CHAPTER 5: GENERAL DISCUSSION

As an overall conclusion, this study is in agreement with other research that has found bird species richness to be greater where there is increased habitat heterogeneity, both within and between habitat remnants (MacArthur 1964; Recher 1969; Karr and Roth 1971; Forman and Godron 1981; James and Warner 1982; Haila 1983; Lynch and Wigham 1984; Freemark and Merriam 1986). Habitat features that were identified as being positive predictors of species abundance on the Armidale Plateau (Chapter 2), can be used as 'environmental building blocks' with which to reconstruct the native ecosystem and restore bird species richness (Barrett and Ford 1993).

As has been shown in previous studies (see Chapter 1 for references), bird assemblages on the Armidale Plateau were influenced by vegetation physiognomy, with most bird groups being more abundant where there was greater vegetation biomass. The dependence between migrant bird species and low shrubby vegetation that has been described in Northern Hemisphere studies (Helle and Fuller 1988; Fuller *et al.* 1989; Hutto 1989), is similar to the situation in the present study, where winter migrants were associated with understorey vegetation. It is likely that the decline in abundance of many bird species in woodland sites affected by dieback was caused by a reduction of vegetation biomass. Excessive grazing by livestock, which is associated with dieback, also removes the understorey vegetation, resulting in a loss of bird species. However, an absence of grazing altogether is likely to result in the loss of herbaceous vegetation, due to the unchecked growth of shrubs. Therefore, increased bird species richness and greater number of ground-foragers where the herb vegetation is well developed, suggests that moderate levels of grazing maintain greater bird species richness. A mix of both herb and understorey vegetation could also be maintained in the absence of grazing by the correct use of fire.

Floristics was another frequent predictor of bird abundance on the Armidale Plateau, a result which is consistent with other Australian studies (see Chapter 1 for references). The serious degradation in the smallest woodland remnants, and resulting loss of bird species, is to some extent offset by the presence of mistletoes in these disturbed sites. Despite the fact that heavy infestations of these parasitic plants can kill trees, mistletoes are likely to be an important source of nectar, fruit and nesting sites for a number of bird species. The seasonal bird surveys (Chapter 3) suggest that winter visitors, and to a lesser extent summer visitors, are attracted to particular sites on the Armidale Plateau by the presence of flowering mistletoes. It also appears that resident honeyeater species make seasonal movements between stringybark woodland and gum-box woodland in response to mistletoe flowering. This situation is similar to that described in the Western Australian wheatbelt by Cale (1990), where honeyeaters move among habitats in which different plants are flowering.

Despite the limited altitudinal range of the survey sites (900 to 1300 m), altitude was a frequent predictor of bird species abundance. Although there are some climatic changes associated with altitude, it is likely that the response of many birds groups to altitude was due to their association with either stringybark woodland or gum-box woodland. These associations are similar to those identified in a previous study on the Armidale Plateau by Ford *et al.* (1986). It was expected that bird species richness would be greater in the gum-box woodland, which occurs on the relatively moist and fertile soils, at lower altitudes (Recher 1985; Braithwaite *et al.* 1989; Recher and Majer 1994). The greater vegetation species richness in gum-box woodland sites was also expected to be associated with greater bird species richness (see Chapter 1 for references). However, bird species richness was greatest in the nutrient-poor stringybark woodland, which occurs at higher altitudes. This was probably due to the increased abundance of territorial species, such as the noisy miner and fuscous honeyeater, in the gum-box woodland (Chapter 3). The noisy miner, being favoured by habitat fragmentation, has increased in abundance on the Armidale Plateau and can dominate patches of gum-box woodland to the exclusion of other species (Chapters 3

and 4). It may also be that the gum-box woodland has been so extensively cleared that there is no longer a complete avifauna associated with this woodland type.

