 (% dry plateau complex at 5km)

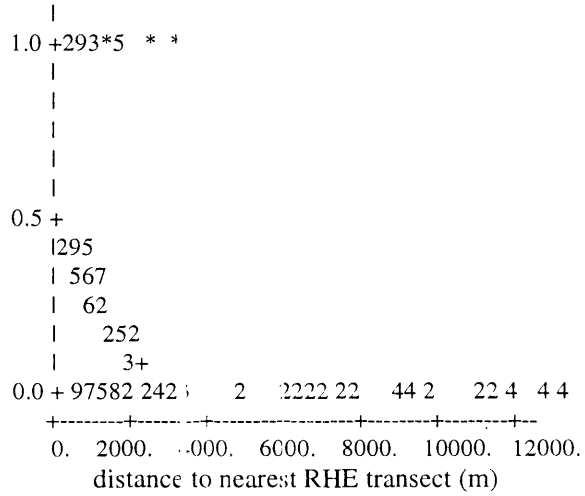


Appendix 7. Binary response curves for significant variables in final, recently-occupied transect model.

7.1 do1 (% dry open forest at 1km)

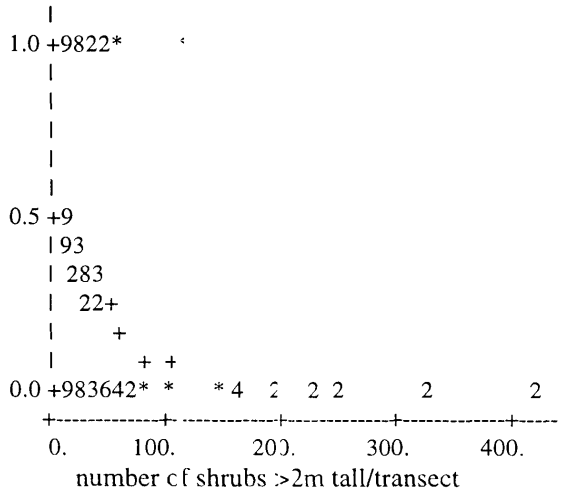


7.2 nrh (distance to nearest Regent Honeyeater transect)

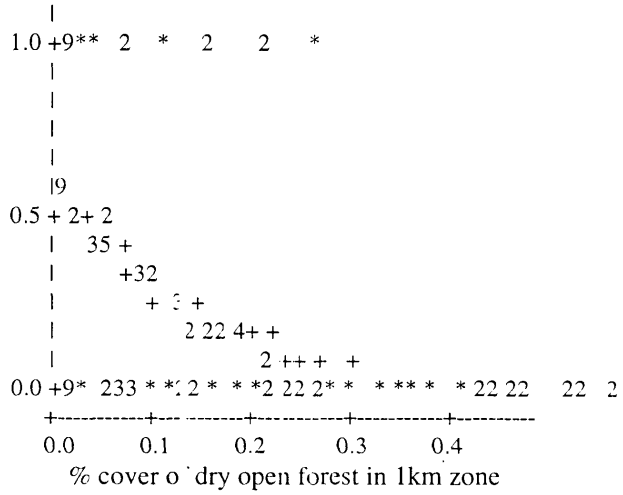


Appendix 8. Binary response curves of significant variables of final, recently + historically-occupied transect model.

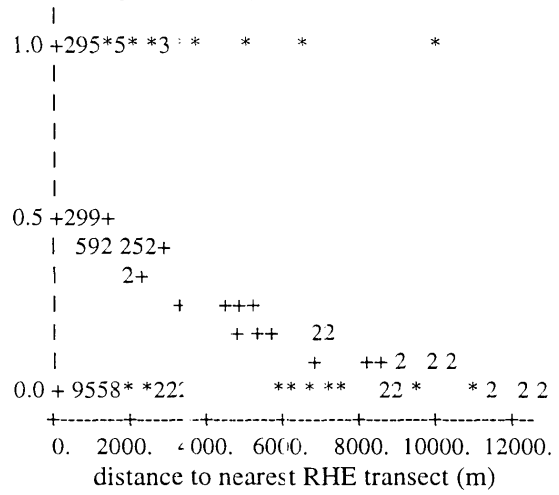
8.1 s2 (no. of shrubs > 2m tall)



