SCIENCE AND RESEARCH INTERNAL REPORT 1.
PRELIMINARY MODELLING OF IMPACTS OF LOGGING ON FOREST BIRDS IN SOUTH WESTLAND.

by

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PRELIMINARY MODELLING OF IMPACTS OF LOGGING ON FOREST BIRDS IN SOUTH WESTLAND.

1.0 INTRODUCTION

In September 1981 the Ministers of Forests and the Environment announced a package of measures for South Westland which included a moratorium on timber production until 1990 in all State Forests south of the Cook River. In 1983 an officials committee recommended that the multi-disciplinary research effort required to enable classification of forests within the moratorium area should be accelerated so that decisions could be made on the future of the forests by 1986 (Sinclair 1983). The New Zealand Wildlife Service (now incorporated into the Department of Conservation) began a detailed assessment of the birdlife of forests in the moratorium area and research into the impacts of logging on bird populations in 1983.

In 1986 the Government directed the Secretary for the Environment to convene a committee to secure an agreed package consistent with existing government policies for land allocation and use in the moratorium area. The committee was to report back to Government by December 1988. A public discussion document was published by the Secretary for the Environment in November 1987 and public comments invited by January 1988.

The impact of possible logging on wildlife in South Westland is a key issue in the land allocation exercise. This paper forms a preliminary statement about the type of data currently being analysed by Science Directorate, Department of Conservation, so that a model for predicting impacts of logging can be finalised. In the interim this report forms a framework for public consideration on issues relevant to potential impacts of logging. The majority of studies of the effects of logging have been concerned with animal numbers in forests which have already been logged, usually comparing numbers with nearby forests which have not been logged, or with forest logged at different times (e.g. MCClure and bin Othman 1965, Gashwiler 1970, Crook et. al. 1977, Onley 1983, Spurr 1984, Taylor 1985). These studies have shown reductions in bird richness and diversity, disappearance of sensitive endemic species, and lack of recolonisation even after decades of regeneration. However, these studies have not shown how loss of critical structural elements in the forest is directly correlated with the loss of birds.

This methodological approach has shown that under the circumstances tested logging was detrimental to bird populations, but it has not provided information which coul-d be used for assessing new logging techniques. Proposals for new logging techniques have been suggested partly because they are thought to have lower impacts on wildlife (e.g. James 1980, 1985). These techniques may become economically viable in the near future, thus increasing the need for a framework to predict the impacts of logging on forest birds. This framework must be able to deal with the changing techniques used in current logging practices and new approaches which may arise in the future.

Such a framework is outlined in this paper. It is based on detailed knowledge of the specific habitat requirements of forest birds in an area proposed for logging. By identifying which structural elements in the forest are preferred and critical to individual species and which elements are targeted in proposed logging the model is able to predict the amount of preferred habitat remaining after the logging.

Seven tree species in South Westland rainforests are merchantable. Two, rimu and silver beech, are the most widely harvested indigenous timber trees in New Zealand, rimu as sawlogs and beech primarily as chipwood.

This report is preliminary and data are not to be quoted in print without prior approval from the Director (Science and Research) Department of Conservation, Wellington. The contents of this report demonstrate how the model can be used for,selected forest bird species and as applied to several merchantable tree species. It is not intended as complete coverage of all forest species. Additional analyses are currently under way and a comprehensive manuscript outlining the model and probable impacts of logging on the forest bird community as a whole is planned for completion by April 1988.

2.0 METHODS

The habitat requirements of 26 forest bird species were studied in unmodified temperate rainforests in South Westland proposed for future logging (O'Donnell and Dilks 1986, and in prep.). The study was undertaken in the Windbag Valley, an inland montane valley situated immediately south of the Paringa River, between Lakes Paringa and Moeraki. The valley has been described in detail-in O'Donnell and Dilks (1986). This area was chosen as almost all major forest types representative of South Westland could be found in close proximity. A major component of the study was the quantification of use by each bird species of 58 plant species groups according to plant size and age, and whether or not they were preferred for feeding (O'Donnell and Dilks in prep (A)). Data were expressed as percent use of each plant species, both overall and seasonally. O'Donnell and Dilks (in prep. (A)) defined which tree species and sizes were critical for each bird, those plants which were used at random, and those not preferred. In this paper we use sections of these data relating to the use of canopy trees to predict the impact of logging on igdividual bird species.

