Greenshank *Tringa nebularia*
Curlew Sandpiper *Calidris ferruginea*
Red-necked Stint *C. ruficollis*
Sharp-tailed Sandpiper *C. acuminata*
Silver Gull *Larus novaehollandiae*
Pacific Gull *L. pacificus*
Caspian Tern *Hydroprogne tschegrava*
Crested Tern *Sterna bergii*
Feral Pigeon *Columbia livia* (introduced)
Common Bronzewing *Phaps chalcoptera*
Yellow-tailed Black Cockatoo *Calyptorhynchus funereus*
Musk Lorikeet *Glossopsitta concinna*
Eastern Rosella *Platycercus eximius*
Green Rosella *P. caledonicus*
Blue-winged Parrot *Neophema chrysostomus*
Swift Parrot *Lathamus discolor*
Pallid Cuckoo *Cuculus pallidus*
Fan-tailed Cuckoo *Cacomantis pyrrophanus*
Horsfield Bronze Cuckoo *Chrysococcyx basalis*
Golden Bronze Cuckoo *C. l. plagosus*
Boobook Owl *Ninox novaeseelandiae*
Laughing Kookaburra *Dacelo novaeguinae* (introduced)
Skylark *Alauda arvensis* (introduced)
Welcome Swallow *Hirundo t. neoxena*
Tree Martin *Petrochelidon nigricans*
Pipit *Anthus novaeseelandiae*
Black-faced Cuckoo-Shrike *Coracina novaehollandiae*
Blackbird *Turdus merula* (introduced)
Spotted Quail-Thrush *Cinclosoma punctatum*
Little Grassbird *Megalurus gramineus*
Reed Warbler *Acrocephalus stentoreus*
White-fronted Chat *Ephthianura albifrons*
Yellow-tailed Thornbill *Acanthiza chrysorrhoa*
Brown Thornbill *A. pusilla*
Tasmanian Thornbill *A. ewingii*
Scrub Tit *Acanthornis magnus*
Brown Scrub Wren *Sericornis humilis*
Striated Field Wren *Calamanthus fuliginosus*
Superb Blue Wren *Malurus cyaneus*
Grey Fantail *Rhipidura fuliginosa*
Satin Flycatcher *Myiagra cyanoleuca*
Scarlet Robin *Petroica multicolor*
Flame Robin *P. phoenicea*
Pink Robin *P. rodinogaster*
Dusky Robin *P. vittata*
Golden Whistler *Pachycephala pectoralis*
Olive Whistler *P. olivacea*
Grey Shrike-Thrush *Colluricincla harmonica*
Spotted Pardalote *Pardalotus punctatus*
Yellow-tipped Pardalote *P. striatus*
Silvereye *Zosterops lateralis*
Crescent Honeyeater *Phylidonyris pyrrhoptera*
Yellow-winged Honeyeater *P. novaehollandiae*
Tawny-crowned Honeyeater *P. melanops*
Eastern Spinebill *Acanthorhynchus tenuirostris*
Noisy Miner *Myzantha melanocephala*
Little Wattlebird *Anthochaera chrysoptera*
Yellow Wattlebird *A. paradoxa*
Strong-billed Honeyeater *Melithreptus validirostris*
Black-headed Honeyeater *M. affinis*
Yellow-throated Honeyeater *Meliphaga flavicollis*
Goldfinch *Carduelis carduelis* (introduced)
Greenfinch *C. chloris* (introduced)
Dusky Woodswallow *Artamus cyanopterus*
House Sparrow *Passer domesticus* (introduced)
Starling *Sturnus vulgaris* (introduced)
Black Currawong *Strepera fuliginosa*
Clinking Currawong *S. arguta*
Grey Butcherbird *Cracticus torquatus*
White-backed Magpie *Gymnorhina hypoleuca*
Tasmanian Raven *Corvus mellori*

CENSUS OF DRY SCLEROPHYLL

H. F. RECHER, D. G. THOMAS and D. R. MILLEDGE

INTRODUCTION

Traditionally, the principal activity of the annual Field-outing of the RAOU has been the compilation of a bird-list for the area visited. It has been thought that, with only a slight change in emphasis, the Field-outing could contribute more valuably to our knowledge of the Australian avifauna. Accordingly, the programme of the 1969 Field-Outing in Tasmania was to make a detailed survey of the avifauna of dry sclerophyll forest that will be affected by the woodchip industry. The censuses of four x 20,250 m² plots made during the Field-outing are reported in this paper and are discussed with respect to possible effects of woodchip operations on wildlife.

