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A METHOD FOR QUANTIFYING HABITAT USE BY FOREST BIRDS

by

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SUMMARY

A method is outlined for quantifying habitat use by forest birds. The procedure is especially useful for comparative bird community studies. This method involves recording the activity and precise position of a bird within the forest each minute for five minutes after the bird is first sighted (five observations). Also recorded are the plant species used, trunk diameter and canopy height; the height of the bird above the ground, forest tier occupied, perch and food types; and the site topography. Habitat use observations are made along that sample forest types representative of a particular area. Applications of the sampling regime are also discussed.

1. INTRODUCTION

Knowledge of the habitat requirements of forest birds is a prerequisite for understanding their ecology. Today, wildlife conservation agencies are required to make specific recommendations on the size and composition of forest reserves which are needed to maintain birds. 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.

During 1983 we began a study of habitat use by forest birds in South Westland with special reference to recording the use that each bird species made of various components of the forest structure. None of the methods available for recording habitat use entirely suited our needs. Most were based on feeding studies of single species, had a variety of sampling intervals, and usually recorded only a limited set of habitat characteristics (e.g. Gibb 1961, 1964, Recher 1977, Terborgh 1980, Powlesland 1981, Bell 1982a, Saether 1983). We needed a method which could be used for all forest birds in all forest types. Consequently we adapted relevant features of several methods for our use.

In this paper we outline the method developed for recording habitat use by South Westland forest birds, discuss the sampling regime, and review the application of the method. The criteria used for recording observations are general enough to be applied to a wide range of bird species, but detailed enough to show how different species use a range of forest types. Our terminology is applicable directly to forest management.

2. THE METHOD

2.1 Synopsis

Numbered markers (station number) were placed at 50 m intervals along so that the observer's position was known at all times. The observer walked slowly along the searching for birds. When a bird or flock was encountered, a standard observation was made that described the activity and

precise position of the bird within the forest structure. If the bird could be followed, four further observations were made at one minute intervals, giving a maximum of five observations per bird. The observations were recorded in a format suitable for direct transcription into a computer for analysis (Figure 1).

2.2 Categories for describing habitat use

One criterion from each of 19 categories was recorded during an observation (Table 1). Full definitions of each criterion are recorded in Appendix 1. The field data were recorded using a three letter code usually derived from the first three letters of an appropriate word, enabling them to be remembered easily. The 19 categories were:

1. TIME : of day the observation was made (24-hour clock).
2. BIRD SPECIES : name of the species under observation.
3. NUMBER OF BIRDS : included in that observation.
4. SEX : of the bird being observed.
5. OBSERVATION NUMBER : the number of the observation (1-5) per bird.
6. ACTIVITY : that the bird was engaged upon.
7. FOREST TYPE : that the bird was present in.
8. PLANT SPECIES : that the bird was using.
9. HOST SPECIES : if PLANT SPECIES was an epiphyte or liane.
10. D.B.H. : diameter at breast height (in cm) of the PLANT SPECIES being used. If the plant was an epiphyte, then D.B.H. of the HOST SPECIES was recorded.
11. STRATUM : tier of the forest that the bird was observed in (Figure 2).
12. BIRD HEIGHT : the height of the bird above the ground (metres).
13. CANOPY HEIGHT : the height of the forest canopy at the site of observation (metres).
14. PERCH TYPE : the specific perch site that was used.
15. FOOD TYPE : the food eaten (eg fruit, seed, leaf).
16. SLOPE : of the site, recorded in degrees.
17. ASPECT : on sloping ground. The direction in which the slope faces (recorded as a compass bearing).
18. ALTITUDE : of the site, in metres above sea level.
19. STATION NUMBER : records the position of the observation along the transect (the last station number passed).

Each observation provided a set of detailed descriptions of the precise position of the bud within the forest structure.

Figure 1: Example of fieldsheet recording habitat-use observations.