2.1 Defining plant preferences

The association between the observed frequency of use by birds and the availability of plant species is tested to determine which plant species are preferred by each bird species. Forest composition along the transects and availability measures were derived using Forest Reconnaissance (Recee) Plots (Allen and McLennan 1983) and Variable Area Plots (Batchelor and Craib 1985). Three measures of availability have been tested, each having different strengths as an indicator of "habitat availability" (O'Donnell and Dilks in prep (A)).

-Stems per hectare is the most easily measured and has least variability. It is used by foresters to calculate timber availability, but is least sound ecologically.

-Basal area is a good estimator of plant biomass and is an appropriate measure of habitat availability for birds which are trunk and bark foragers.

-Percent cover is a more appropriate measure for foliage gleaners.

Because most forest birds use a wide range of microhabitats, we have used all three measures to determine overall preferences. Chi-square tests or G-tests for independence are the most appropriate statistical analyses to test significant associations

(Sokal and Rohlf 1981).

We have defined the following terms:

a) When percent use of a plant is statistically less than expected, this indicates non-preference for that species.

b) When use is statistically greater than expected, this indicates preference for that particular plant.

-Tree species for which use is greater than expected for all three measures of availability are defined as "critical".

-Trees for which use is greater than expected for two measures of availability are defined as "focal".

c) When the statistical analyses vary between preference, non-preference and non-significance with different tests, the value of that tree is considered indeterminate.

d) When there is no significant differences between use and availability of a tree this denotes that the species is being used randomly/incidentally. That is, the bird is not being selective.

e) Significant values are those for which $p<0.05$

Use was compared with availability collectively over the

Whole year and also seasonally to determine if canopy trees were preferred in any particular month of the year.

2.2 Predicting percent loss of preferred plants under different logging regimes.

Once preferences are determined we can predict habitat loss and assess level of impact under different logging regimes. We can assume removal of tree species which are preferred would detrimentally affect the birds which use them. For all plants which are preferred we can calculate percent habitat loss for different logging regimes. We assume that logging will be based on selected target tree species and preferred stem diameter (diameter breast height,dbh) classes. We calculated the number of stems (and percent) of each target tree species in each dbh class from the Variable Area Plots. Availability was compared with percent use of each dbh class by calculating the percent of preferred stems in each dbh class.

We calculated for each preferred tree species the percent of stems in each merchantable dbh class from our data on stems/ha/dbh class. Merchantable stems were defined using criteria used in the past by N.Z. Forest Service: merchantable rimu and beech sawlog stems being 25 cm dbh and over and beech chipwood stems being over 10 cm (R.H. Robinson pers. comm.). We compared this information graphically with the percent of observations of birds in each dbh class.

2.3 Assessing impacts of logging

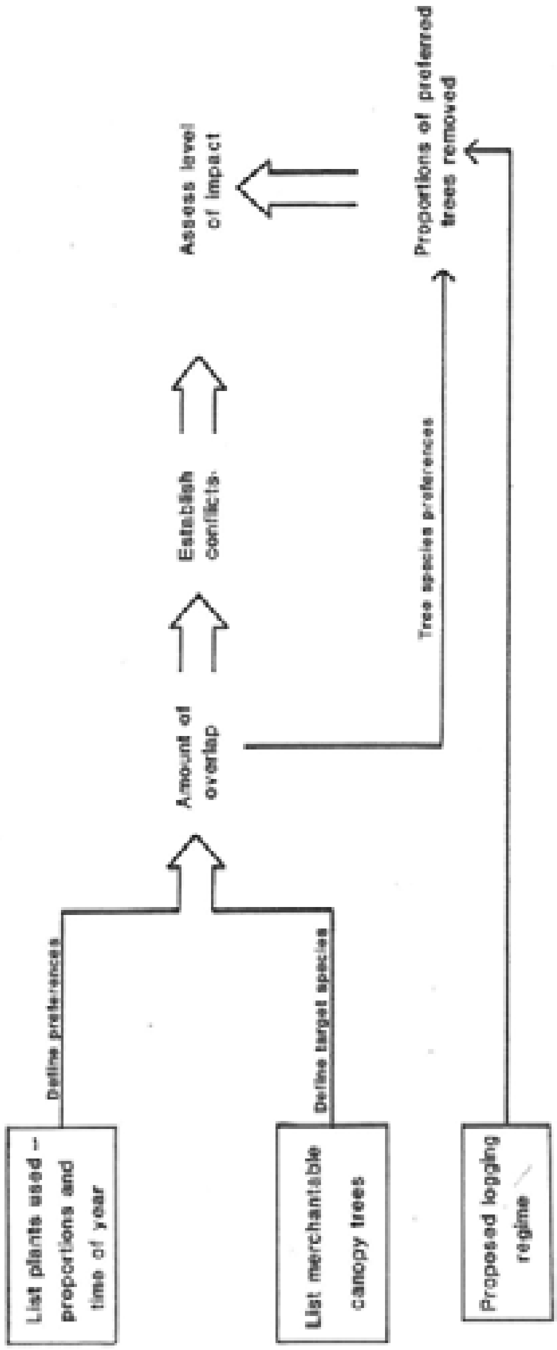
The above calculations enable us to show percent habitat loss with different extraction regimes. The pathways for reaching This stage are illustrated in Figure 1. Using the model we can then judge which level of extraction will remove the least amount of preferred habitat.