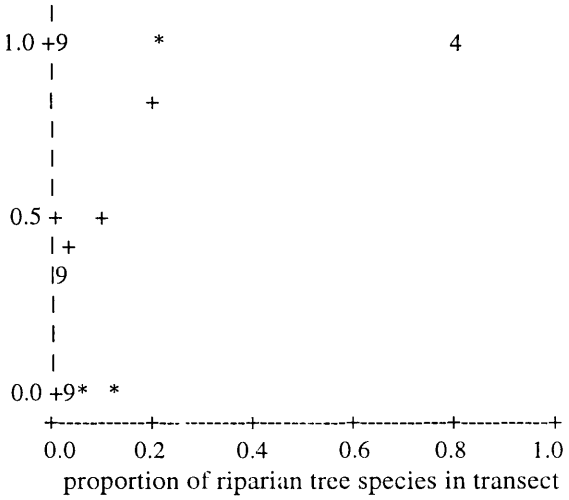
8.2 do1 (% dry open forest at 1km)



8.3 nrh (distance to nearest Regent Honeyeater transect)



8.4 prip (proportion of riparian tree species)



Appendix 9.

Regent Honeyeater Recovery Plan for the Bundarra-Barraba region, New South Wales

Damon L. Oliver
Division of Zoology, University of New England

This regional recovery plan follows the same format as the National Regent Honeyeater Recovery Plan 1994-1998 (Menkhorst 1997). The actions proposed in this plan are based on a thorough review of the current ecological literature, the Regent Honeyeater research findings of Andrew Ley and Beth Williams from 1984 to 1998, and the information contained within the publications and Ph.D. thesis of Damon Oliver, Division of Zoology, University of New England.

Current ecological knowledge

The recent national decline of the Regent Honeyeater was first reported by Peters (1979), and the first review of historical ecological information for the species was presented by Franklin *et al.* (1989). More recent publications on the ecology and recovery planning of Regent Honeyeaters in Victoria and New South Wales can be found in Webster and Menkhorst (1992) and Menkhorst (1997).

Research on the Bundarra-Barraba population of Regent Honeyeaters has been carried out by Andrew Ley and Beth Williams, and other members of the Bundarra-Barraba Regent Honeyeater Recovery Team Operations Group since 1984. In particular, data on breeding behaviour and success, population size, habitat use and regional movements of colour-banded birds have been collected (see Ley 1990, Ley and Williams 1992, 1994, Davis and Recher 1993, Ford *et al.* 1993, Ley *et al.* 1996, 1997). More recently Damon Oliver, in collaboration with the above authors, has undertaken an extensive ecological investigation of Regent Honeyeaters in northern New South Wales as part of his Ph.D. research at the Division of Zoology, University of New England (Oliver 1998a). Specific aspects of his research include regional population surveys of Regent Honeyeaters, habitat and resource selection, foraging behaviour, roosting behaviour (Oliver 1998b), breeding behaviour (Oliver in prep), breeding success and nest site selection (Oliver *et al.* 1998), and diet of juveniles (Oliver 1998c). Andrew Ley and Beth Williams have continued studying

Regent Honeyeaters in the Bundarra-Barraba region in 1997/98, by continuing Damon Oliver's bi-monthly surveys, colour-banding breeding birds, and monitoring nesting events to improve long-term information about the variability of breeding effort and success.

Current Species Status

The Regent Honeyeater (*Xanthomyza phrygia*) is classified as endangered under the Commonwealth *Endangered Species Act* 1992, and under Schedule 1, Part 1 of the New South Wales *Threatened Species Conservation Act* 1995. Under the criteria of BirdLife International, the Regent Honeyeater ranks as endangered as the population is estimated between 250 and 2500 individuals, and has undergone a contraction in range. Estimates of the Regent Honeyeater population size in the Bundarra-Barraba region are variable, but exceed 100 individuals at least in some years (Oliver *et al.* 1998). The maximum regional population size could be as many as 400 birds (Oliver 1998a). However, the population dynamics and viability of the Bundarra-Barraba population is yet to be determined and high priority must be given to further investigation.

Reasons for concern about the status of the Regent Honeyeater in the Bundarra-Barraba region

- ♦ low population number and low densities throughout the region;
- ♦ some evidence of poor breeding success in some years;
- ♦ reliance, and some fidelity to, a small number of breeding and foraging sites in the region;
- ♦ lack of information on regional population dynamics and viability (i.e. is the population stable, declining or increasing?);
- ♦ reliance on Box/Ironbark woodland that comprises only 4% of tree cover in region;
- ♦ continued clearance of Box/Ironbark and other woodland types;
- ♦ grazing and sand extraction a key riparian gallery forest breeding site;
- ♦ evidence of habitat degradation (mistletoe infestations, grazing, firewood collection) at key Regent Honeyeater sites in the region.