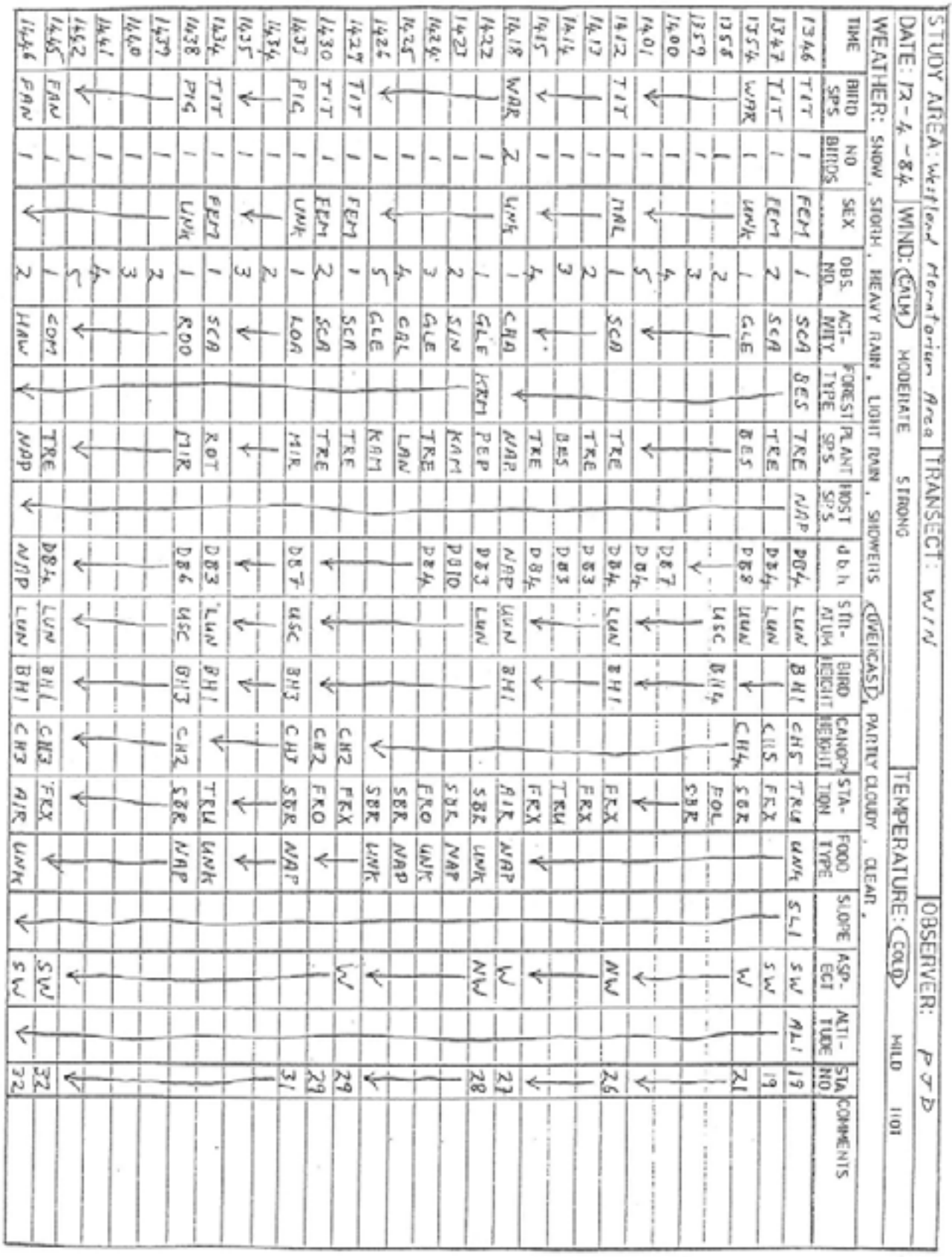


Table 1: Criteria and codes used for recording habitat-use observations by forest birds.

BIRD SPECIES	
bellbird	BEL
blackbird	BLA
brown creeper	CRE
chaffinch	CHA
cuckoo - shining	SCU
long tailed	LTC
dunnock	DUN
falcon	FAL
fantail	FAN
fernbird	FER
goldfinch	GOL
greenfinch	GRE
grey warbler	WAR
harrier	HAR
kea	KEA
kingfisher	KIN
morepork	MOR
parakeet - yellow crowned	YCP
red crowned	RCP
unidentified	UIP
pigeon	PIG
redpoll	RED
rifleman	RIF
robin	ROB
silvereye	SIL
song thrush	THR
tit	TIT
tui	TUI
weka	WEK
yellowhead	YEL

ACTIVITY	
sing	SIN
call	CAL
display	DIS
chase	CHA
roost	ROO
fly	FLY
comfort	COM
hover	HOV
hawk	HAW
glean	GLE
probe	PRO
rip	RIP
scan	SCA
browse	BRO
nest	NES
feed young	FEY
manipulate	MAN
unknown	UNK