We make the following assumptions:

1. Removal of "critical" trees will have serious consequences for birds because of loss of preferred habitat.

2. Removal of "focal" trees will adversely affect birds using them because an important component of the preferred habitat is removed.

Figure 1. Pathway for assessing the impacts of logging.



3. Removal of trees for which frequencies of use and availability are not significantly different may or may not adversely affect the birds using them.

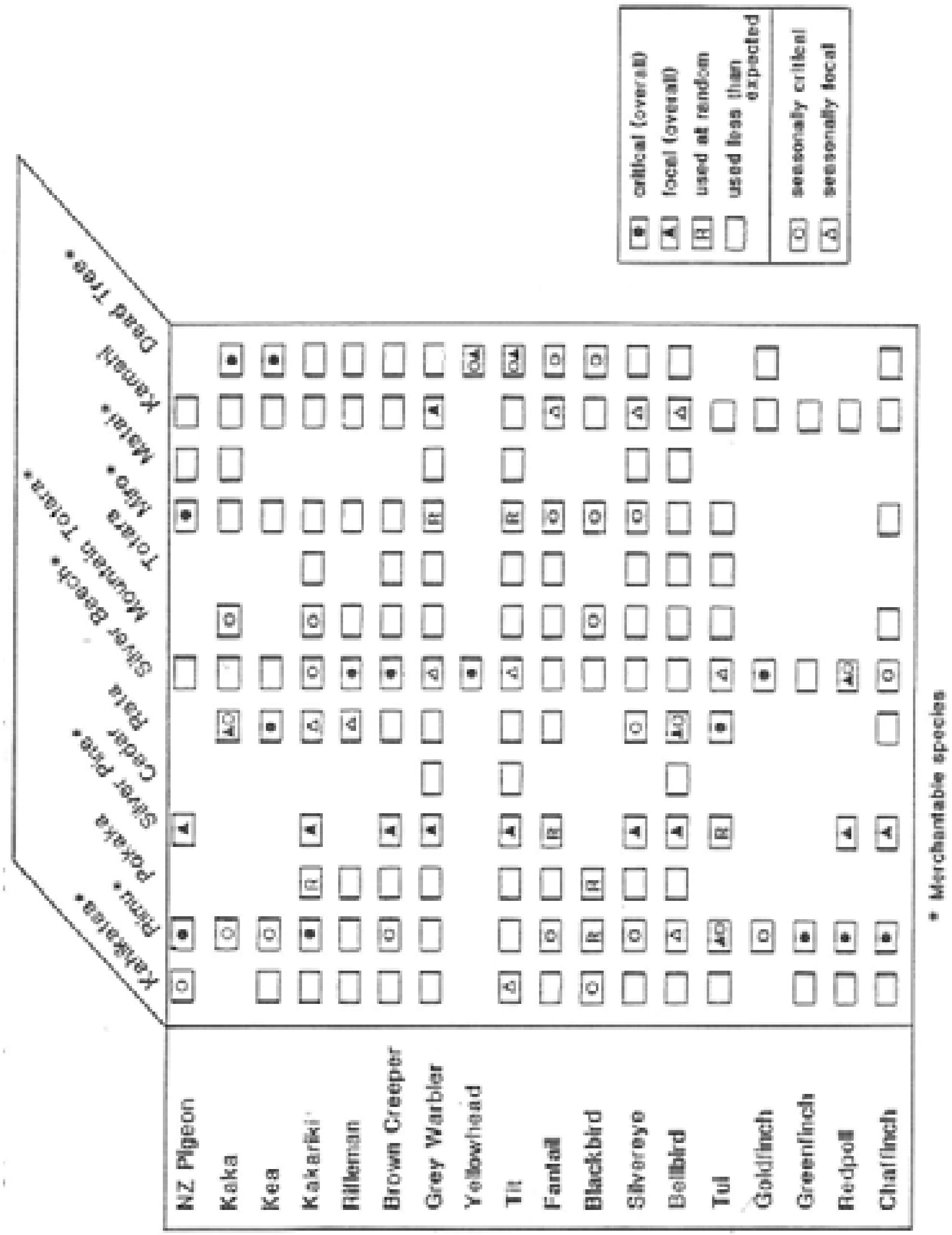
4. Removal of non-preferred trees would be less likely to affect birds.

