INVESTIGATION NO: S7020/182
CORPORATE OBJECTIVE: 6.4

INVESTIGATION TITLE:	Ecological and economic aspects of Canada goose feeding at Grassmere Station, North Canterbury
STUDY VENUE:	North Canterbury
INVESTIGATION LEADER:	K J Potts
ASSOCIATE RESEARCHERS:	E. Costello and P. Harris, Centre for Resource Management, Lincoln College
INVESTIGATION STATUS:	Manuscripts in process
CLIENTS:	DOC, Acclimatisation Societies
EXPECTED FINISH DATE:	May 1990

INVESTIGATION SUMMARY:
It is when geese in the South Island concentrate on lakes and tarns (mainly from autumn-spring) that they are of most concern to farmers, since it is principally from these bases that they have access to the highest quality farmland (geese are attracted to specific lakes and tarns which are associated with cultivated farmland). This study examines the way in which geese using one high country lake (Lake Grassmere) exploit crops and pastures in the area. Stock displacement and cost effects of such feeding are also investigated, and recommendations are made on how geese and agriculture might be better harmonised. Figure 1 shows the study area.

OBJECTIVES:
The two year field study of feeding on farmland (1984-86) was undertaken for two purposes:

1. To provide a theoretical basis for setting up diversionary cropping programmes and other means of minimising goose damage to farmland,

2. To provide detailed impact data for an assessment of costs incurred by the farmer, focusing on critical impact periods and the relative significance of impacts on particular crop and pasture types.

METHODS:
Feeding study:
The main information gathering technique involved systematic dawn to dusk distribution counts over a mapped study area (Fig. 1). Up-dated records were kept of changes in the paddocks and in the lake.

Economic study:
Estimates of 24 hour goose consumption of crops and sown pastures in study area based on data obtained both directly and from secondary sources. The main tool used to assess stock displacement caused by goose feeding was a computer-based stock feed budgeting model (this was adapted from an existing model developed to calculate livestock carrying capacity on South Island high country runholdings). Firstly, the stock feed supply on the station

(including oversown and topdressed tussock grassland beyond the cultivated study area) was assessed according to type, quality, area, seasonal production patterns, and efficiency of utilisation - the latter accounting for differences between herbage grown and that actually consumed by livestock. These data were entered into the model which was then run to produce a figure on maximum sustainable carrying capacity. A second modelling run or series of runs was then done with the food consumed by the geese added to the feed available in each paddock according to month. Essentially the difference between the two sets of results represented stock displacement caused by the geese. The technique offered considerable scope for sensitivity testing, i.e. elements of the goose consumption data could be isolated and manipulated according to food type or time periods to see how these factors contributed to a final stock displacement result. Because Grassmere Station is similar to many other high country runholdings in terms of farmland composition and stocking practices, the modelling exercise was a means of developing insights of general relevance.

RESULTS TO DATE:

Economic study

The modelling analysis indicated that under the stocking/pasture - crop management regimes applying at Grassmere Station, a further 95 sheep could have been grazed in the absence of geese. Although this figure may be seen as a pointer to the level of costs the farmer may be faced with in relation to present numbers of geese on Lake Grassmere, considerable caution should be exercised. It is by no means definitive for Grassmere. Even assuming all consumption estimates were correct and the stock displacement result was fully accurate, the result is really only relevant to the past, not to the present or the future! As will be noted below, very small changes in impact - if they occur at particular times or on particular crops - can drastically alter the stock displacement picture from year to year. Other variables are also involved.

Of far more relevance in the analysis are the results overall and what they have to say about critical impact periods and the relative expenses associated with feeding on particular food types. In other words the major benefit was in actually working the model against a background of considerable farming - particularly high country farming - knowledge.

Some important findings:

First, at Grassmere heavy year-round goose grazing on sown pastures was of little cost significance, accounting for only 12 of the 95 stock units displaced. The important point here is that impacts in the period from autumn to spring were considered to have been more serious than at other times. This conclusion is consistent with the fact that in the tussock grasslands of the high country, pasture ceases to grow in the winter, creating a feed "bottleneck" in the spring which is the limiting factor in terms of stocking rates (Leathers and Costello, 1987).

Very light impact recorded on turnips at Grassmere accounted for 83 of the 95 stock units calculated to have been displaced!! This indicates how very slight differences in year to year use of this expensive crop can produce wide variation in cost. Clearly the protection of turnips at Grassmere and on other high country farms should be a priority.

The timing of cereal cropping in the autumn was probably very desirable. Heavy use made by geese of the highly preferred stubbles (deemed to be of no economic value to the farmer) served to radically reduce impact on autumn-saved sown pasture.

An important point indicated in the modelling analysis was that stock displacement and hence costs due to geese were heavily dependant on stocking policy. Clearly on an understocked farm the cost effects of goose grazing would be reduced.