Existing conservation measures

The Northern New South Wales Group of Birds Australia have mapped remnant Box-Ironbark woodland in the Bundarra-Barraba region (B. Williams and A. Ley unpubl.). This information has been digitised and added to the GIS data of the Northern Tablelands and North West Slopes database of the NSW NPWS. Preliminary vegetation surveys have also been done to the north of

the region, in the Inverell district, and his information will be added to the database. Vegetation cover and community structure data is currently being gathered by Julian Wall (DLWC) for the purpose of defining key areas of threatened habitat in northwestern New South Wales. GIS vegetation information may be useful for constructing predictive models to assess suitability of new sites for Regent Honeyeaters (Oliver 1998a).

Planting of key eucalypt species at four sites on private and crown land close to Regent Honeyeater sites, has been carried out by the Northern New South Wales Group of Birds Australia. Other limited plantings have been done by landholders within the Bundarra-Barraba region. Fencing of, or exclusion of grazing from, important Regent Honeyeater sites has been implemented by two landholders in the Torryburn area, with advice from Hugh Ford and Steve Falconer and the assistance of WWF Australia.

Ecological studies on Regent Honeyeaters have been conducted since 1984 by Andrew Ley, Beth Williams, and other members of the Northern NSW Group of Birds Australia, and since 1994 by Damon Oliver of the Division of Zoology, University of New England.

Biodiversity benefits

Achieving the conservation objectives of the Regent Honeyeater Recovery Plan, will have benefits for other rare or threatened birds that use the same sites and resources as Regent Honeyeaters. These include Painted Honeyeaters, Swift and Turquoise Parrots, and Square-tailed Kites. Protection and enhancement of riparian gallery forest will provide suitable habitat for Barking Owls which are known to occur in the region. Appropriate management of Regent Honeyeater habitat will also maintain the notably high avian species richness and abundance of the Bundarra-Barraba region. Other threatened woodland fauna, such as Squirrel Gliders (H. Hines pers. comm.), and Koalas which have been recorded a Regent Honeyeater sites stand to benefit from habitat management.

Conservation objectives

Long-term objectives

1. To ensure that the species persists in the Bundarra-Barraba region

2. To achieve an improvement in the conservation status from endangered to vulnerable, or to demonstrate that the regional population is stable or increasing in the next 5 years (1998-2002) by:

♦ retaining and enhancing stands of all woodland types, particularly Box/Ironbark communities, and riparian gallery forest, which contain the "key" plant species used by Regent Honeyeaters (Oliver 1998a);

♦ achieving sympathetic and sustainable habitat management at key breeding and non-breeding sites in the Bundarra-Barraba region.

Specific objectives

♦ continue to survey and monitor known Regent Honeyeater sites and continue research into breeding success and movements using colour-banding, with the aim of developing a population viability model for the Bundarra-Barraba region;

♦ identify important sites used in the non-breeding season, using radio-tracking techniques;

♦ identify potential new habitat from exploratory ground surveys and employing predictive habitat models at landscape scale (see Oliver 1998a);

♦ map vegetation in the regions north of Bundarra-Barraba region, particularly to identify new stands of Box/Ironbark woodland;

♦ retain, enhance and manage identified stands of dry open forest and riparian gallery forest containing key plant species in the Bundarra-Barraba region, as well as regions north to the Queensland-New South Wales border. These include remnants on leasehold and freehold land, streamside and roadside reserves, travelling stock reserves, and stands in state forests and conservation reserves;

♦ inform local landowners and communities about Regent Honeyeaters and their predicament and needs.

♦ identify key threats to known key habitat to develop and implement species management to reduce threats.

Assessment criteria

Representatives from the following organisations should provide input and support:

NSW NPWS

NSW State Forests

NSW DLWC

Armidale and Tamworth Rural Lands Protection Boards

World Wide Fund for Nature

Landcare

Northern NSW Group of Birds Australia

Division of Zoology, University of New England

Landowners and other community members of the Bundarra-Barraba region

and assess the success of the recovery plan, based on the following criteria:

♦ Population numbers at known key sites in the Bundarra-Barraba region remain at current levels, and preferably increase;

♦ Reporting rates away from currently well known sites (e.g. near Barraba township) increase to levels near those at regularly used sites;

♦ Breeding effort (number of breeding attempts) and success, on average, remains at the same level as recorded between 1993/94 and 1996/97 (see Oliver *et al.* 1998), or improves.

