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LISTS OF SPECIES

Aves, Tumut, New South Wales, South-eastern Australia.

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Abstract: A large-scale, long-term study of the impacts on vertebrates of landscape change and habitat fragmentation is taking place at Tumut in southern New South Wales, south-eastern Australia. Field surveys focus on counting birds within three broad kinds of sites in the study region. These are: (1) A randomized and replicated set of 85 sites in remnants or fragments of native *Eucalyptus* forest located within the boundaries of the Radiata Pine plantation. (2) Sites dominated by Radiata Pine plantation trees (N = 40 sites). (3) Sites in the large areas of continuous *Eucalyptus* forest adjacent to the plantation that act as "controls" (N = 40 sites). We list of birds recorded during 1996 and 1997. A total of 92 species from 34 families was recorded. The list will be useful for workers examining bird responses to fragmented landscapes as well as those interested in the biodiversity values of plantation landscapes.

Introduction

Habitat loss and habitat fragmentation are two of the key processes threatening the conservation of biodiversity worldwide (Lindenmayer and Fischer 2006). These threatening processes can have multi-facetted impacts on biota (Zuidema et al. 1996), ranging from (among others): species loss and extinction (Fahrig 2003), re-ordered community composition (Davies et al. 2001), altered patterns of species behavior (Rolstad and Wegge 1987), and loss of genetic variability (Sacchari et al. 1998). These factors often interact (Gilpin and Soulé 1986) leading to cumulative effects which can, in turn, make it extremely difficult to accurately predict the impacts of landscape change on biota (Mac Nally and Bennett 1997). Large-scale empirical studies are required to better understand and, in turn, better predict the impacts of habitat loss and habitat fragmentation on biodiversity (Wiens 1999).

On this basis, the Tumut Fragmentation Study was established in southern New South Wales, south-eastern Australia to examine the influence of habitat fragmentation and landscape conditions on a range of vertebrate groups (Lindenmayer et al. 1999). Patches of remnant vegetation have been isolated for between 15 and almost 70 years – a prolonged period during which the localized extinction of species may be expected to occur. One of the objectives of the Tumut Fragmentation Study is to quantify the biodiversity values of patches of remnant native eucalypt forest and woodland surrounded by extensive stands of exotic Radiata Pine (*Pinus radiata*) trees. In this paper we provide a list of birds recorded during extensive surveys completed in 1996 and 1997 as part of the Tumut Fragmentation Study.

Materials and Methods

Study area

The study was undertaken in a 100,000 ha sub-section of the Tumut region in southern NSW, south-eastern Australia (Figure 1). The midpoint of the study area had the following co-ordinates: 148º40' E, 35º10' S. The study region supports the following four broad classes of forest cover (termed "landscape contexts"): (1) Extensive (> 50,000 ha) areas of exotic softwood Radiata Pine

plantation (the Buccleuch State Forest) which have been established predominantly on areas formerly supporting native *Eucalyptus* forest. (2) Remnants of native eucalypt forest that escaped clearing for plantation establishment and are now surrounded by stands of Radiata Pine (Figure 2). These were classified into two broad shape classes: (a) circular or elliptical-shaped remnants (termed patches), and, (b) narrow linear strip-shaped remnants (termed strips), often containing watercourses. And, (3) large continuous areas of native eucalypt forest that bound the northern, eastern and southern boundaries of the Radiata Pine plantation (the Kosciuszko and Brindabella National Parks as well as the Bondo and Bungongo State Forests).