CONCLUSIONS:

Economic study

This study, together with two earlier and more general studies of goose feeding in the South island high country by White (1986) and Leathers and Costello (1986) (both Centre for Resource Management studies), provides a good theoretical basis for making generalisations about when goose grazing is most likely to be of cost significance in the high country, and what pasture and crop types are likely to be the most expensive and worthy of protection.

The studies highlight the fact that the goose 'problem' as it exists on pastoral farmland is not so much one of volume of food consumed, but of timing. The difficulties involved in assessing costs associates with feeding on pastoral farmland are considerably greater than for unstocked cropping farmland. For instance, with wheat, an assessment can be made directly on the basis of measurements of on-site damage, where costs are determined by comparing actual and expected yields.

RESULTS TO DATE:

Feeding study

The results show that geese using Lake Grassmere fed extensively on lake weed as well as on nearby cultivated farmland (semi-aquatic vegetation and oversown and topdressed tussock grassland were largely avoided). Farmland was favoured less in the winter than in the spring-autumn period, probably because of the influence of severe frosting on pasture growth. The pattern of farmland food use tended to be different between day and night. In the daytime, food choice was determined mainly on the basis of closeness to the lake and freedom from disturbance. Established sown pasture (>1 year old) was the most heavily used farmland resource in the daytime, not because it was the most widely distributed of all farmland resources, but because it was the most readily available in undisturbed conditions near the lake. At night (based on dawn and dusk observations) choice was more related to absolute food preference. Birds were more likely at this time to venture beyond lakeside paddocks into areas associated with high daytime disturbance.

There was considerable evidence that geese at Lake Grassmere feed more extensively on farmland at night than do geese in Europe and North America. In the latter places large ground predators such as foxes appear to inhibit night feeding.

CONCLUSIONS TO DATE:

Feeding study

By increasing our understanding of how geese behave on farmland we are now in a much better position to choose and site diversionary crops and offer suggestions on how farmers can manage their land to reduce goose damage. Overseas studies and techniques are relevant here, although New Zealand would appear to have problems not faced to the same extent in North America and Europe. It seems that because night feeding is more of a reality in New Zealand, the potential for siting vulnerable and expensive crops near roads and farmbuildings (as is done for their protection in North America and Europe) is not such a straightforward proposition. As was shown at Grassmere, geese made considerable use at night of daytime disturbed areas.

The economic dimension obtained in the overall goose study at Grassmere is of considerable advantage in deciding when management intervention is warranted - particularly in the South Island high country.

PUBLICATIONS:

Harris, P. S.; Potts, K. J.; Costello, E. J. 1987: An assessment of the economic impact of Canada goose grazing on Grassmere Station using a farm management modelling technique. Centre for Resource Management publication, 35pp.

In progress

The feeding ecology of Canada geese on farmland in N.Z.