PLANT SPECIES	
not applicable	NAP
standing dead tree	SDT
windthrow	WTH
astelia	AST
beech - black	BEB
beech - hard	BEH
beech - mountain	BEM
beech - red	BER
beech - silver	BES
cedar	CED
clematis	CLE
coprosma foetidissima	FOE
coprosma rotundifolia	ROT
coprosma, small leaved	SCO
coprosma, large leaved	LCO
divaricating shrub (other)	ODS
fern	FER
fuchsia	FUC
Halls totara	HTO
hinau	HIN
hutu	HUT
kahikatea	KAH
kaikomako	KAI
kamahi	KAM
kiekie	KIE
kowhai	KOW
lancewood	LAN
lawyer	LAW
mahoe	MAH
manuka	MAN
mapou	MAP
marbleleaf	MAR
mingimingi	MIN
miro	MIR
mistletoe	MIS
muehlenbeckia	MUE
olearia	OLE
orchid	ORC
parsonia	PAR
pate	PAT
pepperwood	PEP
pigeonwood	PIG
pokaka	POK
pseudopanax edgerleyi	EDG
pseudopanax simplex	SIM
rata	RAT
rata, vine	RAV
rimu	RIM
rohutu	ROH
senecio	SEN
silver pine	SIP
supplejack	SUP
three finger	THR
toatoa	TOA
totara	TOT
treefern	TRE
tutu	TUT
wineberry	WIN

DBH	
not applicable	NAP
herbaceous	DB1
sapling - 5cm	DB2
5 - 10 cm	DB3
11 - 20 cm	DB4
21 - 40 cm	DB5
41 - 60 cm	DB6
61 - 80 cm	DB7
81 - 100 cm	DB8
101 - 200 cm	DB9
200 cm+	D10
unknown	UNK

STRATUM	
above canopy	ABC
emergent	EME
unshaded canopy	USC
shaded canopy	SHC
upper understorey	UUN
lower understorey	LUN
ground	GRO
unknown	UNK

BIRD/CANOPY HEIGHT	
0 - 5 metres	BH1
6 - 10 m	BH2
11 - 15m	BH3
16 - 20m	BH4
21 - 25m	BH5
26 - 30m	BH6
31 - 35m	BH7
36 - 40m	BH8
41 - 45m	BH9
46 - 50m	B10
50 m+	B11

STATION	
trunk	TRU
large branch	LBR
small branch	SBR
twig	TWI
trunk - dead	TRX
large branch - dead	LBX
small branch - dead	SBX
twig - dead	TWX
crook	CRO
foliage	FOL
dead foliage	FOX
hole/crevice	HOL
vine	VIN
ground litter	LIT
ground bare	GRB
ground moss/fern	GRM
rock/stone	ROC
aerial	AIR
frond	FRO
dead frond	FRX

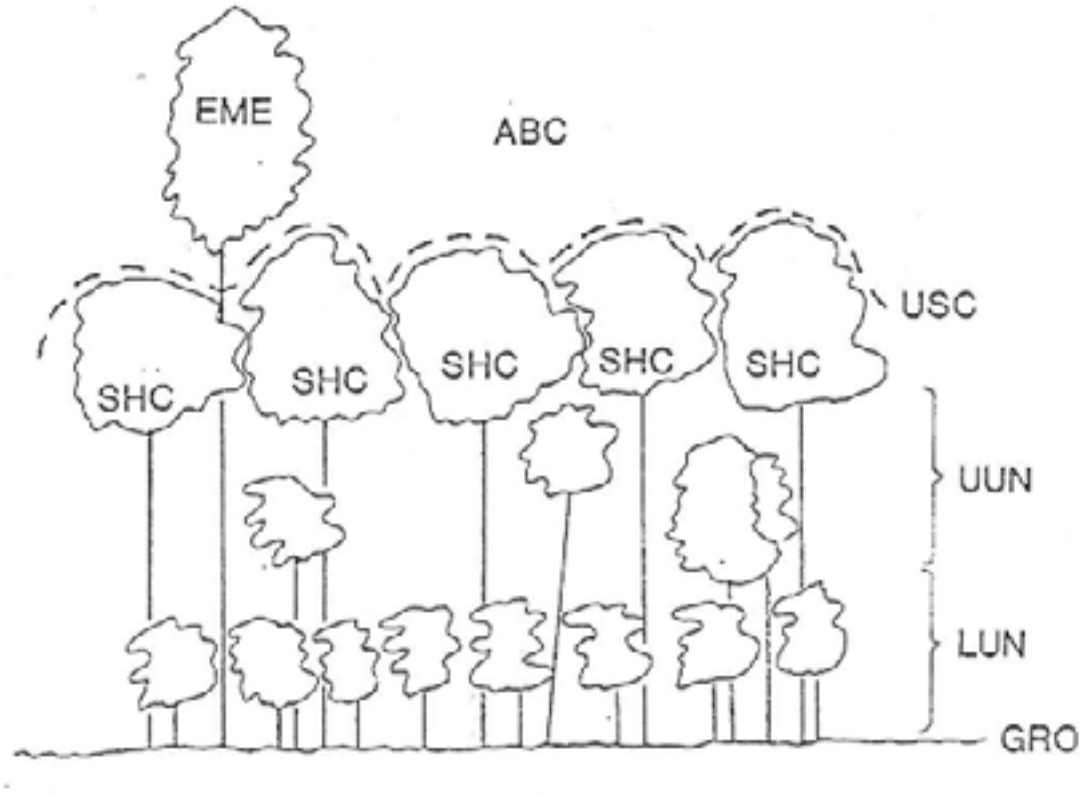
FOOD TYPE	
not applicable	NAP
seed	SEE
fruit	FRU
flower/nectar	FLO
honeydew	HON
leaf	LEA
bud	BUD
moss	MOS
lichen	LIC
invertebrate	INV
wood	WOO
vertebrate	VER
unknown	UNK