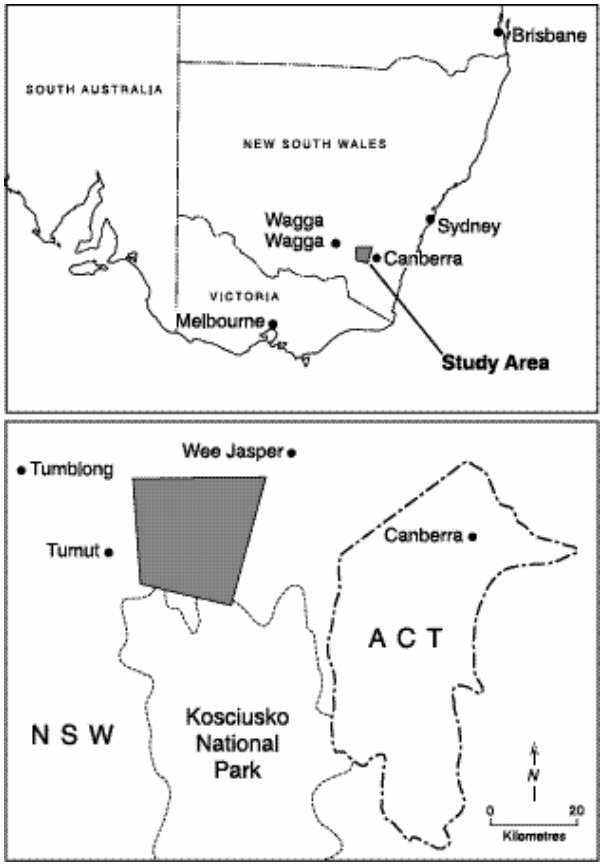

Figure 1. The location of the Tumut region in south-eastern Australia.

Clearing of native vegetation to plant Radiata Pine commenced in the mid-1930s and continued until the mid-1980s. The remnants within the plantation were set aside for a number of reasons, including steepness, protection of water quality and representativeness of the original vegetation cover. Detailed field surveys (Lindenmayer et al. 1999) indicated that characteristics of the remnants and continuous areas of eucalypt forests such as lithology, climate, and topography could be matched in areas planted to Radiata Pine.

Survey design

The study region contained 192 remnants of native eucalypt forest located within the boundaries of the Radiata Pine plantation; 85 remnants were selected using stratified random sampling. The set of 85 eucalypt remnants was replicated across several stratified classes:- four patch size classes (1-3 ha, 4-10 ha, 11-20 ha and > 20 ha), two isolation age classes (< and > 20 years since fragmentation), and five dominant eucalypt forest type classes (*Eucalyptus viminalis, E. radiata, E. camphora, E. macrorhyncha* and *E. bridgesdiana,* and *E. dalrympleana, E. pauciflora* and *E. stellulata*).

In addition to the 85 eucalypt remnants, a further 80 sites was selected for study; 40 in large continuous areas of eucalypt forest, and 40 in Radiata Pine stands. Recurrent thinning and clearfelling of the planted pine stands over the past 65 years meant that the Radiata Pine stands very rarely contained isolated eucalypt trees, a factor which has influenced the response of some forest birds in other studies (Recher et al. 1987).

Climate, forest type and geology data were used to cross-match the 165 sites in the study, ensuring that the range of environmental and other conditions were matched across the landscape context classes (Lindenmayer et al. 1999).

Bird surveys

A permanent transect was established at each of the 165 sites (i.e. the 85 eucalypt remnants, 40 sites in large areas of continuous eucalypt forest and 40 sites in Radiata Pine forest). For Radiata Pine sites, sites in continuous areas of native forests, and the 63 eucalypt remnant sites of area > 3 ha, a 600 m long x 50 m wide transect was set out. For the eucalypt remnant sites of area < 3 ha, the length of the transect was scaled relative to area. In the case of the eight eucalypt remnant sites of area 1-2 ha, a 200 m transect was established. A 400 m long transect was established for the 14 eucalypt remnant sites of

area 2-3 ha. A continuous line of colored flagging tape was set out along the center of each transect and points marked every 100 m, starting at 0 m. Thus for most sites, bird data were recorded at seven plots using a five-minute point interval count (*sensu* Pyke and Recher 1983).