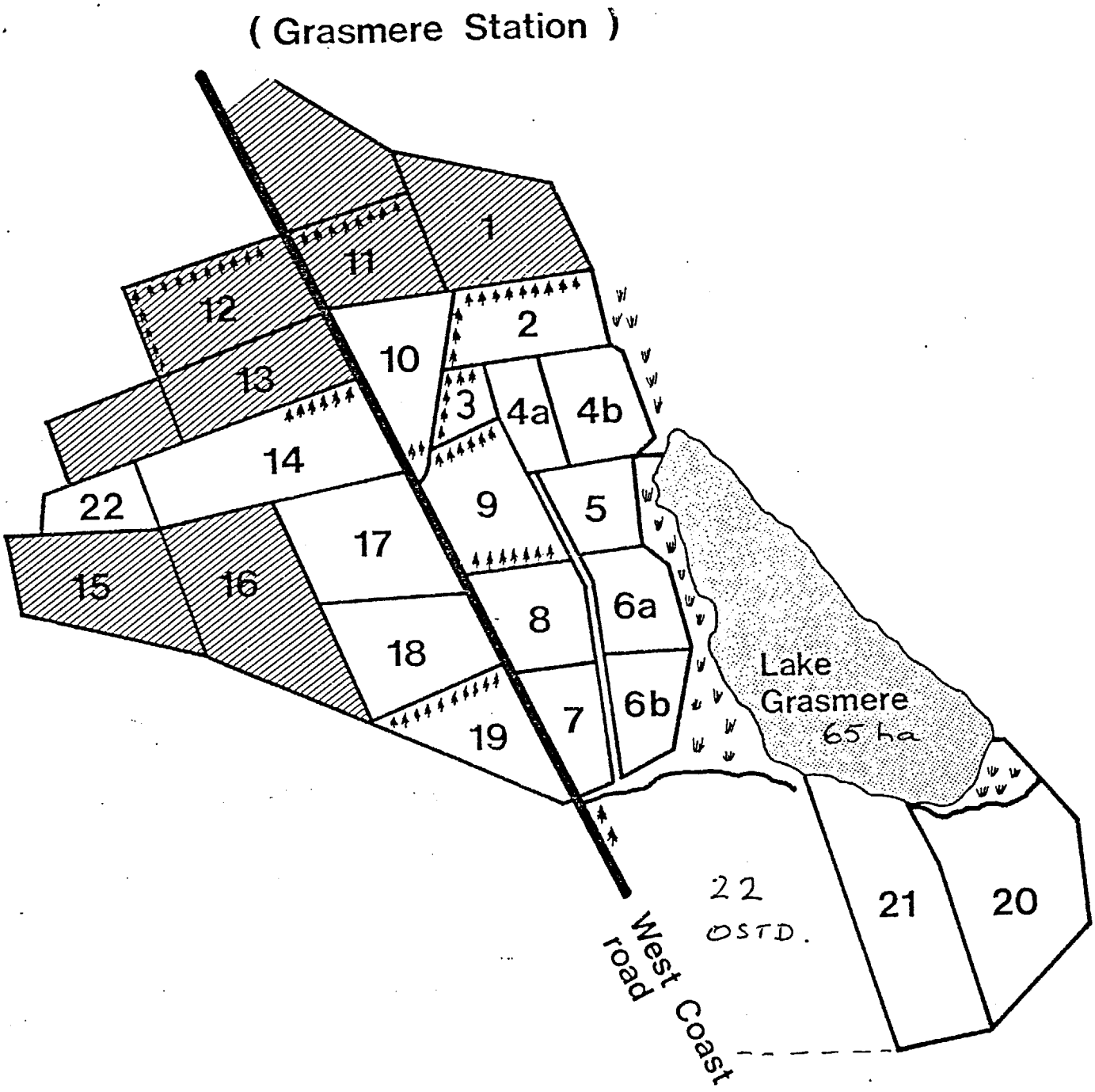

Figure 1: Study area. Paddocks 1-21 cultivated farmland, mainly established pasture, some new pasture and crops. Paddock 22 oversown and top dressed tussock grassland (OSTD). Surrounding areas mainly OSTD.

INVESTIGATION NO: S 5020/155
CORPORATE OBJECTIVE NO: 3.3

TITLE: Foods and foraging behaviour of South Westland forest birds.

INVESTIGATION LEADER: Colin F.J. O'Donnell

ASSOCIATED RESEARCHER: Peter J. Dilks

STUDY VENUE: West Coast and Canterbury Regions

INVESTIGATION STATUS: Manuscript in process

CLIENT: DOC

EXPECTED FINISH DATE: December 1989

INVESTIGATION SUMMARY:

Part of the research associated with the South Westland Management Evaluation Programme. The foods, foraging and feeding stations were studied in a temperate rainforest bird community in South Westland, New Zealand. Feeding ecology for 18 bird species is related to the phenology of fruit and flower availability and to seasonal patterns. The degree of specialisation in these birds is discussed, ? are their groupings into foraging guilds, the predictability of fruit and flower sources as food and the role of birds as pollinators and dispersers.

Knowledge of the habitat requirements of forest birds is a prerequisite for understanding their ecology. Today, conservation agencies are required to make specific recommendations as to the size and composition of reserves and management options for rare, threatened and endangered species. To accomplish this, information must be obtained on:

(a) how birds use their habitat;
(b) the area of habitat required to maintain viable populations;
(c) the degree of overlap in habitat use between species; and
(d) the potential for competition between species.

This information is used to predict the impact of forest management practices on birds by identifying important components of forest structure.

OBJECTIVES:

1. To quantify frequency of use of foods and seasonal variations in a South Westland bird community. In order to determine species requirements.

2. To relate findings to the conservation status and management of forest birds, in particular, threatened species.

METHODS:

1. The foods and foraging activities of forest birds were recorded using instantaneous sampling in the Windbag Valley, South Westland. Transects were walked daily for 10 days every two months from October 1983 to December 1985. The observers walked

slowly searching for birds. Whenever a bird was located its foraging activity, food type, level within the forest and substrate were recorded.

2. The timing and duration of fruiting and flowering of forest plants were recorded to quantify seasonal food availability.

3. A total of 437,856 feeding observations was collected. These were sorted by bird species into frequency tables. Use of the food types was separated into six time periods: October-November, December-January, February-March. April-May, June-July, and August-September.

ACTIVITIES 1988-89:

The database was further analysed and a paper describing the foraging ecology of South Westland birds written. Referees comments on the second draft have been compiled and the final manuscript is nearly ready for submission to Unit Leader.

RESULTS:

1. Plant Phenology: Flowers were generally available in spring but for more limited periods than fruit and seeds. Few species flowered throughout the year. Flowering patterns were markedly different between years and at different altitudes. Fruits were generally available 6-9 months of the year, beginning in early autumn. Seed availability reflected fruiting patterns, also with considerable variations.