Recovery Actions

1. Organisational arrangements

Foundation members of the Bundarra-Barraba Operations Group of the National Regent Honeyeater Recovery Team will evaluate and review their progress. Implementation of

recommendations from their past and current research should mainly be the responsibility of the NSW NPWS, and also representatives of the following organisations:

- State Forests of NSW
- NSW DLWC
- Landcare
- Greening Australia
- World Wide Fund for Nature
- Armidale and Tamworth Rural Lands Protection Board
- Barraba, Bingara, Guyra, Manilla and Uralla Shire Councils

Team members and representatives of the above bodies should meet every 12 months to assess the effectiveness of the recovery plan and progress of implementation of recommendations.

1.1 Appoint full-time extension officer funded by NSW NPWS to liaise with landholders, government agencies and Landcare, for voluntary conservation agreements, wildlife refuge agreements, threatened species property agreements, or covenants on freehold land where Regent Honeyeater habitat is threatened by current landuse practises (e.g., ringbarking regrowth eucalypts, heavy stock grazing).

1.2 Obtain funding for the Bundarra-Barraba region Operations Group to continue regular surveying and monitoring of known sites every two months, and for further breeding studies in the next 5 years (1998/99-2002/03) (salary $15000 p.a., travel costs $9000 p.a.).

2. Active management

2.1 Survey and map stands of key tree species (Box/Ironbark woodland, riparian gallery forest) on crown and freehold land in regions surrounding Bundarra-Barraba. In particular, complete mapping recently undertaken by Bundarra-Barraba Operations Group in the region north east of Inverell, which has had recent Regent Honeyeater records, but otherwise received little attention. Utilise NSW NPWS GIS database to run predictive models to assess the suitability of new sites within and outside Bundarra-Barraba region.

2.2 Use all available administrative avenues to protect and enhance important Regent Honeyeater habitat, including State Environment Planning Policy 46, and Native Vegetation Conservation Act, Threatened Species Property Agreements, voluntary conservation agreements, wildlife refuge agreements and covenants. Involve Rural Lands Protection Boards in management agreements so that stronger penalties can be enforced for illegal timber removal in crown reserves with important habitat, and to minimise impacts of road metal and gravel quarries in reserves. Educate Shire Council Road Engineers about ecologically sensitive maintenance of roads near key sites. Encourage shires to produce roadside management plans. Promote the idea of significant roadside vegetation areas used by Regent Honeyeaters, similar to the system used in Victoria for Grey-crowned Babblers.

2.3 Develop Regent Honeyeater management plan to address key threats in identified core breeding habitat.

Management of significant woodland and forest stands in the Bundarra-Barraba region requires:

- the retention of mature trees within stands;
- that regeneration is occurring to replace large trees;
- maintaining high tree canopy cover at all key sites;
- encouraging shrub regeneration at some key sites;
- maintaining diversity of tree species within Box/Ironbark woodland, and in some locations plant Stringybarks for nesting material;
- protecting key sites from degradation by active management of grazing reduction, removal of excessive mistletoe, and illegal collection of firewood;
- monitoring and minimising impacts of sand mining on riparian breeding habitat at the Gwydir River, Torryburn;
- increasing size and connectivity of habitat patches used by Regent Honeyeaters to increase amount of potential habitat and to reduce the possible impacts of large habitat edges.

2.3 Use tree-planting programs (e.g. Greening Australian, Landcare), with the assistance of local community (e.g. schoolgroups) to create habitat on cleared land, and to connect remnant stands, creating larger patches. Promote the planting of shrub layer to provide

source of nesting material for Regent Honeyeaters, and to discourage the colonisation by Noisy Miners, which may compete with or displace Regent Honeyeaters.

2.4 Appoint a "woodland conservation extension officer" (see 1.1) (as opposed to specific title of Regent Honeyeater Extension Officer) to work with local community at Regent Honeyeater sites. Such a person should promote benefits of fencing and replanting for maintaining biodiversity, rather than focussing too much on one bird species, as well as improvements to farm production and ecosystem health. An ideal role model for this position would be Ray Thomas of Mollyulah-Tatong Landcare Group,or Ruth Trémont from WWF.