SLOPE	
not applicable	NAP
0 - 10°	SL1
11 - 20°	SL2
21 - 30°	SL3
31 - 40°	SL4
41 - 50°	SL5
51 - 60°	SL6
60° +	SL7
unknown	UNK

ASPECT	
not applicable	NAP
north	N
north-east	NE
east	E
south-east	SE
south	S
south-west	SW
west	W
north-west	NW
unknown	UNK

ALTITUDE	
0 - 100 m	AL1
101 - 200 m	AL2
201 - 300 m	AL3
301 - 400 m	AL4
401 - 500 m	AL5
501 - 600 m	AL6
601 - 700 m	AL7
701 - 800 m	AL8
801 - 900 m	AL9
901 - 1000 m	A10
1000 m +	A11
unknown	UNK

Figure 2: Forest strata – schematic location of strata



Key:
ABC - above canopy
EME - emergent
USC - unshaded canopy
SHC - shaded canopy
UUN - upper understorey
LUN - lower understorey
GRO - ground

2.3 Sampling frequency

Our South Westland study was carried out over three years. The study area was visited for 10 consecutive days at two monthly intervals. Ten transects ranging from 0.25 km to 2.5 km in length were sampled during each visit. The transects were traversed as often as day length and weather allowed and were started alternately from opposite ends so that all parts were sampled at different times of the day.

2.4 Recording

Records were transcribed directly onto field sheets (Figure 1). Initially we dictated observations into tape recorders, but transcription of tapes was extremely time consuming and there was no immediate check on the accuracy of observations or the reliability of the recording devices.

Criteria such as tree diameter, bird and canopy height, slope and altitude were not recorded as specific measurements, but were grouped into class intervals to minimise observer error. Initially, on each field trip heights were measured using appropriate instruments. However, with experience measurements could be estimated accurately and quickly.

3. APPLICATION AND ANALYSIS

The method may be used for either;

(i) long term detailed studies of the birdlife of an area,
(ii) collection of comparable data on specific bird species on a casual basis over a wide geographic area.

Data were analysed by computer to determine frequency histograms of habitat use for each bird species. Examples of histograms are percent use of plant species, and stem diameter classes used for different activities. Percent use could be summarised both overall (Figure 3) or for each seasonal survey (Figure 4). Cross-tabulations between variables could also be produced (Table 2, Figure 5).

Bird preferences for plants were determined by comparing the abundance of each plant species with its use by birds. The level of preference for plant species was determined using a rigorous framework (Appendix II). The frequency of use of each plant was compared with the frequency of availability of that species for a number of tests. Where use was significantly greater than expected ($p<0.001$) for all tests the plant species was defined as being preferred (e.g. if rimu made up 5% of the trees present in the forest but 40% of pigeon observations were recorded in rimu then rimu was regarded as a preferred species for pigeons). Differences between use and availability were tested statistically using the G test of independence (Sokal & Rohlf 1981).

There are many ways of sampling forest composition and structure. We used Forest Reconnaissance Plots (Allen & McLennan 1983) and Variable Area Plots (Batcheler 1985) to obtain three measures of availability : stems/ha, basal area and percent foliar cover. The detailed procedure for defining preferences is summarised in Appendix

Figure 3: Percent use of canopy tree species by forest birds in temperate rainforests, South Westland, New Zealand