3.0 RESULTS

3.1 Merchantable tree species preference

We quantified use of plant species by 18 forest bird species (O'Donnell and Dilks in prep.(A)) and tested whether the eight merchantable species were preferred or not by each bird. There were 81 species of vascular plants and ferns recorded in the study area. These were catagorised into 58 species groups used by forest birds (O'Donnell and Dilks in prep.(A)). Of 47,813 feeding observations recorded, nearly 70% were in 13 species of canopy tree, and 422 in the eight merchantable species. The results are summarised in Figure 2. Rimu was critical or focal for 13 of the 18 bird species. and silver beech for ten species. Standing dead trees were critical for two rare and threatened species, kaka and yellowhead. Kahikatea was critical for only one native species, the New Zealand pigeon. Kakariki (parakeets), which are also rare in South Westland, preferred five canopy species (Figure 2).

Figure 2: Canopy tree species preferences in South Westland forest birds (gaps indicate plants not used by particular bird species).



Sections 3.3 - 3.5 summarise results for the main merchantable species (rimu, silver beech and dead trees) in more detail. Rimu, standing dead trees and windblown trees are the likely main target for future sustained yield systems in South Westland (Secretary for the Environment 1987).

3.2 Rimu

Despite its relatively small biomass in the forest (6-14%, O'Donnell and Dilks in prep. (A)), rimu was used by all species except yellowhead. Over 40% of feeding observations of N.Z. pigeon, kakariki, greenfinch, redpoll and chaffinch occurred in this species. Rimu was highly preferred by these species overall, and was seasonally critical for a further seven species, including the endemic kaka, kea, tui and brown creeper. Seasonal use of rimu varied significantly for 14 species. Many species preferred it in autumn and winter (February - June), when fruit or seeds were available.

Rimu stems <20 cm dbh represented over 50% of stems available, but six bird species (N.Z. pigeon, kaka, tui, blackbird, redpoll and goldfinch) did not use plants of that size at all. Other birds used stems <20 cm dbh less than 5% of the time, except for silvereyes (17%) and tits (28%), Trees with large diameter stems from 60 cm to over 200 cm dbh represented <15X of stems in the forest, but received 70-90% of use by N.Z. pigeon, kaka, kakariki, brown creeper, tui, bellbird, chaffinch, goldfinch, redpoll and greenfinch.

3.3 Silver beech

All species used silver beech, one of the most frequent components in the forest. Beech was the most important plant used by yellowheads (752 of observations). It was also very important for rifleman (452), brown creeper (47%), goldfinch (71%) and redpoll (37%). Silver beech was critical for eight species including kaka, kakariki, chaffinch and the above mentioned species. Seasonal use varied significantly in all but yellowhead and fantail. N.Z. pigeon, kaka and bellbird used silver beech significantly more in spring/summer months. Others used beech more often in autumn and winter (kakariki, brown creeper, goldfinch and tui).

All species preferred large diameter stems. Trees with a diameter of 60-80 cm dbh were the most important for N.Z. pigeon, brown creeper, rifleman, goldfinch, redpoll and chaffinch. Trees 80-100 cm were also very important to kaka and yellowhead and stems >10U cm for kaka and kea. Feeding observations for other species were more evenly spread through the diameter classes >20 cm dbh; use of smaller stems was relatively minor.

3.4 Dead trees

Both standing dead trees and wind thrown trees were used extensively by some forest birds. Dead trees were most important for kaka (10.3% of total observations), kea (20.6Z) and yellowheads (6.5%). Six species preferred dead trees (Figure 2). They were critical overall for kaka and kea, and seasonally critical for the remaining four species. Kaka, rifleman and yellowhead mainly used the large trunks, those with 80-100 cm dbh being most important. Silvereye and grey warbler were the only species which preferred small trunks (<20cm dbh).