2. Foods and foraging behaviour of forest birds: Food items taken by 18 bird species were summarised (Table 1). Foraging patterns were related to fruiting and flowering patterns of forest plants in South Westland. Of the species studied only NZ pigeon was totally herbivorous. The 3 parrot species, 2 honeyeaters and the silvereye had broad omnivorous diets which varied considerably with season. Of the remaining species, flycatchers, warblers and rifleman were almost entirely insectivorous and introduced finches had mixed seed and invertebrate diets. The South Westland bird community was comprised of a large number of generalist feeders and few dietary specialists. The kaka had the most diverse repertoire of foods and foraging techniques. However, it was a sequential specialist, moving from one specialist food source to another throughout its annual cycle. The marked irregularity of flowering and fruiting of many forest plants makes these unpredictable food sources.

CONCLUSIONS:

1. The foraging information can be used to:
   (a) Determine how generalist or specialist forest birds are in their requirements and therefore the vulnerability of their conservation status.
   (b) Predict the impacts of habitat modification (e.g. logging) on forest birds. By modelling response to habitat change we can assess the impacts of different extraction rates of new and future logging techniques.
   (c) Provide specifications for optimum plant composition of reserves and conservation areas.

2. Considerable overlap between the preferred foods of kaka and possums was identified. In South Westland kaka numbers were particularly low north of the Paringa River. This scarcity coincides with high possum numbers and the occurrence of extensive die-back in the highland rata-kamahi forest. Possums may compete directly with kaka for food. Mistletoes, which are very important food sources in certain seasons, are rare and almost gone from many forests with possums.

The possible role of possums in the decline of kaka requires immediate study. The current spread of possums into southern South Westland is of considerable concern because the region supports the last outstanding kaka populations in the country.

3. Foraging data can be used for new projects. For example, over 5,000 observations of kaka will be analysed in more detail. Information on frugivory, selection of fruits etc has important implications for current theories on co-evolution of plants and bird dispersers. Bright fruit colours are often quoted as important dispersal cues. However, our data shows that dark coloured fruit (black, purple and particularly green) are preferred by many species.

PUBLICATIONS/REPORTS

O'Donnell, C.F.J.; Dilks, P.J. Forest birds in South Westland status, distribution and habitat use. *NZ Wildlife Service. Occ. Publ. No.10,* 179 pp.

O'Donnell, C.F.J.; Dilks, P.J. (In press.) Feeding on fruits and flowers by insectivorous forest birds. *Notornis 36.*

O'Donnell, C.F.J.; Dilks, P.J. In press. Sap-feeding by kaka *(Nestor meridionalis)* in South Westland. *Notornis 36*

Table 1: Food types of forest birds in South Westland
(Percent of feeding observations).

	Number of observations	Invertebrates (confirmed)	Invertebrates (probable)	Nectar	Honeydew	Sap	Fruit	Leaf/bud	Seed	Moss	Lichen	Wood	Gall	Unknown
Pigeon	2339	-	-	1.3	-	-	72.3	10.0	0.3	-	-	-	0.2	15.5
Kaka	3180	14.7	54.3	12.1	0.1	2.8	7.6	1.1	6.0	0.2	0.1	0.4	-	-
Kea	233	12.5	32.2	37.8	-	-	-	4.3	9.4	3.4	-	0.4	-	-
Kakriki	579	-	-	-	-	-	11.4	1.7	13.5	-	-	-	-	72.7
Riflemen	2073	18.4	80.6	-	-	-	0.7	-	-	-	-	-	-	-
Brown creeper	2353	17.2	80.7	0.1	-	-	0.5	-	-	-	-	-	-	-
Grey warbler	6997	12.1	86.5	-	-	-	0.2	-	-	-	-	-	-	-
Yellowhead	712	16.7	81.6	0.8	-	-	0.4	-	-	-	-	-	-	-
Tit	7109	9.1	89.1	-	-	-	0.3	-	-	-	-	-	-	-
Fantail	5161	13.1	85.4	0.1	-	-	0.3	-	-	-	-	-	-	-
Blackbird	247	1.6	-	-	-	-	25.5	-	-	-	-	-	-	72.1
Silvereye	9708	8.1	73.2	7.6	0.1	-	10.5	0.1	0.1	0.1	0.1	-	-	-
Bellbird	4270	10.2	64.6	14.7	3.5	-	6.5	0.1	-	-	-	-	-	-
Tui	695	5.3	-	41.3	3.2	-	14.1	-	-	-	-	-	-	35.1
Chaffinch	659	6.7	-	-	-	-	2.0	-	33.7	-	-	-	-	56.8
Greenfinch	79	17.7	-	-	-	-	-	-	21.5	-	-	-	-	60.8
Goldfinch	987	7.1	-	-	-	-	-	-	6.2	-	-	-	-	86.6
Redpoll	432	-	-	-	-	-	2.1	-	8.6	-	-	-	-	87.5
No of species	18	15	10	9	4	1	15	6	9	3	2	2	1	8

INVESTIGATION NO: S5020/154
CORPORATE OBJECTIVE: 1.3

TITLE: Habitat use by forest birds in temperate rainforests, South Westland, New Zealand.