As has been found in other Australian studies (see Chapter 1 for references), the presence of large, mature trees was a positive predictor of bird species richness. In particular, hollow-nesters were more common in these sites, probably as a result of there being more nest-hollows in larger trees (Mackowski 1984, Stokes in prep.). Bark-foragers, honeyeaters and fruit-eaters (some of which are also hollow-nesters) were also more common where large trees were present, probably due to there being greater amounts of loose bark and mistletoes on larger trees (Loyn 1985b). Large trees existed close to human settlement in small isolated patches of woodland, where they had been left as shade-trees for stock. Large trees also occurred in larger, less accessible patches of woodland (mostly gum-box) where there was less timber removal (Chapter 2). Hollow-nesters appear to be associated with these latter sites, being less common in woodland close to farm buildings, and less common where dieback was present. This result is in agreement with previous research which suggest that birds that depend on nest-hollows are particularly susceptible to habitat clearing and fragmentation (Robinson 1991; Garnett 1992; Stokes in prep.). The removal of fallen timber for firewood also threatens bird species on the Armidale Plateau. Logs serve as physical obstacles that reduce grazing pressure, allowing leaf-litter to build up and the understorey and herb vegetation to regenerate. The presence of logs was a positive predictor of bird species richness, emphasising the importance of protecting the ground ecosystem in a grazing landscape. This result confirms previous claims, that leaving timber and other vegetation to break down naturally is an important conservation measure for rehabilitating degraded habitat (Tubbs 1974; Bennett 1992; Davidson and Davidson 1992; Recher 1993).

The application of island biogeography theory to reserve design suggests that bird species richness will be lower in smaller reserves (MacArthur and Wilson 1967; Diamond 1975; Wilson and Willis 1975). Although not significant, this view was supported by the surveys

which were repeated each season for two years. The cumulative number of bird species from these surveys tended to be greater in the largest woodland patches on the Armidale Plateau (Chapter 2 - Figure 2.4). However, the single survey in 294 woodland sites indicates that the area of the woodland patch was a negative predictor of bird abundance and bird species richness per site indicating that the majority of species were more common in smaller patches. This survey suggests that as far as alpha diversity (diversity at a given survey point in a single habitat type) based on a single survey in a large number of sites is concerned, most of the bird species richness was in woodland patches as small as 20 ha. The seasonal surveys indicate that these smaller remnants are most important as reservoirs for species richness during spring and autumn, when many birds are moving through the landscape (Chapter 3).

The single survey in 294 sites also indicated that the number of bird species per site was significantly greater in the intermediate-sized woodland patches. The lower species richness in the continuous woodland (> 400 ha) is likely to be due to a dilution effect, with the birds being dispersed over a larger area of woodland habitat. This is supported by the repeat surveys which indicate that species richness in the largest woodland patches increases with time. However, it may also be due to increased nest predation in these continuous woodland areas (Barrett *et al.* in prep.). Whether a single survey or seasonal surveys are considered, the number of bird species was markedly reduced in woodland patches that were smaller than 6 ha. These smallest woodland sites are the most heavily impacted by grazing pressure, dieback and timber removal on the Armidale Plateau. The abundance of noisy miners and avian nest predators is also greater in these smallest woodland patches. It is also likely that the lower bird species richness in these smallest woodland patches was due to the effects of area and isolation (MacArthur and Wilson 1967; Diamond 1975; Wilson and Willis 1975).

Exceptions to the trend towards greater abundance in smaller woodland patches (single survey in 294 sites) were the understorey-dependent species, fruit-eaters, honeyeaters and

winter visitors, all of which were more common in larger woodland patches on the Armidale Plateau. A feature which is common to these four bird groups is that they were all more common where there was greater vegetation biomass. This suggests that a primary impact of reducing the area of the woodland remnants on the Armidale Plateau is the subsequent removal of the canopy and understorey vegetation by factors such as dieback, selective logging and grazing by livestock (Ford and Bell 1981; Morgan 1981). None of the four bird groups that were more common in larger woodland patches were affected by patch isolation, and it is likely that their dependence on larger woodland patches can be offset by the protection of understorey vegetation in smaller woodland patches. Other research has found understorey-dependent species to be particularly susceptible to habitat fragmentation (see Chapter 1 for references).

The presence of noisy miners appears to alter the response of bird species richness to the area of the woodland patch. While the overall trend in the data from the single survey in 294 sites was towards bird species richness being negatively correlated with woodland area, the opposite trend occurred when sites with noisy miners were considered separately (Chapter 2 - Figure 2.3). This study also suggests that a patch size of around 20 ha may be a threshold, below which noisy miners are more effective at excluding other bird species from their territories. If this is so, then maintaining patch sizes to a minimum of 20 ha throughout the landscape may be a means of controlling noisy miners on the Armidale Plateau. The seasonal surveys indicate that some noisy miner territories may be established as a seasonal response to nectar availability (Chapter 3).