Until recently the dry sclerophyll forests along the coast of south-eastern Australia had limited commercial value. Most logging was selective and did not seriously alter the environment. Now, techniques and markets are available that allow more intensive use. The new methods completely clear extensive areas and will result in conversion to stands of timber of the same age. The wood itself will be 'chipped' and the woodchips exported. Tasmania and the southern coast of New South Wales will be the first areas affected by this new industry, and fears have been expressed as to possible effects on wildlife. Complete clearance for woodchips will certainly have a more obvious effect on habitats than do traditional forestry methods, but without greater knowledge of the ecology of wildlife in dry sclerophyll forests it is difficult to predict, or even guess, what these effects will be.

METHODS

The four 20,250 m² plots were set out along the Lake Leake Highway, about 16 km east of Campbell Town, from 0.8 to 1.6 km apart and situated on the edge of the Eastern Tiers, which are included in the woodchip concession and close to the site of the first processing plant. The area is at an altitude between 300 and 600 m with an annual rainfall of about 760 mm. Vegetation, apart from cleared land, is dry sclerophyll forest with eucalypts as dominants, the species varying with aspect, soil, drainage and altitude. The plots were typical of the area, and all had been altered by logging and light sheep-grazing. Each was surrounded by large areas of similar habitat, and each appeared to be uniform. Although they were close together, plots differed in appearance and were selected to represent the range of habitat in the area.

Plot 1. An area of open forest with one corner bordered by a grassy field. It has been logged within the last two years, and most of the trees are fairly small (< 20 m) *Eucalyptus dalrympleana* with a few mature *E. dalrympleana* and *E. aggregata*. There is a sparse understorey of young eucalypts, but little bushy vegetation. The low shrub-layer is continuous but open, primarily small wattles *Acacia* sp., sedges and bracken.

Plot 2. This area has been logged within the last twelve months, but many over-mature trees have been left.

The canopy is open, but the tree-cover is more continuous than on the other plots; some trees are over 40 m high. The dominant species are *E. obliqua* and *E. dalrympleana*. The understorey is well developed and consists of wattles and young eucalypts. The medium and low shrub-layer is thick and consists mostly of bracken, sedges and wattles. The area appears to be less heavily grazed than the other plots, but is scarred by logging roads and skid marks.

Plot 3. An area of open forest on lower and wetter ground. Dominants, up to 25 m high, are *E. dalrympleana* and *E. aggregata*. The low shrub and herbaceous layers are lush, but heavily grazed grasses and sedges including clumps of Cutting Grass (*Gahnia* sp.). The understorey is very sparse and consists of scattered wattles and small eucalypts. The forest has been logged within the last twelve months.

Plot 4. Similar to Plot 3, but with more open tree-cover. The dominant tree is *E. dalrympleana*. Fairly heavy grazing, and earlier cutting and firing, has resulted in a sparse shrub-layer.

Each plot was censused four times between 29 October and 3 November 1969. Those taking part were divided into four parties under the direction of a leader familiar with the objectives of the project and with censusing techniques. The plots were censused once by each group, and the separate observations combined to provide an estimate of the birds using or breeding on the plots. Attention was also paid to birds occurring in the surrounding forest. Each party consisted of at least six observers, and it ought to have been possible to census the entire plot simultaneously with each individual recording birds from a small section of the plot. In practice, the most experienced observer(s) criss-crossed the plot recording birds present, while the others worked primarily in locating nests and recording other signs of breeding: singing males, 'courtship feeding', feeding young or carrying nesting material.

RESULTS

Forty species were recorded on or near the census plots (Table I); eleven of these are endemic to Tasmania. All are known to breed in dry sclerophyll forest, but none is restricted to it. Only four other species (Swamp Quail *Coturnix ypsilophorus*, Tawny Frogmouth *Podargus strigoides*, Owlet-Nightjar *Aegotheles cristata*, Dusky Woodswallow *Artamus cyanopterus*) occur commonly in dry sclerophyll forest although several others have been recorded (Ridpath and Moreau 1966), but not necessarily breeding.