INVESTIGATION LEADER: Colin F.J. O'Donnell

ASSOCIATED RESEARCHER: Peter J. Dilks

INVESTIGATION STATUS: Manuscript in process

CLIENT: DOC

EXPECTED FINISH DATE: December 1989

INVESTIGATION SUMMARY:
Part of research associated with the South Westland Management Evaluation Programme.

Seasonal use of canopy and understorey trees was quantified in a South Westland forest bird community (26 forest bird species). Frequency of use of plant species by each bird species was compared with availability to determine if each plant was used selectively or at random. In this way we determined preferences and defined critical trees and shrubs for each bird. Use of different sized (aged) trees was also quantified to show preferences. Many canopy tree species, usually of large size, were critical for a number of forest birds.

Knowledge of the habitat requirements of forest birds is a prerequisite for understanding their ecology. Today, conservation agencies are required to make specific recommendations as to the size and composition of reserves and management options for rare, threatened and endangered species. To accomplish this, information must be obtained on:

(a) how birds use their habitat;
(b) the area of habitat required to maintain viable populations;
(c) the degree of overlap in habitat use between species; and
(d) the potential for competition between species.

This information is used to predict the impact of forest management practices on birds by identifying important components of forest structure.

OBJECTIVES:

1. To quantify plant species use and preferences in a South Westland forest bird community.

2. To use the information for assessing and predicting impacts of forest management practices on each forest bird species.

3. To produce standardised methods for quantifying habitat use by forest birds for use nationally.

METHODS:

1. Habitat use: Observations were made along transects that sampled forest types representative of the South Westland area. Whenever birds were encountered their activity and precise position within the forest structure were recorded each minute for up to 5 minutes. Also recorded were the plant species used, truck diameter and canopy height; the height of the bird above the ground, forest tier occupied, perch and food types and the site topography. Field trips were made for 10 days, every two months, between October 1983 and December 1985 (O'Donnell & Dilks 1986, 1988).

2. Plant Availability: The vegetation community was surveyed concurrently to obtain data on the relative abundance of plant species. Variable Area Plots provided data on stems per ha and basal areas (m^2/ha of each plant species. Reconnaissance Plots gave measures of percent foliar cover. These measures provided three different indices of the availability of plant species.

3. Plant species preferences: Habitat-use data were converted by computer into frequency histograms for each bird species to show such variables as percent use of plant species, or use of different stem diameter classes for different activities. Percent use was summarised both overall or for each of the 6 seasonal surveys. Bird preferences for plants were examined by comparing a plant's frequency of abundance with its frequency of use statistically.

   The preferences for plants used were then defined using a rigorous statistical framework (Figure 1). A plant species is considered to be preferred by a bird species when use of the plant is statistically greater than expected from its abundance.

   The associations between the observed frequency of use and the frequency of availability (relative abundance) of plant species were tested to determine which plant species were preferred by each bird species (Figure 1). The associations were tested for each index using G-tests for independence. Significance values were those for which $p<0.05$. The results were tested for each season and for amalgamated data.

Definition of preferences

We have defined preferences using the following terms:

(a) When percent use of a plant was statistically less than expected this indicated "non-preference" for that species.

(b) When use was statistically greater than expected, this indicated "preference" for that particular plant.
   - Plant species for which use was significantly greater than expected for all three measures of availability were defined as "critical".
   - Plants for which use was greater than expected for two measures of availability were defined as "focal".

(c) When there was no significant differences between use and availability of a plant this denoted that the species was being used randomly.

ACTIVITIES:

1988 was spent analysing the extensive database further and preparing a large paper for publication. The second draft of the paper has been refereed and comments are now being integrated into a final draft for unit leaders approval.

RESULTS TO DATE:

1. Methods manuals:
   Manuals for mapping the distribution of forest birds and for recording their habitat use have been published (O'Donnell & Dilks 1988a, 1988b).

2. Plant use and preferences:
   All plant species (59 groups representing 82 species) were used some time by forest birds. However, nearly 70% of feeding observations were in the 13 species of canopy tree. About one fifth of the observations were in the 29 groups of shrubs and the remaining records were in the 17 groups of vine, epiphyte, grass and fern species.

   The number of plants used by individual bird species varied considerably. Yellow-breasted tit and silvereye used over 50 species groups while brown creeper, grey warbler, fantail and bellbird each used over 40 species groups. Birds which used a much more limited range of plants included 3 introduced finches (redpoll, goldfinch, greenfinch; 6-10 plant species), and the endemic kea, kakariki and yellowhead (11-17 plants). Percent use of canopy trees species is summarised in Figure 2.

   All birds used a wide range of plant sizes. However, most use was of large diameter sterns. For example, kea and yellowhead mainly used stems 81-100 cm in diameter while bellbirds and rifleman made greater use of stems 41-60 cm. Tit, fantail, grey warbler and silvereye used markedly smaller stems, with peak use of those 11-20 cm.