3. Population monitoring

3.1 Continue bi-monthly surveys for Regent Honeyeaters and other endangered birds (e.g., Swift Parrots) at all known sites, using Damon Oliver's transects or sites that were occupied by Regent Honeyeaters. Ideally, the same standardised 20-minute, one-hectare survey should be used, and all bird species and their abundance recorded to demonstrate changes, if any, to numbers of Regent Honeyeaters and other birds. This will require funding for salary and travel costs. If finances unavailable, this could be perpetuated by ornithology (Zoology/Natural Resources) students at UNE, as part of course requirements.

3.2 If surveys are continued, they require at least a qualitative ranking or index of flowering and bud potential for each survey site, whether or not Regent Honeyeaters are found, to further investigate the relationship between nectar availability and site selection

3.3 Provide incentives (financial, personnel) to carry out opportunistic searches in Inverell region, Warrumbungle National Park and Pilliga Nature Reserve, with the aim of finding Regent Honeyeaters, and specifically to locate birds colour-banded in the Bundarra-Barraba region. Involve Barraba field naturalists in all monitoring activities. They may be able to carry out qualitative, or even quantitative surveys in some of Damon Oliver's western transects, if Armidale personnel are unavailable.

3.4 Ensure all sightings are reported to the National Regent Honeyeater Recovery Team Co-ordinator (DNRE, Melbourne). Provide Barraba personnel with regular updates of activities, and sightings further east in the region.

4. Research

Further ecological research on the Bundarra-Barraba Regent Honeyeater population is necessary to fill in information gaps from previous research by Ley, Williams, Oliver and others. Ideally, Honours or postgraduate students from the University of New England should be involved. Some financial support for travel and equipment should be sought from NSW NPWS or budgeted for in the second stage of the national recovery plan (1998-2002).

Movement studies

4.1 Continue colour-banding birds and monitoring for resightings of banded birds. If feasible, radio-track individuals for large-scale movements to identify new post-breeding autumn and winter habitat. Colour-banding will at least provide local movement data and further evidence of site fidelity.

Ecological requirements

4.2 If movement studies or opportunistic surveys identify new habitat in autumn and winter, investigate the use of resources, and conduct activity budgets to assess whether food limitation, or excessive aggression is a problem.

4.3 Investigate the nectar production of key eucalypts used by Regent Honeyeaters. In particular, test the hypothesis that larger trees produce more nectar per flower or more flowers per unit area/volume than smaller trees (Honours or Masters project).

4.4 Investigate flowering phenology and distribution of key eucalypts used by Regent Honeyeaters, with the assistance of apiarists, with the possible aim of developing a movement model based on resource patterns.

Breeding population studies

4.5 Continue monitoring and measuring the breeding success of Regent Honeyeaters in the next five breeding seasons, at regular breeding sites, to assess whether breeding success and effort are stable or decreasing.

4.6 Use colour banding and breeding data of Andrew Ley, Damon Oliver and Beth Williams to produce a population model, which could be done by Honours student.

Socio-economic studies of landholder "stewardship"

4.7 Study the feasibility and impact of landholder "stewardship" (Binning 1997, Curtis 1997) of protecting/managing remnant vegetation (Honours/Masters project for Agricultural Economics/Natural Resources student). Survey landholders in the region for their responses to voluntary conservation agreements or covenants. Measure landholder opinions to on-farm benefits, and tax incentives for fencing off woodland remnants, planting trees for firewood production, windbreaks, shelterbelts.

5. Extension

5.1 Local community should be made aware through regional media releases. Articles in wildlife magazine, journals and newsletters are a valuable means of increasing support and awareness.

5.2 Interest groups (e.g. Barraba personnel, Armidale personnel) could be kept informed through a newsletter twice-yearly.

5.3 Local government and community groups need to be kept informed and involved in recovery program, and on issues regarding management of habitat.

5.4 Consideration should be given to applying to funding bodies (e.g. NHT) for habitat restoration work, or to encourage companies involved in mining operations to invest money in rehabilitation of habitat immediate to and surrounding the impact site (e.g. Woodsreef Asbestos Mine, Sand Mining at Gwydir River, Gold Mining exploration at Black Mountain).