The home-ranges of most species are probably greater than 20,000 m^2, and it is not possible to provide the precise number of individuals on any plot. We can, however, list the species recorded and those having nests or young, and average the numbers of birds of each species recorded during each census. These data give a comparative measure of species diversity and population density. Although forty species were recorded for all plots, the highest number occurring on any plot was twenty-six on Plot 2 (Table II). Only fifteen were seen on Plot 3, eighteen on Plot 1, and twenty-two on Plot 4. Some of these were transients and were seen only once. Some occurred often enough to suggest that their home-range included all or part of a plot. Nests or other indications of breeding were noted for twelve species. To obtain an estimate of the number of species for each plot, the data can be analysed in two ways. In the first, only species with nests or which showed unmistakable signs of breeding were counted (Table II). The second method ignores breeding activity and simply uses the mean number of individuals of each species recorded during the four censuses. This gives a species-count that can be used to calculate an index of diversity weighted for the relative abundance of species. We used the 'Shannon-Wiener Function' (see MacArthur and MacArthur 1961)

$$H = -\sum_i p_i \log_e p_i$$

where p_i is the proportion of the ith species. H is a measure of the uncertainty of the census because it measures the probability that the second bird seen will differ from the first, the third from the first and second, and so forth. However, the index is more expressive in the present case if transformed into the 'number of equally common species', which is given by

$$\text{number of equally common species} = e^H$$

DISCUSSION

Whether we determine species number for each plot from the number of known breeding pairs or from e^H, the results are essentially the same (Table II). Plots 1, 3 and 4 have about the same number of breeding birds, but Plot 2 is much richer and also has the greatest number of individuals. Plot 3 appears to have the fewest species and individuals.

Recher (1969) recorded diversities (e^H) of 10.3 and 14.8 for species of birds in two plots of dry sclerophyll forest on the central coast of New South Wales. These values are similar to those found in comparable temperate-zone habitats in the Northern Hemisphere. This limited study suggests that the avifauna of Tasmanian dry sclerophyll forests is as rich at any single point as the avifaunas on the Australian mainland or in Northern Hemisphere forests. However, like other islands, Tasmania has fewer species than nearby continents (Ridpath and Moreau 1966). Consequently, there are fewer differences in composition of the avifauna from place to place or from habitat to habitat, and few Tasmanian birds are restricted to dry sclerophyll forests. In other words, extending the study to include larger areas of dry sclerophyll forest would not result in a similar steady increase in the number of species recorded.

Twenty-one of the forty species recorded occurred on more than one plot and nine on all four. Of the sixteen species recorded only in one plot, nine are either uncommon, e.g. the bronze cuckoos, or have large home-ranges, e.g. raptors, and probably occurred fortuitously; this further suggests that differences between plots are few. Only Plot 2 stands out as having a greater number of species and individuals. In spite of having been logged recently many large trees remain in it, and it has a well-developed understorey and dense bush-layer. The understorey and bush-layers are less well developed on the other plots, and this probably accounts for the differences between these and Plot 2.

All four plots have been logged and grazed by domestic stock, and cannot be considered natural or primaeval. Yet they and similarly affected forests and forest-edges of the area support a large number of birds. The logging has been highly selective. Few trees are removed from any area and even then many large trees are left. Logging has created openings in the forest where the growth of bushy vegetation and smaller trees has been encouraged. In comparison, the effects of grazing and irregular burning to encourage new growth for stock seem negligible. Probably past logging has improved the habitat for wildlife. The creation of open spaces and edges has added considerable diversity to what otherwise might have been unbroken forest. Complete clearing will have the opposite effect; diversity of the habitat will be