   Figure 3 summarises canopy tree species preferences. The diagram shows which plants were preferred (critical and focal species), those used at random, and those used less than expected. Preferences varied considerably between bird species. The most important plants were rimu (preferred by 11 bird species), silver pine (by 9 species) and silver beech and rata (by 7 species each). The results also highlight the importance of dead trees for endemic birds. Standing dead trees were critical overall for kaka and kea and seasonally critical for yellowhead. Use of each tree species varied significantly between seasons e.g. Table 1.

   The most important shrubs were raukawa and wineberry which were each preferred by 7 bird species. Fuchsia, haumakaroa, broadleaf, lancewood and pate by 3 bird species.

CONCLUSIONS TO DATE:

The habitat use information can be used by conservation managers to:

1. Determine how generalist or specialist forest birds are in their requirements and therefore the vulnerability of their conservation status.

2. Predict the impacts of habitat modification (e.g. logging) on forest birds. By modelling response to habitat change we can assess the impacts of different extraction rate or new and future logging techniques.

3. Provide specifications for the optimum plant composition of preserves and conservation areas.

4. The data has provided a baseline for resource information on threatened forest birds such as kaka, kakariki and yellowhead. the information can now be used to guide further more detailed work on these species. Conservation management of them will become very important in the near future.

5. There is still considerable scope for dealing with the database. For example, analysis of 2500 5-minute bird counts now that new forest typing is available for the forests. Bird numbers could now be correlated with a large number of environmental variables.

PUBLICATIONS/REPORTS:

Department of Conservation 1987. Conservation values in southern South Westland. Compiled by C. Woolmore and C.F.J. O'Donnell, DOC, Hokitika.

Department of Conservation 1988. South Westland South of the Cook River. Resource Management Study. DOC Wellington. 79 pp.

O'Donnell, CFJ 1987. Wildlife Resource-birds. Chapt.14 pp 97-123. *In:* Orchard, M.J.; Familton, H.R.; Pfahlert, J.J. *(Compilers).* South Westland Management Evaluation Programme Vo1.1 Resources. NZ Forest Service and Dept Lands and Survey, Hokitika.

O'Donnell, C. 1987. A wildlife haven. Chapt.4. Pp 65-74. *In* Hutchings, G. & Potten, C. *(eds).* Forests, Fiords and Glaciers. New Zealand's World Heritage. Royal Forest and Bird Protection Society, Wellington.

O'Donnell, C.F.J.; Dilks, P.J. 1986. Forest birds in South Westland. Status, distribution and habitat use. *NZ Wildlife Service Occasional Publ. No10.*

O'Donnell, C.F.J.; Dilks, P.J. 1987. Preliminary modelling of the impacts of logging on forest birds in South Westland. *Science and Research Internal Report No.l.*

O'Donnell, C.F.J.; Dilks, P.J. 1988. Mapping the distribution of forest birds. *Science & Research Series No.l.*

O'Donnell, C.F.J.; Dilks, P.J. 1988. A method for quantifying habitat use in forest birds. *Science and Research Series No.4*

O'Donnell, C. 1988. Forest bird studies in South Westland. Pp 56-63. *In* J.L. Napper *(Compiler).* Extended summaries of selected research projects. *Science and Research Internal Report No.26.*

Figure 1: Procedure for defining tree species preferences by forest birds.