Island biogeography theory is primarily based on studies which surveyed a correspondingly larger area in larger "islands" of habitat, and these studies are therefore not directly comparable to the present study in which sites of equal area were surveyed in different sized woodland patches. However, what is noteworthy is that conclusions about the effect of area, in the present study, are very different to those based on the theory of island

biogeography. Furthermore this has implications for the conservation and management of woodland birds in pastoral areas.

The results presented in this thesis lead one to question the validity of broadly applying island biogeography theory to remnant vegetation on the Armidale Plateau. More profoundly, these results also question the usefulness of applying the fragmentation model to this landscape. The analogy between oceanic islands and land reserves is strongest if the landscape is truly fragmented. That is to say that the remnant habitats in total only cover a small portion of the landscape, have discrete boundaries, and are easily distinguished from the surrounding matrix which is hostile to the majority of species occurring in the remnants (Simberloff 1986; Saunders *et al.* 991). There are some landscapes where the analogy between remnant vegetation and oceanic island is appropriate, such as remnant woodland in the Western Australian wheatbel (Saunders 1989). The fragmentation model does not, however, appear to be well suited to the New England Tablelands, where the majority of woodland remnants are diffusely fragmented and the boundaries often hard to define. Furthermore, the seasonal surveys indicate that the distinction between remnants is arbitrary, with many birds move regularly among remnants throughout the landscape. As well as honeyeater species moving between gum-box and stringybark woodland, a large portion of the bird species appear to move into the intermediate-sized patches during spring and autumn and out of them during summer and winter (Chapter 3). There are also bird species which have large home-ranges, such as the raptors, larger honeyeaters and open-country species such as the magpie and Australian raven, which appear to use several woodland patches within their daily movements. The lack of isolation effects on the Armidale Plateau (Chapter 2) further supports the view that bird species do not perceive woodland remnants to be discrete habitat fragments within a hostile matrix.

While many bird species will cross open grassland, it should be noted that where possible most birds remain close to tree cover (Chapter 3). Despite the increased presence of noisy miners in strips of woodland, strips of woodland connecting two patches were used as fly-

ways by both migrant and resident species. This study supports the view that, even in a landscape where bird species make regular movements across grassland with scattered trees, a continuous strip of woodland linking two patches will serve as a thoroughfare for bird movement (see Chapter 1 for references). The present study also supports previous studies which show that birds also use water-courses as fly-ways (Finch 1989; Croonquist and Brooks 1993; Isaacs 1994). However, the present study does not indicate that such corridors are essential for the movement of birds through the landscape.

Like most of the New England Tablelands, the Armidale Plateau is a landscape in transition. As woodland clearing continues and as dieback becomes more extensive among scattered trees and small patches, large patches will become increasingly important as reservoirs for bird species richness. Presently, during a given season, woodland patches as small as 20 ha contain as many bird species per site and appear to be as important for maintaining bird species richness as extensively wooded areas (> 400 ha). In such a landscape, predictions based on island biogeography and the fragmentation model appear to have limited application. Furthermore, it is unwise to base a management strategy for conserving bird species richness on models that require further degradation of the landscape before they become broadly applicable. In view of such concerns, the present study was instrumental in proposing the habitat variegation model as an alternative to the fragmentation model (McIntyre and Barrett 1992). This model draws no sharp distinction between habitat remnants and the surrounding hostile matrix. In its most general form a variegated landscape is described as a 'constantly shifting mosaic of habitats of varying suitability'. When applied to the Armidale Plateau the distinction between woodland and grassland is no longer necessary, the whole of the landscape is viewed as the conservation resource for the whole bird community. In its most simple form, the woodland remnants provide the core breeding areas for sub-populations, while the surrounding grassland with scattered trees provides cohesiveness for the metapopulations by permitting easy dispersal.

The idea that regional biodiversity can be preserved within a system of reserves is based on the fragmentation model. The reserves themselves are the fragments which are preserved, and the surrounding matrix continues to degrade because it is not seen as important. A common result of interpreting the landscape as fragmented, is that regional conservation strategies tend to emphasise the importance of the largest habitat fragments (see introduction in Chapter 1). After all, the largest fragments are likely to contain more species, including scarce or 'indicator species' which if conserved should result in most other species being conserved (see Chapter 1 for references). However, the present study has described how such an approach to regional conservation can result in marginal species being given higher conservation priority than local, core species. By definition marginal species are unlikely to be in their optimum habitat, and as such are more likely to be regionally rare and sensitive to habitat disturbance. As such, it is the marginal species that are often the best 'indicator species'. On the Armidale Plateau, it is only woodland remnants larger than 400 ha that are sufficient to accommodate the majority of 'indicator' species. These indicator species are likely to be dependent on the extensively wooded, least disturbed areas on the Armidale Plateau because they are in marginal habitat, in most cases being better adapted to the wetter forests to the east of the New England Tablelands. Furthermore, the average size of the grazing properties on the Armidale Plateau is around 1000 ha, so a conservation strategy which gives priority to remnants that are at least 400 ha is beyond the means of private landholders (Chapter 4).