TABLE I

Bird censuses for four plots of dry sclerophyll forest

	Mean no. of individuals per census			
	Plot 1	Plot 2	Plot 3	Plot 4
Brown Goshawk *Accipiter fasciatus*		0.25		
Collared Sparrowhawk *A. cirrhocephalus*				0.25
Brown Falcon *Falco berigora*		Recorded in area		
Common Bronzewing *Phaps chalcoptera*			0.25	
*Green Rosella *Platycercus caledonicus*	0.50	5.00†	3.00	1.25
Blue-winged Parrot *Neophema chrysostomus*				1.25
*Swift Parrot *Lathamus discolor*	0.25	0.75		
Pallid Cuckoo *Cuculus pallidus*	1.50	0.75		0.50
Fan-tailed Cuckoo *Cacomantis pyrrhophanus*		0.50		0.25
Horsfield Bronze Cuckoo *Chrysococcyx basalis*		0.25		
Golden Bronze Cuckoo *C. lucidus*				0.25
Boobook Owl *Ninox novaeseelandiae*	0.25			
Kookaburra *Dacelo novaeguinae*	0.75	0.25		1.00
Tree Martin *Petrochelidon nigricans*		1.75		
Pipit *Anthus novaeseelandiae*		Recorded in area		
Black-faced Cuckoo-Shrike *Coracina novaehollandiae*	1.25†	1.50	1.50	0.25
Spotted Quail-Thrush *Cinclosoma punctatum*		0.50†	0.25	0.50
Brown Thornbill *Acanthiza pusilla*	5.75†	1.00		1.00
*Brown Scrub Wren *Sericornis humilis*		1.25		
Superb Blue Wren *Malurus cyaneus*	4.00†	3.50†	1.00	4.75
Grey Fantail *Rhipidura fuliginosa*		2.25		
Satin Flycatcher *Myiagra cyanoleuca*		0.50		
Scarlet Robin *Petroica multicolor*	0.75	1.25‡		
Flame Robin *P. phoenicea*	1.00	1.00	1.25	
Dusky Robin *P. vittata*		1.75‡	0.50	
Golden Whistler *Pachycephala pectoralis*		Recorded in area		
Grey Shrike-Thrush *Colluricincla harmonica*	1.25	2.50	2.50	1.25
Spotted Pardalote *Pardalotus punctatus*				1.50
*Yellow-tipped Pardalote *P. striatus*	4.50†	4.00†	5.25†	4.75†
*Yellow-throated Honeyeater *Meliphaga flavicollis*	0.25	4.00	3.50†	2.75
*Black-headed Honeyeater *Melithreptus affinis*	2.50	3.25	2.25†	1.75
*Strong-billed Honeyeater *M. validirostris*	0.50	5.00		0.50
New Holland Honeyeater *Phylidonyris novaehollandiae*				1.00
Eastern Spinebill *Acanthorhynchus tenuirostris*		0.50	0.50	0.50
Little Wattlebird *Anthochaera chrysoptera*		Recorded in area		
*Yellow Wattlebird *A. paradoxa*	2.00†	2.00	0.50	2.00
Starling *Sturnus vulgaris*				0.25†
*Black Currawong *Strepera fuliginosa*			0.50	
*Clinking Currawong *S. arguta*	1.75			
Raven *Corvus tasmanicus*	0.50	0.75	0.25	0.25

NOTE: * Endemic species marked with an asterisk.
† Nesting in plot.
‡ Young noted in plot.

TABLE II

No. of species and size of population

Plot	1	2	3	4
No. species	18	26	15	22
No. pairs of birds nesting	9	15	7–8	9
No. equally common species (e^H)	11.1	15.0	10.1	10.8
No. individuals	29	46	23	28

reduced and a uniform forest environment created. Some birds will benefit greatly, but others will be eliminated. Those benefited and those affected adversely would change as the forest matured. Those unable to survive immediately after complete clearing would do well once the forest matured, and vice versa. It is important, therefore, that some areas of each stage of forest succession be always preserved to ensure that breeding stocks of all species will have a place suitable for nesting, from which they can colonize surrounding areas as these mature or as they are cut.

We do not wish to suggest that woodchip operations will not affect wildlife. We merely point out that if managed with consideration for its requirements, the woodchip industry need not be an ecological disaster.

There are many ways in which the industry could have disastrous consequences for wildlife. Clearing very large areas without considering the mobility of the various species could result in a gradual loss of those that disperse slowly. To reafforest cleared areas with exotics (e.g. pines) or restrict the regrowth of the native forest to a few species (i.e. tending towards monoculture) would greatly reduce the number and kinds of animals (both vertebrates and invertebrates) able to survive. Elimination of undergrowth or of understorey vegetation and the use of controlled burning to reduce fire-hazard could also affect wildlife adversely. It would also be wise to leave some over-mature trees to provide nest-sites for hole-nesting species.

It is important that forestry practices in the woodchip concessions (and elsewhere) be determined in consultation with persons familiar with the ecology and behaviour of native plants and animals. Done correctly, the woodchip industry can not only contribute to Australia's economic prosperity, but can assist materially in the conservation of its wildlife.

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