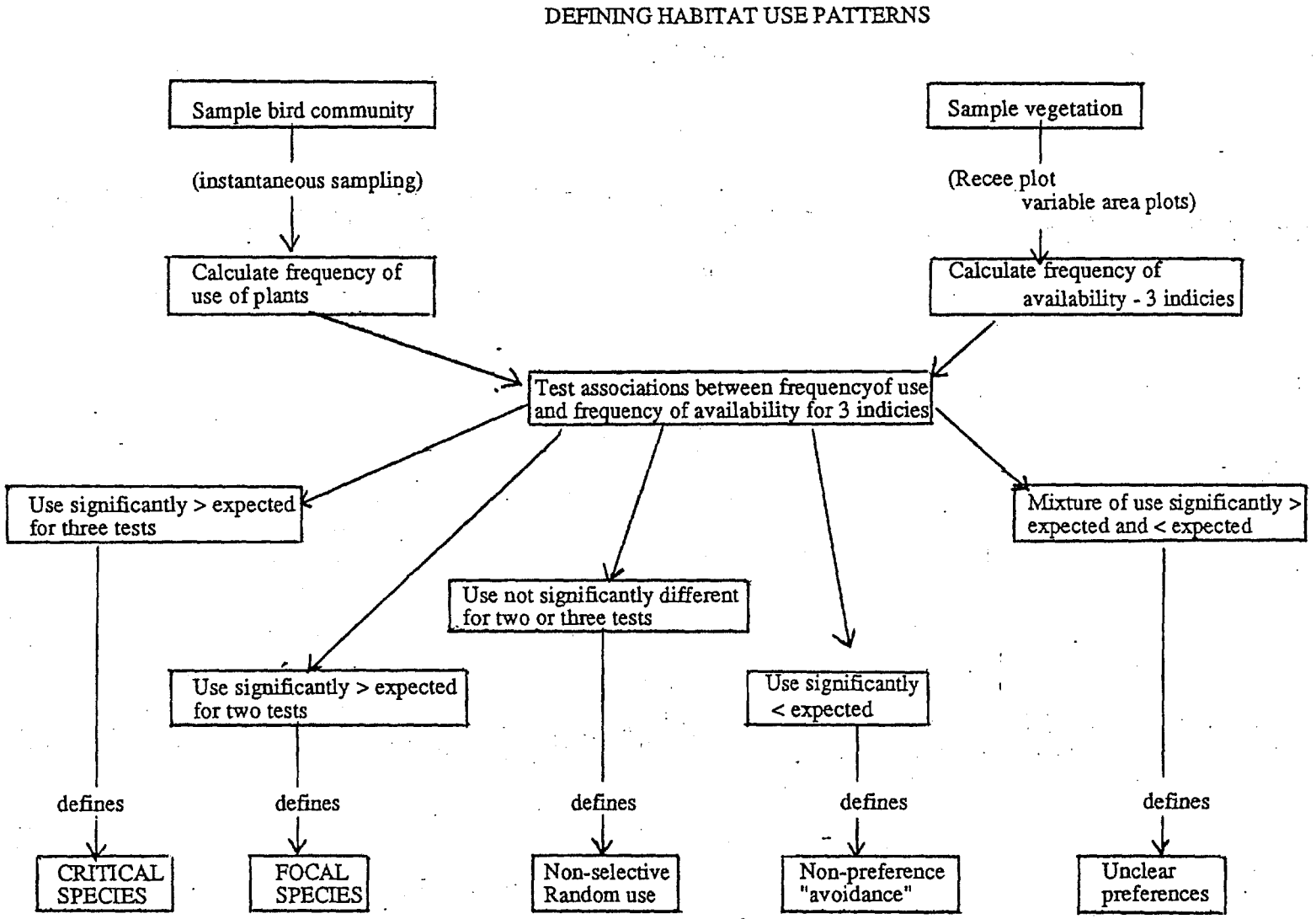

Figure 2: Percent use of canopy tree species by forest birds in temperate rainforest, South Westland, New Zealand.