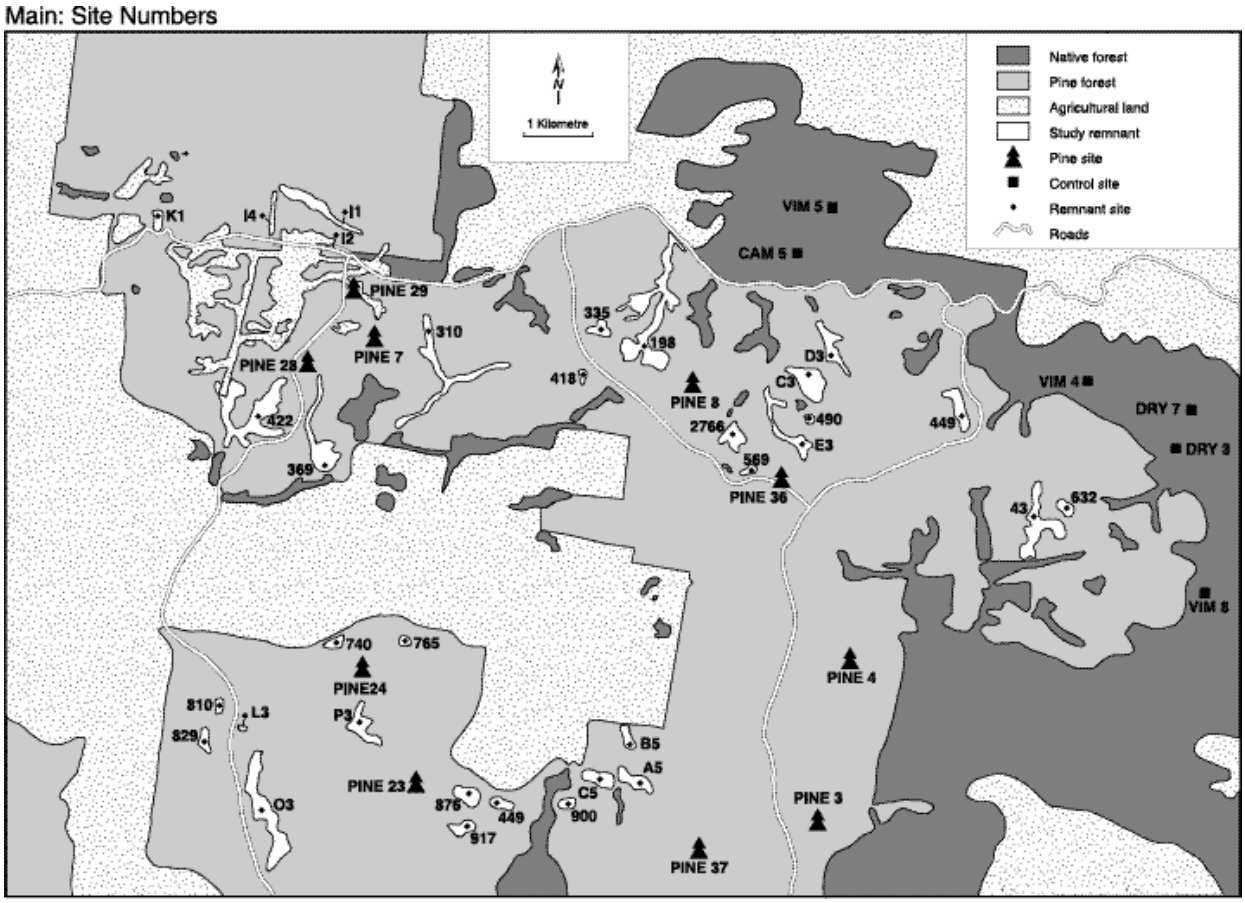

Figure 2. A subset of the three broad site types in the Tumut study region.

Two surveys for birds were undertaken, one in late October-early November 1996 and a second in late October-early November 1997. In the study region, late October-early November is the peak-breeding season when birds have established territories and exhibit strong patterns of site fidelity. For each point count, observers recorded the numbers of each bird species seen or heard within an approximate 50 m radius. Birds flying over transects were recorded but not included in the analysis. Counts were completed between 05:30 - 09:30 h and were not undertaken on days of poor weather (rain, snow, high wind, heavy fog or heavy cloud cover). To minimize the effect of confounding between landscape context classes and weather conditions, representatives from all four context classes were sampled on any given day.

A total of 10 experienced bird observers from the Canberra Ornithologists Group participated in the surveys in 1996 and 1997. All 165 sites were surveyed in 1996 and approximately 50 % of the remnant sites were sampled a second time during that year. Different observers were used for the repeat counts. The same 165 sites were re-surveyed in 1997. Although observers were experienced, they varied in their ability to detect some (but not all) groups of birds. Cunningham et al. (1999) showed that for the 10 experienced observers, extra variability due to observer heterogeneity can be compensated for by averaging the counts of two or more observers at the same site.

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Results and Discussion

Table 1 contains a detailed list of birds recorded during field surveys conducted in 1996 and 1997 as part of work quantifying avifaunal responses to landscape change and landscape context. We recorded 92 species from 34 families (Table 1).