* = less than 0.5% of observations

▮ = measures of availability for canopy tree species

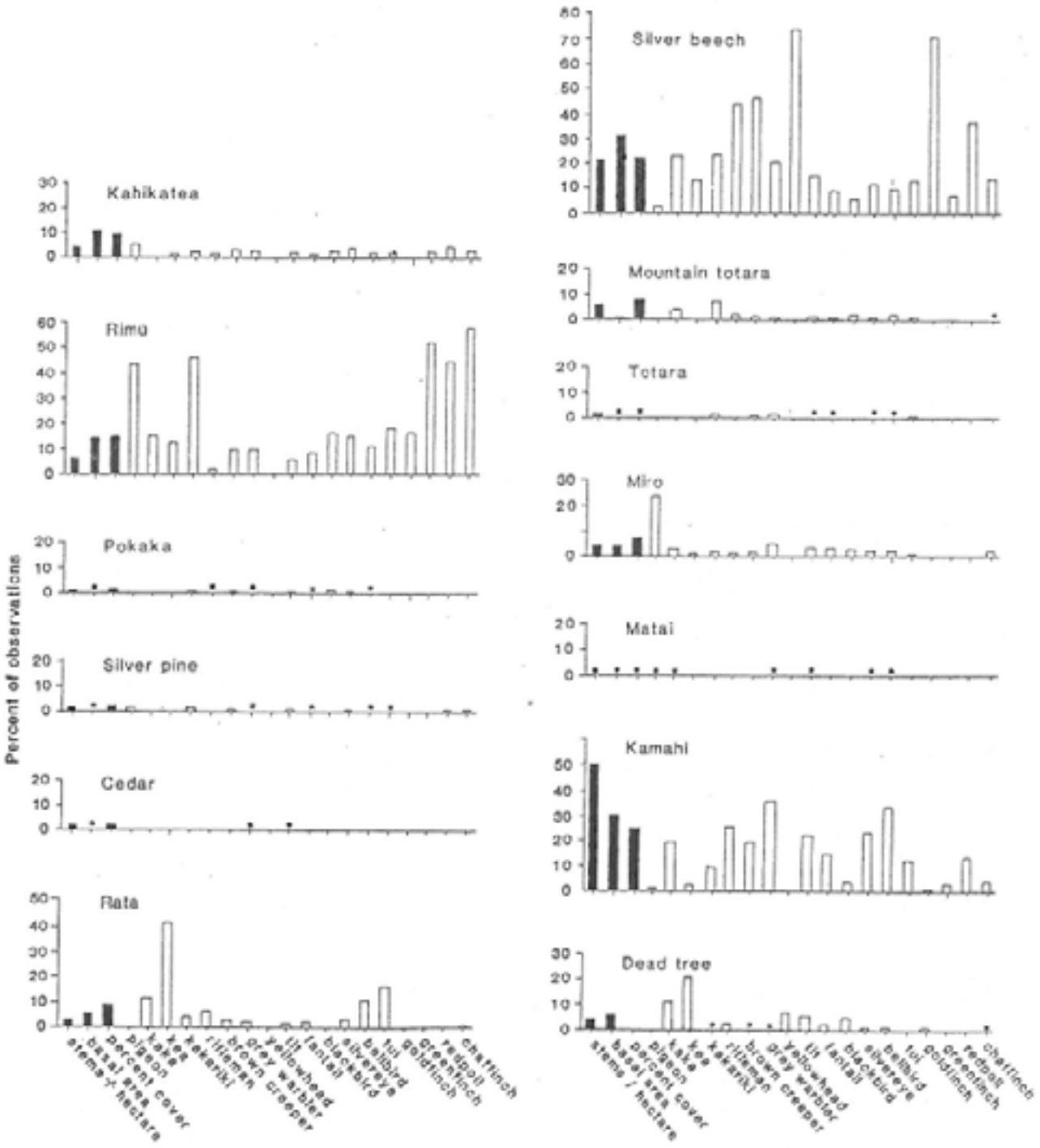


Figure 4: Seasonal use of standing dead trees by selected bird species.