6. Captive Management

6.1 If Bundarra-Barraba region population reaches critically low level (e.g. no birds recorded in two years of continued surveys, or if there are no breeding records in two consecutive years), consider establishing a small breeding colony at Taronga Zoo. Wild birds will have to be captured and housed in aviaries for captive husbandry. This recommendation will be based on the success of the current captive breeding program at Taronga Zoo, and the findings of the DNA study being carried out at present.

6.2 If captive husbandry successful, consider release of captively-reared birds at both known suitable sites, and new sites, based on predictions of habitat models (Oliver 1998a).

7. Review of progress

The Bundarra-Barraba Operations Group will conduct an annual review of progress of the recovery plan. The review should also involve members of the national recovery team, and people from outside the Regent Honeyeater recovery effort. Each regional member of the operations group will present a progress report. For example, ecological findings will be presented by members of the Northern NSW Group of Birds Australia, and the liaison officer (see 1.1) will report on the success of implementing management recommendation based on research, and the recovery plan.

References

Binning, C. E. (1997). Beyond reserves: options for achieving nature conservation objectives in rural landscapes. Pp. 155-168 in *Frontiers in Ecology: Building the Links*. Klomp, N., and Lunt, I. (eds.). Elsevier Science Ltd..

Curtis, A. L. (1997). Landcare, stewardship and biodiversity conservation. Pp. 143-154 in *Frontiers in Ecology: Building the Links*. Klomp, N., and Lunt, I. (eds.). Elsevier Science Ltd..

Davis, W. E. Jr., and Recher, H. F. (1993). Notes on the breeding biology of the Regent Honeyeater. *Corella* **17**, 1-4.

Ford, H. A., Davis, W. E., Debus, S., Ley, A., Recher, H. F., and Williams, B. (1993). Foraging and aggressive behaviour of the Regent Honeyeater *Xanthomyza phrygia* in northern New South Wales. *Emu* **93**, 277-281.

Franklin, D. C., Menkhorst, P. W., and Robinson, J. L. (1989). Ecology of the Regent Honeyeater *Xanthomyza phrygia*. *Emu* **89**, 140-154.

Ley, A. J. (1990). Notes on the Regent Honeyeater *Xanthomyza phrygia*. *Australian Bird Watcher* **13**, 171-173.

Ley, A. J., Oliver, D. L., and Williams, B. (1996). Observations on colour-banded Regent Honeyeaters *Xanthomyza phrygia*. *Corella* **20**, 88-92.

Ley, A. J., Oliver, D. L., and Williams, B. (1997). Theft of nesting material involving honeyeaters (Meliphagidae). *Corella* **21**, 119-123.

Ley, A. J., and Williams, M. B. (1992). The conservation status of the Regent Honeyeater near Armidale, New South Wales. *Australian Bird Watcher* **14**, 277-281.

Ley, A. J., and Williams, M. B. (1994). Breeding behaviour and morphology of the Regent Honeyeater *Xanthomyza phrygia*. *Australian Bird Watcher* **15**, 366-376.

Menkhorst, P. (1997). *Regent Honeyeater Recovery Plan 1994-1998*. Department of Natural Resources and Environment in conjunction with the Regent Honeyeater Recovery Team.

Oliver, D. L. (1998a). Ecology and conservation of the endangered Regent Honeyeater *Xanthomyza phrygia* in northern New South Wales. Ph.D. thesis, University of New England, Armidale, New South Wales.

Oliver, D. L. (1998b). Roosting of non-breeding Regent Honeyeaters *Xanthomyza phrygia*. *Emu* **98**, 65-69.

Oliver, D. L. (1998c). The importance of insects and lerp in the diet of juvenile Regent Honeyeaters *Xanthomyza phrygia*: implications for the conservation of an endangered woodland bird. *Wildlife Research* (in press).

Oliver, D. L., Ley, A. J., and Williams, M. B. (1998). Breeding success and nest site selection of the endangered Regent Honeyeater *Xanthomyza phrygia* near Armidale, New South Wales. *Emu* (in press).

Peters, D. E. (1979). Some evidence for a decline in the population status of the Regent Honeyeater. *Australian Bird Watcher* **8**, 117-123.

Webster, R., and Menkhorst, P. W. (1992). *The Regent Honeyeater (Xanthomyza phrygia): population status and ecology in Victoria and New South Wales.* Arthur Rylah Institute for Environmental Research Technical Report Series Number 126. Department of Conservation and Environment, Melbourne.