Notably, other surveys conducted outside the formal counting periods (including those using automatic bird recording devices; see Cunningham et al. 2004) did not produce any species additional to those listed in Table 1.

Table 1. Detections of bird species in the Tumut Fragmentation Study classified by four broad classes of sites. Codes are: Rare (detected at < 25 % of sites), uncommon (detected at 25-50 % of sites), common (detected at 50-75 % of sites), and abundant (detected at > 75 % of sites).

Common Name	Scientific Name	Eucalypt controls	Eucalypt patches	Eucalypt strips	Radiata Pine
FAMILY: ACCIPITRIDAE					
Brown Goshawk	*Accipiter fasciatus*	Rare	Rare	Rare	Absent
Collared Sparrowhawk	*Accipiter cirrhocephalus*	Rare	Absent	Absent	Absent
Little Eagle	*Hieraaetus morphnoides*	Absent	Rare	Rare	Absent
Wedge-tailed Eagle	*Aquila audax*	Rare	Rare	Rare	Absent
FAMILY: ANATIDAE					
Pacific Black Duck	*Anas superciliosa*	Absent	Absent	Rare	Rare
Wood Duck	*Chenonetta jubata*	Rare	Absent	Rare	Absent
FAMILY: ARTAMIDAE					
Australian Magpie	*Gymnorhina tibicen*	Rare	Rare	Rare	Rare
Dusky Woodswallow	*Artamus cyanopterus*	Rare	Absent	Rare	Absent
Grey Butcherbird	*Cracticus torquatus*	Rare	Rare	Rare	Rare
Grey Currawong	*Strepera versicolor*	Rare	Rare	Rare	Absent
Pied Currawong	*Strepera graculina*	Sparse	Sparse	Rare	Sparse
FAMILY: CACATUIDAE					
Galah	*Cacatua roseicapilla*	Rare	Rare	Rare	Absent
Gang-gang Cockatoo	*Callocephalon fimbriatum*	Rare	Rare	Rare	Rare
Sulphur-crested Cockatoo	*Cacatua galerita*	Common	Common	Sparse	Sparse
Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*	Rare	Rare	Rare	Rare
FAMILY: CAMPEPHAGIDAE					
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Rare	Rare	Rare	Rare
Cicadabird	*Coracina tenuirostris*	Rare	Absent	Absent	Absent
White-winged Triller	*Lalage sueurii*	Absent	Absent	Rare	Absent
FAMILY: CHARADRIIDAE					
Masked Lapwing	*Vanellus miles*	Absent	Rare	Rare	Absent
FAMILY: CINCLOSOMATIDAE					
Eastern Whipbird	*Psophodes olivaceus*	Rare	Rare	Rare	Rare
Spotted Quail-thrush	*Cinclosoma punctatum*	Rare	Absent	Absent	Rare
FAMILY: CLIMACTERIDAE					
Red-browed Treecreeper	*Climacteris erythrops*	Rare	Rare	Rare	Absent
White-throated Treecreeper	*Cormobates leucophaeus*	Common	Common	Common	Rare
FAMILY: COLUMBIDAE					
Common Bronzewing	*Phaps chalcoptera*	Rare	Rare	Rare	Rare
Peaceful Dove	*Geopelia striata*	Absent	Absent	Absent	Rare
Wonga Pigeon	*Leucosarcia melanoleuca*	Rare	Rare	Rare	Absent
FAMILY: CORCORACIDAE					
White-winged Chough	*Corcorax melanorhamphos*	Rare	Rare	Rare	Rare
FAMILY: CORVIDAE					
Australian Raven	*Corvus coronoides*	Rare	Rare	Rare	Rare
Little Raven	*Corvus mellori*	Rare	Rare	Rare	Rare
FAMILY: CUCULIDAE					
Brush Cuckoo	*Cacomantis variolosus*	Rare	Absent	Rare	Rare
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	Rare	Rare	Rare	Rare
Horsfield's Bronze-Cuckoo	*Chrysococcyx basilis*	Rare	Rare	Rare	Rare
Pallid Cuckoo	*Cuculus pallidus*	Absent	Rare	Absent	Absent
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	Rare	Rare	Rare	Rare