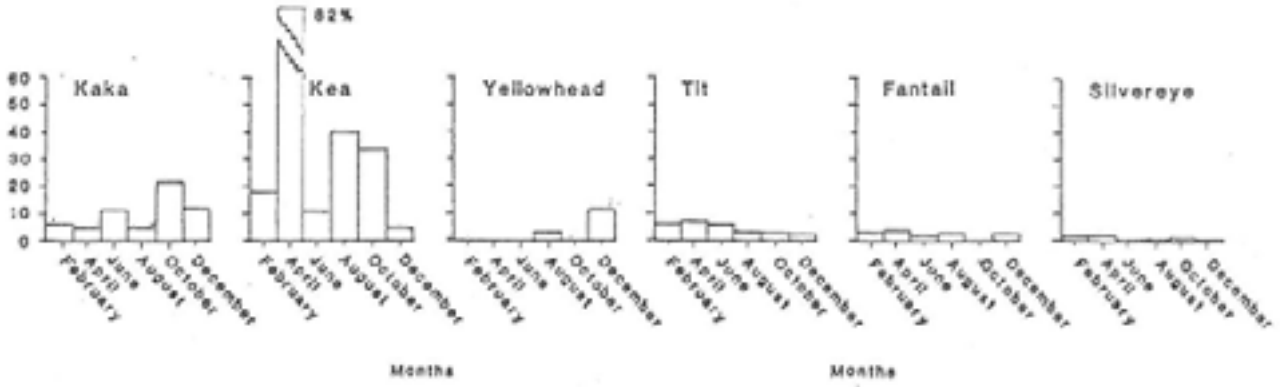
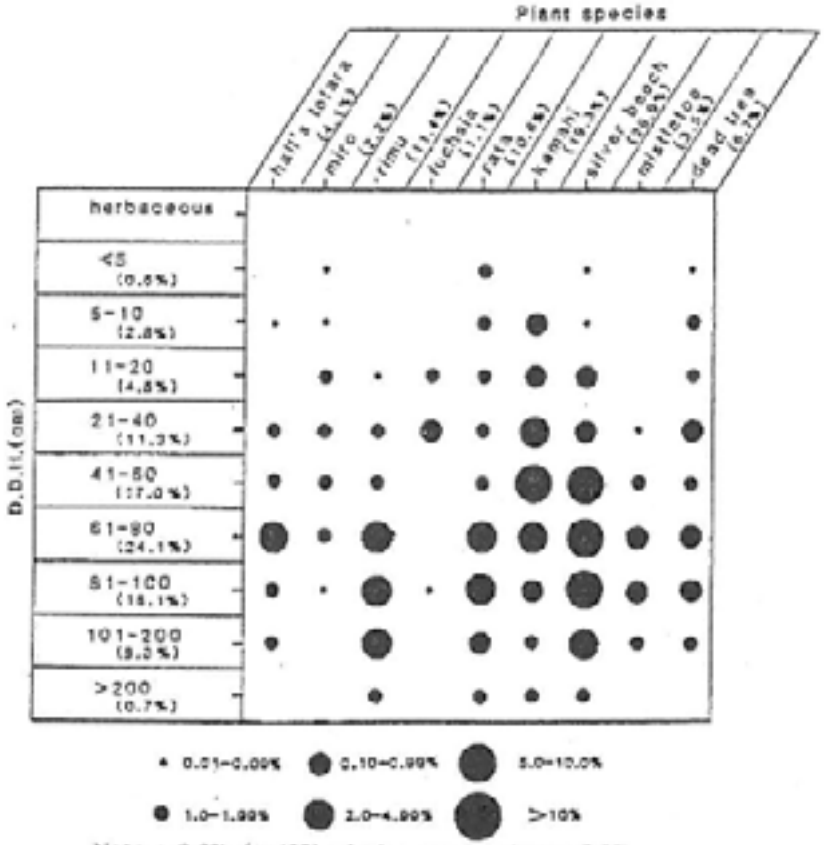


Figure 5: Size (dbh) and species of plant used by kaka in the Windbag Valley (total observations = 5334). Note :- when a bird was recorded on an epiphyte (e.g. mistletoe) the dbh of the host (silver beech) was recorded.



Note : 9.2% (n=480) of obs. not in plants; 5.0% (n=216) in the following species: moss spp., fern spp., tree fern spp., orchid spp., matai, supplejack, kiekie, pigeonwood, mahoe, Muehlenbeckia spp., wineberry, mersleleaf, lawyer, pate, Pseudopanax simplex, P. edgerleyi, broadleaf, mapou, Coprosma foetidissima, and Senecio spp.

Table 2: Seasonal use of feeding substrates by kaka.
(Percentage of feeding observations, n = 3180)

Substrate	Over-all	Months OCT	DEC	FEB	APR	JUN	AUG	Significance #
AIR	0.03	-	-	-	0.3	-	-	NS
GROUND	0.13	-	-	-	1.1	-	-	NS
FOLIAGE /TWIGS	29.5	21.2 ***	33.9	49.8 ***	30.9	29.7	24.7 **	***
BRANCHES	48.4	55.1 *	46.1	38.1 **	40.8	48.6	51.5	***
TRUNK	21.3	23.7	20.1	12.0 ***	27.0 *	21.7	23.8	***

 # G – test for independence: significance * = p 0.05, ** = p 0.01 and *** = p 0.001

4. DISCUSSION

4.1 Sampling interval

One minute intervals between observations were chosen for several reasons. Firstly it took time to record the data for each observation, and thus intervals of less than one minute were impractical. However, once observers became familiar with all criteria and codes, staggered observations enabled more than one bird to be followed. Secondly a minute interval allowed time either to follow a bird, or to find those which had moved out of sight.