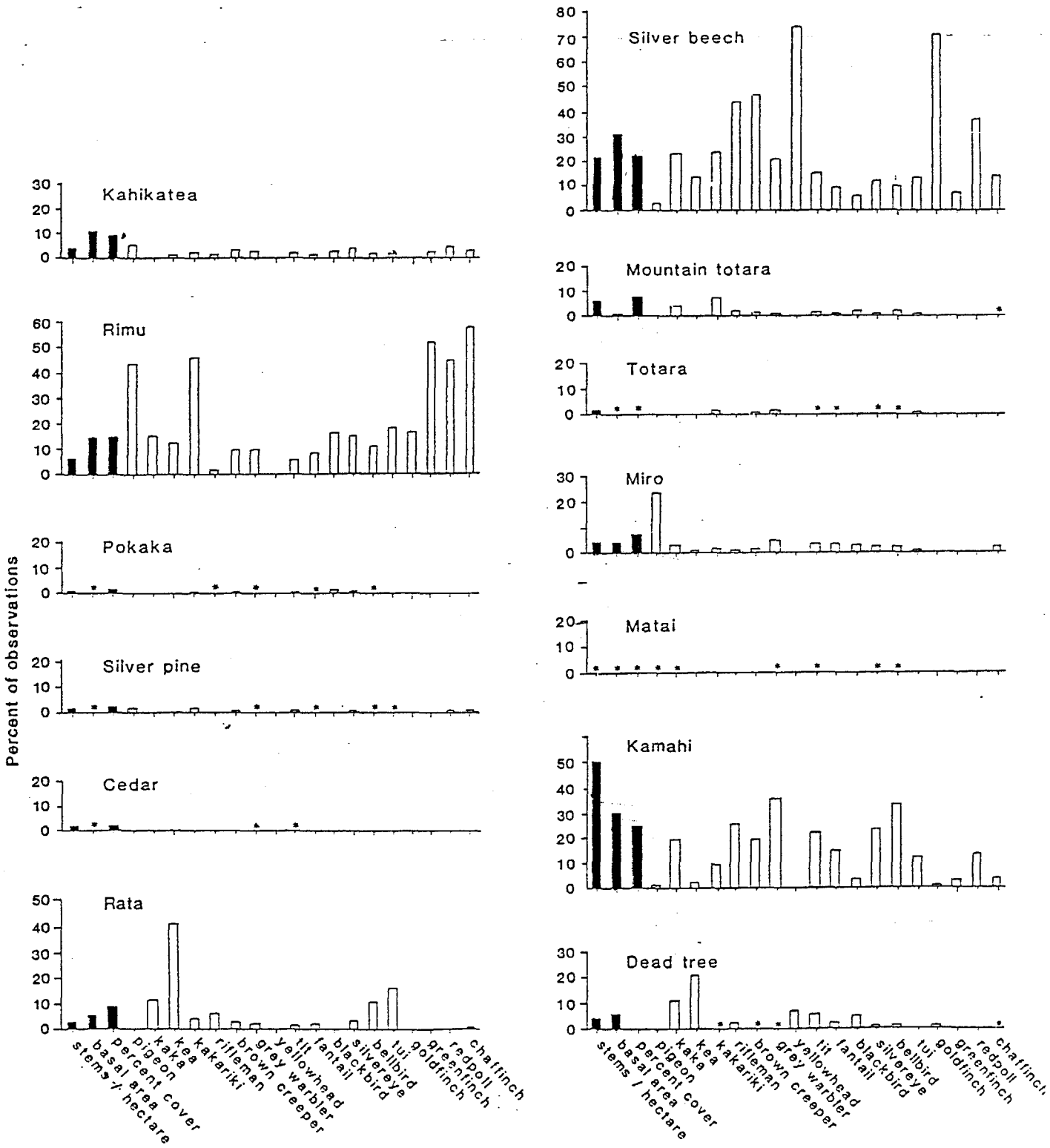

Figure 3: Canopy tree species preferences in South Westland forest birds (gaps indicate plants not used by particular bird species).

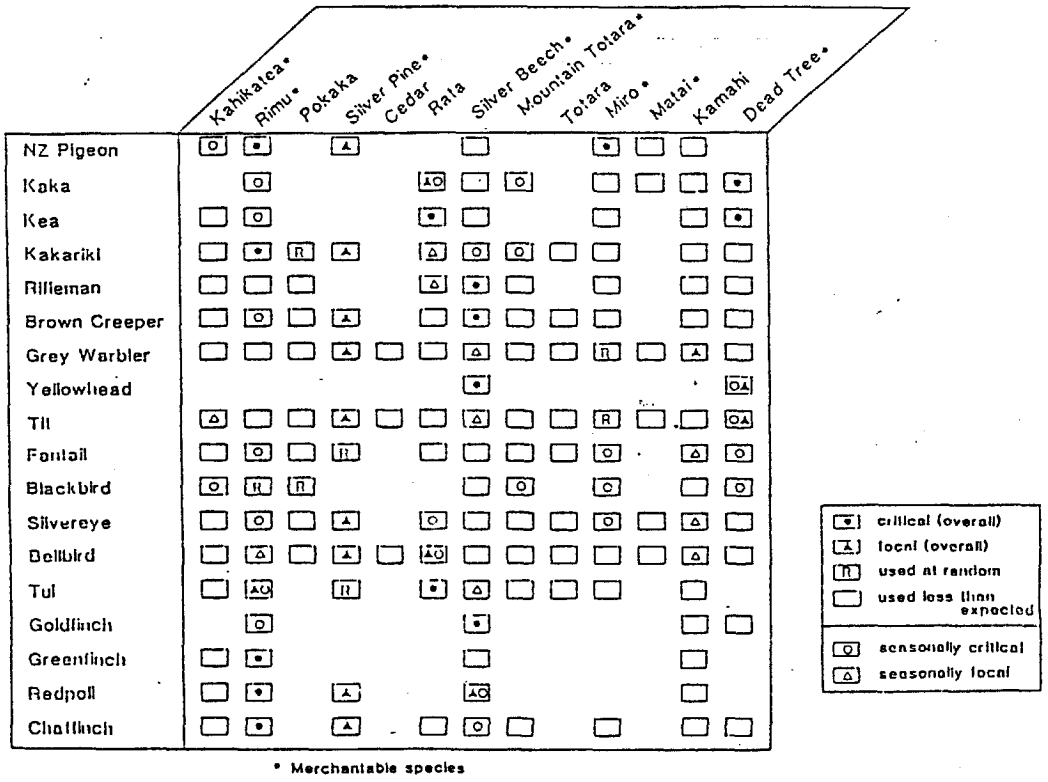

Table 1: Seasonal use of rimu (% of total monthly observations in rimu).

	Feb	Apr	Jun	Aug	Oct	Dec	Significance
N Z pigeon -	70.7	27.1	1.1	1.1	-	73.9	***
kaka	4.2	28.8	37.1	12.1	8.5	7.0	***
kea	-	-	11.1	-	-	32.9	
kakariki	54.7	21.3	22.8	75.5	35.7	43.4	***
rifleman	0.2	10.2	3.0	1.1	0.8	-	
brown creeper	7.8	11.6	18.5	8.0	5.4	8.7	
yellowhead	-	-	-	-	-	-	
grey warbler	5.4	8.9	11.3	11.7	12.3	6.3	***
fantail	7.3	4.2	11.5	13.0	6.1	6.6	***
yellow-breasted tit	4.6	4.1	6.4	8.1	4.9	7.8	***
silvereye	10.5	12.5	18.9	14.7	14.6	16.1	
bellbird	9.7	10.9	12.5	14.7	4.3	9.2	***
tui	36.5	47.2	9.0	2.3	3.5	15.2	***

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