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FAMILY: DICAEIDAE					
Mistletoebird	*Dicaeum hirundinaceum*	Rare	Rare	Rare	Rare
FAMILY: DICRUDIDAE					
Grey Fantail	*Rhipidura fuliginosa*	Common	Common	Abundant	Sparse
Leaden Flycatcher	*Myiagra rubecula*	Rare	Rare	Rare	Rare
Magpie-lark	*Grallina cyanoleuca*	Absent	Rare	Absent	Rare
Rufous Fantail	*Rhipidura rufifrons*	Rare	Rare	Rare	Rare
Satin Flycatcher	*Myiagra cyanoleuca*	Rare	Rare	Rare	Absent
Willie Wagtail	*Rhipidura leucophrys*	Absent	Rare	Rare	Rare
FAMILY: FALCONIDAE					
Brown Falcon	*Falco berigora*	Absent	Rare	Absent	Absent
Nankeen Kestrel	*Falco cenchroides*	Absent	Rare	Rare	Absent
FAMILY: FRINGILLIDAE					
European Goldfinch	*Carduelis carduelis*	Rare	Rare	Rare	Rare
FAMILY: HALCYONIDAE					
Laughing Kookaburra	*Dacelo novaeguineae*	Rare	Rare	Rare	Rare
Sacred Kingfisher	*Todiramphus sanctus*	Rare	Rare	Rare	Rare
FAMILY: HIRUNDINIDAE					
Tree Martin	*Hirundo nigricans*	Absent	Rare	Absent	Absent
Welcome Swallow	*Hirundo neoxena*	Absent	Absent	Rare	Absent
FAMILY: MALURIDAE					
Superb Fairy-wren	*Malurus cyaneus*	Rare	Rare	Rare	Rare
FAMILY: MELIPHAGIDAE					
Brown-headed Honeyeater	*Melithreptus brevirostris*	Rare	Rare	Rare	Rare
Crescent Honeyeater	*Phylidonyris pyrrhoptera*	Rare	Rare	Rare	Rare
Eastern Spinebill	*Acanthorhynchus tenuirostris*	Rare	Rare	Rare	Rare
Noisy Friarbird	*Philemon corniculatus*	Rare	Rare	Rare	Rare
Red Wattlebird	*Anthochaera carunculata*	Common	Rare	Rare	Rare
White-eared Honeyeater	*Lichenostomus leucotis*	Rare	Rare	Rare	Rare
White-naped Honeyeater	*Melithreptus lunatus*	Sparse	Rare	Rare	Rare
Yellow-faced Honeyeater	*Lichenostomus chrysops*	Abundant	Abundant	Abundant	Sparse
FAMILY: MENURIDAE					
Superb Lyrebird	*Menura novaehollandiae*	Rare	Rare	Rare	Rare
FAMILY: MEROPIDAE					
Rainbow Bee-eater	*Merops ornatus*	Absent	Absent	Rare	Absent
FAMILY: MUSCICAPIDAE					
Bassian Ground Thrush	*Zoothera lunulata*	Rare	Rare	Rare	Rare
Blackbird	*Turdus merula*	Rare	Rare	Rare	Sparse
FAMILY: NEOSITTIDAE					
Varied Sittella	*Daphoenositta chrysoptera*	Rare	Rare	Rare	Rare
FAMILY: ORIOLIDAE					
Olive-backed Oriole	*Oriolus sagittatus*	Rare	Absent	Rare	Rare
FAMILY: PACHYCEPHALIDAE					
Crested Shrike-tit	*Falcunculus frontatus*	Rare	Rare	Rare	Rare
Golden Whistler	*Pachycephala pectoralis*	Rare	Rare	Sparse	Sparse
Grey Shrike-thrush	*Colluricincla harmonica*	Common	Common	Common	Common
Olive Whistler	*Pachycephala olivacea*	Rare	Rare	Rare	Rare
Rufous Whistler	*Pachycephala rufiventris*	Sparse	Sparse	Common	Common
FAMILY: PARDALOTIDAE					
Brown Thornbill	*Acanthiza pusilla*	Sparse	Sparse	Sparse	Sparse
Buff-rumped Thornbill	*Acanthiza reguloides*	Rare	Rare	Absent	Rare
Pilotbird	*Pynoptilus floccosus*	Rare	Rare	Rare	Rare
Spotted Pardalote	*Pardalotus punctatus*	Common	Sparse	Sparse	Rare
Striated Pardalote	*Pardalotus striatus*	Common	Sparse	Rare	Rare
Striated Thornbill	*Acanthiza lineata*	Rare	Rare	Rare	Rare
Western Gerygone	*Gerygone fusca*	Rare	Absent	Absent	Absent
White-browed Scrubwren	*Sericornis frontalis*	Sparse	Common	Common	Abundant
White-throated Gerygone	*Gerygone olivacea*	Rare	Rare	Rare	Absent
Yellow Thornbill	*Acanthiza nana*	Rare	Absent	Absent	Rare
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	Absent	Rare	Rare	Absent