Some studies using instantaneous sampling (Altmann 1974) have followed birds for 30-minute periods (e.g. Verner 1965, Mason & Oring 1966), or for as long as possible (e.g. Hay 198 1, Read 1984). The 5-minute period we suggest enables the gathering of large samples which contain independent observations of as many individuals as possible. A shortcoming with some single-species studies (e.g. on birds which are rare or seen infrequently) is that large data sets may be derived from a few individuals. While this approach may be the only method available for studying rare species, the aims of many community studies dictate the need to sample as many individuals and species as possible.

4.2 Sample sizes

Our method aims at maimising the records of habitat use of each bird in order to increase the precision and accuracy of interpretation of the data. It assumes that the data represent directly the proportion of time that birds spend on different plant species, or in following specified activities. This assumption should be valid when there are large samples taken from representative forest types throughout the year.

The five one-minute observations minimise the potential for artificial inflation of sample sizes through having a large number of observations from few individuals. Over-reliance on samples from a few individuals can invalidate statistical tests and assumptions about independence of the observations (Machalis *et al*. 1985). The 5-minute observation period on a succession of different birds reduces the likelihood of such problems.

During our three year project we made between 1358 and nearly 8000 observations per field trip, giving an overall total of 65 541 one minute observations. However, sample sizes were less than 100 for six of the 24 species observed (dunnock, falcon, harrier, long-tailed and shining cuckoos, and song thrush). There were less than 1000 observations for another five species (blackbird, greenfinch, kea, redpoll and yellowhead). Seventy nine percent of all observations were from seven species (bellbird 9.6%, fantail 9%, grey warbler 11.9%, kaka 8.1%, pigeon 9.4%, silvereye 17.7% and tit 12.9%). There was a sufficiently large number of observations only from these latter seven species to analyse the data by season, activity, and time of day.

4.3 Potential biases

The method is applicable to all forest bird species and it should be possible to standardise future research, allowing more accurate comparisons between studies than are possible at present. However, our method does have some limitations. These include;

1. The frequency of certain activities may be over-estimated because the observer is tempted to record unusual events even if they do not occur at the specified instant (Altmann 1974).

2. There can be a bias towards recording birds at more visible foraging locations. These problems should be minimised if observers use the method in a neutral manner and record their observations accurately and precisely. However, Wagner (1981) concluded that instantaneous sampling was not always biased towards more visible locations.

3. Visibility can be limited in tall forests, creating difficulties in ensuring that all levels are sampled evenly. Results can be biased towards the lower vegetation, but if care is taken and frequent pauses made to scan the canopy this influence can be minimised. (In fact a large proportion of our observations resulted from audible cues (sounds of movement, calls)). In South Westland we tried using platforms overlooking the forest canopy. The disadvantage with these was that only birds in and above the canopy could be seen. When a bird was lost from view, an observer on a platform had less opportunity to move to another vantage point, compared to an observer on the ground. Use of platforms may be feasible in small study areas or with unlimited manpower, but it is impractical when a range of forest types are being studied with few observers.

4. Observer variability in estimating heights and diameters tends to be unpredictable (Block *et al.* 1987). For example, Bell (1982b) could not record heights accurately above 10 m in rainforest. For this reason we recorded these data as height or diameter classes.

5. Care must be taken not to record behaviour resulting from the presence of the observer. Some birds, (e.g. fantails and tits) were attracted by the observer. In such cases the bird was ignored until it began behaving naturally. In most cases however, birds seemed indifferent to the observer.

6. When large flocks of birds were present it was difficult to keep track of individuals. If it was impossible to follow one bird for the five observations, each observation was based on a bird selected at random.

CONCLUSIONS

This paper describes a standard, systematic method for quantifying habitat use by forest birds. The information sets used should remain as simple as possible and yet provide sound data presented in a concise and easily digested form which people without an ornithological background can use and understand. Reliable statements can be made on what birds require in forests when based on thousands of observations on frequency of use of different components of the forest. These observations should be analysed in conjunction with detailed vegetation descriptions of study areas.