A review of the conservation status of 137 land bird species occurring on the Armidale Plateau, indicates that only 33 species (24%) are abundant and widely distributed on the New England Tablelands (Chapter 4). The remainder are either locally extinct (6 spp.), declining (18 spp.), vulnerable due to their dependence on healthy woodland (35 spp.), or marginal species that tend to be habitat specialists and may never have been common on the New England Tablelands (45 spp.). This assessment was foreshadowed by Howe (1986) in an earlier assessment of birds on the New England Tablelands, and near Dorrigo in northeast New South Wales. If the present trend towards further extinctions of bird

species on the Armidale Plateau is to be halted, a conservation strategy with achievable goals must be put in place. We now know that regional conservation will not be effective without off-reserve management, and the willing participation of local landholders in the conservation initiatives (Shaffer 1987; Syme 1987; Wallace and Moore 1987; Goldney and Bowie 1990; Saunders 1990; Bradbury 1991; Woinarski and Tidemann 1991; Hobbs *et al.* 1993; Ford *et al.* 1995). The present study has demonstrated that conservation strategies based on the fragmentation model, which give priority to large remnants and 'indicator' species, may undermine both the off-reserve conservation and the cooperation of landholders. Conserving the 'indicator species' that are dependent on extensive areas of woodland, is the role of national parks and State forests. The danger with emphasising these rarer, more sensitive species is that conservation becomes a government responsibility and not a community one in which all landowners can play a part (Ford *et al.* 1995).

In Chapter 4 it is proposed that the requirements of regionally rare species that are sensitive to disturbance and dependent on extensive woodland areas, be separated from those of the majority of locally occurring species. It is suggested that conservation priorities on the Armidale Plateau be initially focussed on maximising bird species richness throughout the landscape, and maintaining viable populations of the core species. This can be partly achieved by protecting existing large patches of woodland which tend to occur in crown reserves, national parks and nature reserves. However, the brunt of the responsibility for these core species lies with private landholders, because during any given season most of these core species occur in the smaller woodland patches between large reserves. The present study suggests that bird species diversity can be maximised in these 'off-reserve' areas by maintaining a network of woodland patches as small as 20 hectare in area throughout the landscape. Other researchers have suggested that if the natural environmental variation is considered, a network of remnants less than 100 ha in area should be sufficient to conserve most regional avian diversity in parts of Australia (Loyn 1985a; Lambeck and Saunders 1990), in England (Moore and Hooper 1975), in northwest

California (Rosenberg and Raphae 1986), and in the southern Finnish forests (Haila *et al.* 1994). Such studies point the way forward for conserving bird species richness in highly modified, rural environments, where the majority of remnants will always be relatively small.

In a view that is partly derived from the present study, McIntyre *et al.* (1992) argue that the conservation of a minority of regionally rare species that are sensitive to habitat disturbance should be a secondary priority to the majority of more tolerant species (see also McIntyre 1992). The rationale behind this 'species triage' argument is that it is folly to pour vast conservation resources into a handful of species, when for want of a little attention the majority of species move closer to extinction. Similar views have been expressed by Verner (1986) and Loman and Von Schantz (1991), who argue that maintaining species richness is a valid conservation goal, and Kitching (1994) who suggested that aims for conserving national biodiversity should be kept separate to those associated with endangered species programs.

Maintaining bird species richness throughout rural landscapes is as much a question of responsible land management as it is a question of species conservation. Already areas of the New England Tablelands are showing signs of serious land degradation as a result of tree loss and stock grazing - that is soil erosion and a rising water table (Curtis *et al.* in press). Whether landholders modify their management practices out of consideration for other species, or in the interests of self preservation, the management goals are similar. Surely this is a situation where tolerance and co-operation on the part of both landholder and conservationist can lead to a solution that is more than the sum of its parts. This thesis is as much a hypothesis generator as it is a source of guidance. Further studies are necessary which periodically monitor bird assemblages on the Armidale Plateau and focus on species which appear to be falling through the conservation safety net.