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FAMILY: PASSERIDAE					
Red-browed Finch	*Neochmia temporalis*	Rare	Rare	Rare	Rare
FAMILY: PETROICIDAE					
Eastern Yellow Robin	*Eopsaltria australis*	Rare	Sparse	Sparse	Sparse
Flame Robin	*Petroica phoenicea*	Rare	Rare	Rare	Rare
Red-capped Robin	*Petroica goodenovii*	Absent	Absent	Absent	Rare
Rose Robin	*Petroica rosea*	Rare	Rare	Rare	Rare
Scarlet Robin	*Petroica multicolor*	Rare	Rare	Rare	Rare
FAMILY: PHALACROCORACIDAE					
Little Black Cormorant	*Phalacrocorax sulcirostris*	Rare	Absent	Absent	Absent
FAMILY: PSITTACIDAE					
Crimson Rosella	*Platycercus elegans*	Sparse	Common	Common	Sparse
Eastern Rosella	*Platycercus eximius*	Absent	Rare	Absent	Absent
King Parrot	*Alisterus scapularis*	Rare	Rare	Rare	Rare
FAMILY: PTILONORHYNCHIDAE					
Satin Bowerbird	*Ptilonorhychus violaceus*	Rare	Rare	Rare	Rare
FAMILY: STURNIDAE					
Common Starling	*Sturnus vulgaris*	Absent	Rare	Rare	Absent
FAMILY: ZOSTEROPIDAE					
Silvereye	*Zosterops lateralis*	Rare	Rare	Rare	Sparse

Some interesting results were obtained from surveys and these have been reported in detail elsewhere (Lindenmayer et al. 2002). For example, the rare Olive Whistler (*Pachycephala olivacea*) was unexpectedly recorded in stands of Radiata Pine and the species was closely associated with thickets of the understorey invasive weed Blackberry (*Rubus fructicosus*). Other species (e.g. Cicadabird [*Coracina tenuirostris*]) occurred only in the eucalypt "controls" and were absent entirely from all other kinds of sites including large (120+ ha) eucalypt patches and strips.

Extensive analyses of field data gathered on birds have been completed (Lindenmayer et al. 2002). Some general findings to date include:

- Landscape context is important for many bird species — conditions in the matrix (here extensive plantations of exotic Radiata Pine) considerably influence their presence and abundance in remnant eucalypt patches.

- Larger remnants supported more species of birds. However, even small and intermediate eucalypt remnants had considerable value for forest birds and were used by many taxa for shelter and breeding.

- Important interactions occurred between the remnant eucalypt patches and the Radiata Pine. For example, many bird species occurred in the matrix because of the spatial juxtaposition of the two landscape context classes.

- Structural complexity within the Radiata Pine matrix (e.g. large eucalypt logs and native understorey vegetation) strongly influenced the ability of some birds and small mammals to persist.

The list in Table 1 should be of broad interest to an increasing number of researchers working on habitat fragmentation (reviewed by McGarigal and Cushman 2002; Fahrig 2003; Lindenmayer and Fischer 2006) as well as the many workers studying the biodiversity values of plantation landscapes (e.g. Estades and Temple 1999; Kavanagh et al. 2005; Hobbs et al. 2006).

Field surveys of birds at Tumut are ongoing and major re-counts will be recommenced in the coming years as large parts of the plantation estate are clearfelled and new stands are established as part of second and third rotation forestry. Quantification of landscape context effects whereby old (30+ year) stands are replaced by young regrowth (2-5 year old) plantation pine.

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