3.5 Predicting the impacts of logging

3.5.1 Clear-felling

If clear-felling of rimu were to occur in South Westland (ie removal of all stems >20 cm dbh), and assuming that non-merchantable stems were left intact, between 90 and 100% of preferred trees would be lost to forest birds (Figure 3). Thus almost all the preferred rimu used by 12 species for which rimu is critical would be removed. If silver beech were removed for chipwood and sawlogs (i.e. all stems >10 cm), the resulting habitat loss would be similar (Figure 4). If only beech sawlogs were removed (stems >20 cm), up to c.20X of preferred trees would remain for some species. However, most if not all silver beech

Figure 3 : Impacts of rimu logging: Example of predicted habitat loss if different stem diameter classes are targeted by logging.

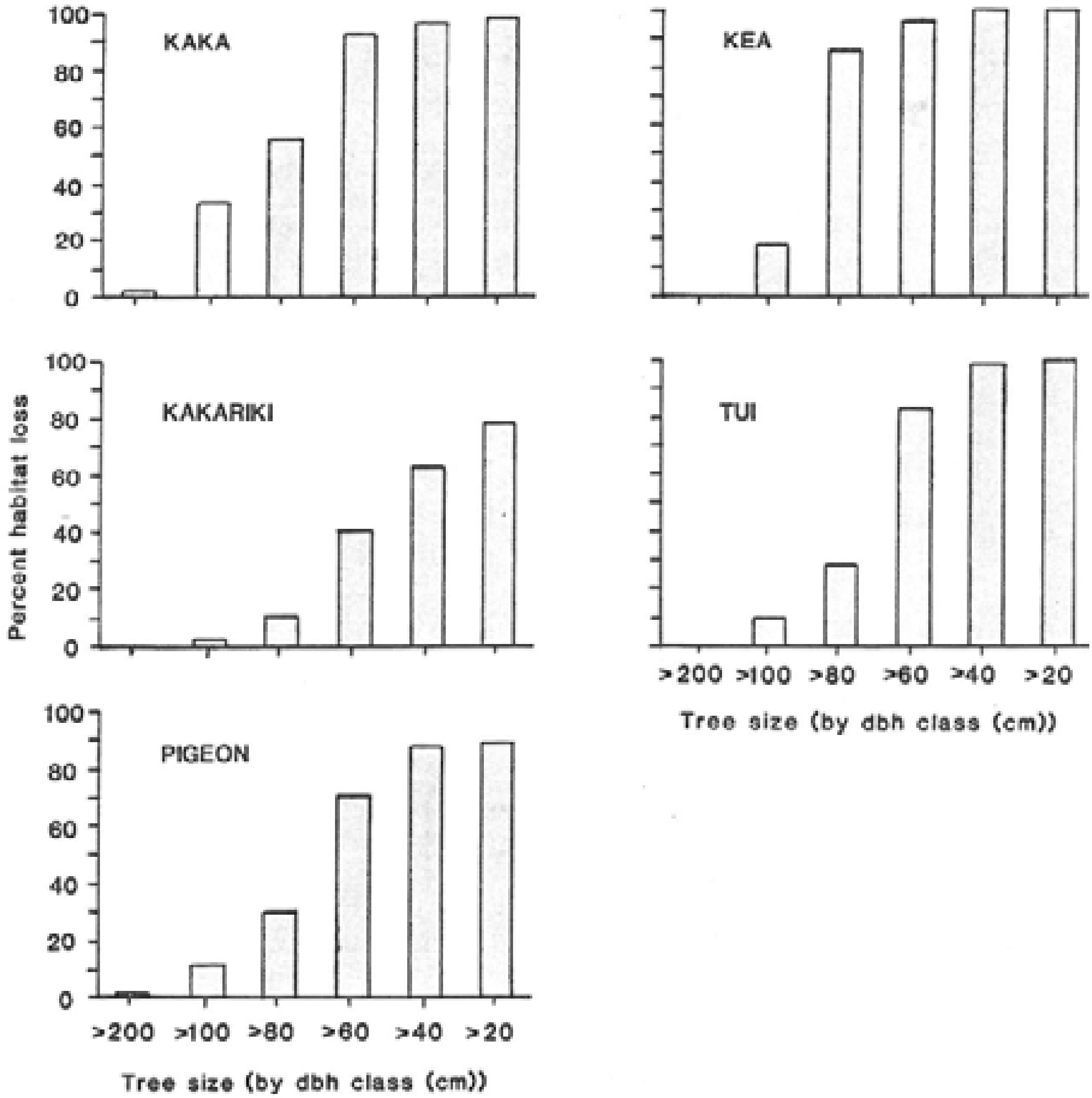
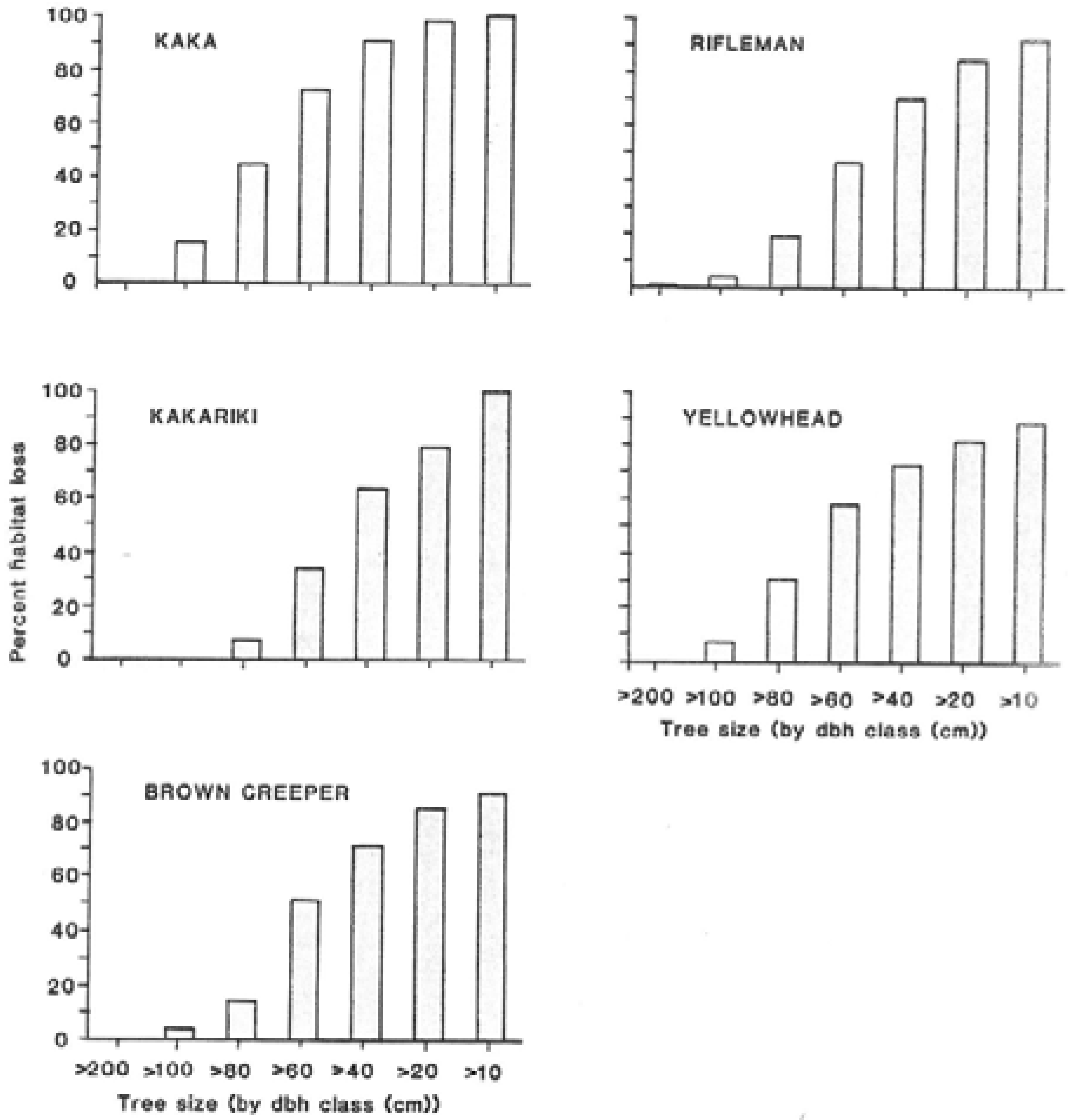


Figure 4: Impacts of silver beech logging: Examples of predicted habitat loss if different stem diameter classes are targeted by logging.



used by kaka, goldfinch, and redpoll would still disappear. In reality, during clear-felling, non-merchantable stems are not left untouched by the logging.

3.5.2 Sustained yield and helicopter logging

Sustained-yield techniques are based on aiming to extract a proportion of merchantable trees on a long term cycle, usually by targeting certain preferred stems or age classes.

The predicted impacts of different logging extraction rates are shown for rimu in Figure 3 and silver beech in Figure 4. These figures illustrate the cumulative effects of taking an increasing proportion of preferred trees out of the forest. In the Windbag Valley rimu extraction of only stems >200 cm dbh would represent removal of <1% of merchantable trees; removal of stems >100cm, 6.72 extraction; >80 cm, 11.2%; >60 cm, 30%; >40 cm, 46.7% and >20 cm, 100%. If rimu trees >200 cm dbh are removed, 2% of kaka habitat and no kakariki habitat would disappear (Figure 3). However, because stems of this size are so rare in the forests, from an economic viewpoint they would make an unrealistic target for logging. If rimu trees >100,.cm dbh are removed (representing only 6.7% of all rimu present)', then over 33% of kaka habitat, 18X of kea habitat, 10 % of tui habitat, 11% of pigeon habitat and 2.5% of kakariki habitat would disappear. The loss of disproportionately large amounts of preferred trees continues through other dbh classes. For example, if rimu >80 cm dbh (1-1.2% of those available) are removed there will be a loss of 55% of kaka habitat, and if trees >60 cm are removed (30% of those available),92% of kaka habitat would disappear. The impact of removing large diameter rimu is least marked in kakariki with losses of 11% of habitat with extraction of 11.2% of trees (trees >80cm dbh), 40% loss with 30% extraction (>60 cm), a 63% loss with 46.72 extraction (>40 cm) and 78% loss if all merchantable trees are logged.

Similar trends can be seen if silver beech is targeted, although-the level of habitat loss is not so extreme if only large diameter trees are removed. For silver beech, extraction of trees >2OO cm dbh represents removal of <1% of stems available; removal of all stems >100cm, 5.2% extraction; >80 cm, 10%; >60 cm, 20%; >40 cm, 40Z; >20 cm, 70%; and >10 cm, 100% of merchantable trees. Extraction of all beech trees >80 cm dbh (10% of trees available) would mean losses of habitat for rifleman (20%), yellowhead (30%), kaka (45%) and brown creeper (152). As with rimu, the most extreme impacts of logging would be with kaka with 20% extraction indicating a 70% loss of preferred trees.

4.0 DISCUSSION

We suggest that trees defined as critical for individual bird species are the most important components of the forest, and their removal will have the most adverse impact. Therefore predicting loss of critical trees under different logging regimes will provide the most sensitive indication of the likely consequences of logging on forest birds. Maintenance of critical trees is the minimum requirement for the conservation of birds which prefer them. Maintenance of other plants is also very important (O'Donnell and Dilks in prep (A) and (B)), but assessment of critical trees provides a bench mark for judging the impacts of logging. Our data substantiate the claims that logging is detrimental to birdlife in New Zealand, and that any future logging in South Westland rainforests would have severe consequences.

Our data indicate that logging impacts are severe, even when very low volumes of trees are extracted, but they also give us a insight into why forest birds have declined or disappeared elsewhere. The fact that large canopy and emergent rimu are critical to so many forest birds is not necessarily surprising; nor is the use of standing dead trees. These preferences have been suggested previously (e.g. Coker and Imboden 1979, Saunders 1983), but empirical data have not been available to substantiate such claims. The logging of large diameter senescent, unstable, standing dead or wind thrown trees is thought to mimic most closely the natural processes of canopy disruption (Smael et.al. 1985) and have a low environmental impact (James 1985). Our habitat-use data indicate that these target trees are highly preferred by many forest birds and that their removal would have a disproportionately severe effect on the birds using them. The first trees marked for removal are those with limited chance of survival to the next felling cycle because of bad lean, broken crowns or rot defect (James and Franklin 1977, Smale et al.1985). The system of coup or patchwork logging initiated in the early 1980s focused on old, even-age stands of rimu (James 1980, Buckman and Orchard 1985, James 1983). Bird species most affected are those which feed largely on invertebrate larvae characteristic of deadwood, or on seasonally abundant fruit or nectar foods which are generally restricted to, or are more abundant on, mature trees. Assertions of low impact of proposed helicopter and portable chainsaw milling may be true in terms of overall forest structure, but not in terms of impacts on the forest bird community. These new sustained-yield techniques not only focus on the very forest trees which are most critical for some forest birds (standing dead, windthrown , and old "over mature" trees), but they also mean that much more extensive forest areas could be subject to management, including those considered historically as "protection forest" because they are too steep or high to log. Because trees of very large diameter are so rare in the forest, each individual tree is probably a focal feeding site and removal would be devastating.

Large trees are generally very old. A sample of rimu in terrace podocarp forest in South Westland indicated that trees over 40 cm dbh were at least 375 years old (Six Dijkstra 1981). Trees 10-20 cm in diameter were 100-200 years old, and stems 20-40 cm generally 150-400 years old. Miro and mountain Totara generally became established at least 150 or more years after rimu and silver pine (Six Dijkstra 1981). The age of senescent trees ranged from 539-646 years. The smallest mature miro tree in the area was 432+ years old, the largest silver pine (53 cm dbh) was 392 years old and the largest mountain totara (25 cm) 367 years old.

Therefore, it seems unlikely that a crop rotation management regime would maintain the values of the forest for the bird community. Silver beech management as practiced in Southland forests is based on a rotation of only 180-200 years, with the average crop being 50-60 cm dbh (Franklin 1981). Beech trees over 100cm dbh may be as old as 400 years (D. Franklin pers. comm.). Any rotation cycle in podocarp or beech forest would not allow trees to grow old enough to become important habitat components for species such as kaka,kakariki and yellowhead. Beech management aims at reducing the number of wood boring insects (Spurr 1984), such as pinhole borer,which are important bird foods even in healthy trees. Tree fungi are also probably important foods for forest parrots (O'Donnell and Dilks in prep (B)); these too are considerably reduced in beech management. Our data have dealtwith availability of preferred feeding habitat. Logging of these old trees also has important implications for hole-nesting birds such as kaka, kakariki, yellowhead and rifleman, all of which depend on snags which usually occur on senescent or standing dead trees.

Generally the birds most dependent on these trees are also those which have been declining and are rare. Kaka, kakariki and yellowhead may be threatened with extinction if factors causing their decline are not halted (O'Donnell and Dilks 1986). These species are now rare or absent in most New Zealand forests, although some local concentrations still remain especially in South Westland where logging would threaten these remaining concentrations. Decline is still continuing even over the last 10-15 years (Gaze 1985, O'Donnell and Dilks 1986).

5.0 ACKNOWLEDGEMENTS.

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7.0 SUMMARY

7.1 A preliminary framework for predicting the impacts of different logging practices on forest birds is introduced.

7.2 The model is based on detailed knowledge of the specific habitat requirements of forest birds. By identifying which structural elements in the forest are preferred and critical to individual species, and which elements are targeted in proposed logging regimes (species, dbh classes, percent extraction), the model is able to predict the amount of preferred habitat remaining after logging.

7.3 Our data indicate that logging impacts in South Westland would be severe, even when very low volumes of trees are extracted. The logging of very large diameter, senescent, unstable, standing dead, or wind thrown trees would have a disproportionately severe effect on the threatened species such as kaka, kakariki and yellowhead.

APPENDIX 1. Binomials of animal names used in the text.

N.Z. pigeon	*Hemiphaga novaeseelandiae*
Kaka	*Nestor meridionalis*
Kea	*Nestor notablis*
Kakariki	*Cyanoramphus auriceps*
Rifleman	*Acanthisitta chloris*
brown creeper	*Finschia novaeseelandiae*
yellowhead	*Mohua ochrocephala*
grey warbler	*Gerygone igata*
fantail	*Rhipidura fuliginosa*
blackbird	*Turdus merula*
tit	*Petroica macrocephala*
silvereye	*Zosterops lateralis*
bellbird	*Anthornis melanura*
tui	*Prosthemadera novaeseelandiae*
goldfinch	*Carduelis carduelis*
greenfinch	*Carduelis chloris*
redpoll	*Acanthis flammea*
chaffinch	*Fringilla coelebs*
pinhole borer	*Platypus spp.*

APPENDIX 2. Binomials of plant names used in the text.

Cedar	*Libocedrus bidwillii*
mountain Totara	*Podocarpus cunninghamii*
miro	*Prumnopitys ferruginea*
matai	*Prumnouitys taxifolia*
kahikatea	*Dacrvcarpus dacrvdioides*
rimu	*Dacrydium cupressinum*
silver pine	*Lanarostrobos colensoi*
rata	*Metrosideros umbellata*
pokaka	*Elaeocarpus hookerianus*
kamahi	*Weinmannia racemosa*
silver beech	*Nothofagus menziesii*