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APPENDIX 1. DETAILED DEFINITIONS USED FOR DESCRIBING FOREST HABITAT AND BIRD ACTIVITY

(codes used on field sheets given after each criterion)

1. STUDY AREA : Name of area where study is being carried out; e.g.	
Westland Moratorium Area	WMA
2. TRANSECT: Name of transect; e.g.	
Windbag Track	WIN
Bismark Terrace	BIS
Konini Ridge	KON
3. OBSERVER e.g.	
Colin O'Donnell	COD
Peter Dilks	PJD
4. DATE Day, month and year	21-01-87
5. WIND	
calm	CAL
light	LIG
moderate	MOD
strong	STR
6. TEMPERATURE	
cold	COL
mild	MIL
hot	HOT
7. WEATHER	
snow	SNO
storm	STO
heavy rain	HER
light rain	LIR
showers	SHO
overcast	OVE
partly cloudy	PTC
clear	CLE
8. TIME OF DAY e.g. Seven minutes past one	1307
9. BIRD SPECIES	
bellbird *(Anthornis melanura)*	BEL
blackbird *(Turdus merula)*	BLA
brown creeper *(Finschia novaeseelandiae)*	CRE
chaffinch *(Fringilla coelebs)*	CHA
dunnock (*Prunella modularis)*	DUN
falcon *(Falco novaeseelandiae)*	FAL
fantail *(Rhipidura fuliginosa)*	FAN
fernbird *(Bowdleria punctata)*	FER
goldfinch *(Carduelis carduelis)*	GOL

greenfinch *(Chloris chloris)*	GRE
grey warbler *(Gerygone igata)*	WAR
harrier *(Circus approximans)*	HAR
kaka *(Nestor meridionalis)*	KAK
kea *(Nestor notabilis)*	KEA
kingfisher *(Halcyon sancta)*	KIN
long-tailed cuckoo *(Eudynamis taitensis)*	LCU
morepork *(Ninox novaeseelandiae)*	MOR
parakeet red-crowned *(Cyanoramphus novaezelandiae)*	RCP
parakeet -unidentified sp.	UIP
parakeet yellow-crowned *(Cyanoramphus auriceps)*	YCP
pigeon *(Hemiphaga novaeseelandiae)*	PIG
redpoll *(Carduelis flammea)*	RED
rifleman *(Acanthisitta chloris)*	RIF
robin *(Petroica australis)*	ROB
shining cuckoo *(Chalcites lucidus)*	SCU
silvereye *(Zosterops lateralis)*	SIL
song thrush *(Turdus philomelos)*	THR
tit *(Petroica macrocephala)*	TIT
tui *(Prosthemadera novaeseelandiae)*	TUI
weka *(Gallirallus australis)*	WEK
yellowhead *(Mohoua ochrocephala)*	YEL

10. NUMBER OF BIRDS being monitored during each observation usually 1

11 .SEX of bird being observed

male	MAL
female	FEM
both	BOT
immature	IMM
unknown	UNK

12. OBSERVATION NUMBER.

Up to five observations are made for each individual	1-5

13. ACTIVITY

sing ;full song or subsong when the primary activity	SIN
call ;single calls or notes	CAL
display e.g. courtship, copulation or distraction displays	DIS
chase ; intra or interspecific interactions	CHA
roost; sleeping, inert	ROO
loaf; non-active but alert, looking around	LOA
fly; flying through or above the forest	FLY
comfort; bathing, drinking or preening	COM
hover ;searching for and taking food when the prey is on the substrate and the bird is in flight	HOV
hawk ;searching for and taking food when both prey and bird are in flight	HAW
glean ;searching for and taking food from the surface of substrate when the bird was not on the wing	GLE
probe ;penetrating into the substrate in search of prey. Most commonly searching soil, litter or rotting wood	PRO
rip ;peeling the surface to expose another substrate	RIP
scan ;use of a vantage point to look for prey, when the bird stops, looks and flies to another perch if no prey are sighted (Powlesland 1981)	SCA

browse ; feeding on vegetation	BRO
manipulate ; manipulating food before it is consumed, e.g a tit banging an invertebrate against a branch	MAN
nest ; a bird carrying nest material or at a nest site	NES
feed; young, self-explanatory	FEY
unknown	UNK

14. FOREST TYPE e.g.

silver beech	BES
kamahi-rimu	KRM

15. PLANT SPECIES

not applicable	NAP
standing dead tree	SDT
astelia	AST
beech -black *(Nothofagus solandri var solandri)*	BEB
beech -hard *(Nothofagus truncata)*	BEH
beech -mountain *(Nothofagus solandri var. cliffordtioides)*	BEM
beech -red *(Nothofagus fusca)*	BER
beech -silver *(Nothofagus menziesii)*	BES
broadleaf *(Griselinia littoralis)*	BRO
cedar *(Libocedrus bidwillii)*	CED
clematis *(Clematis spp.)*	CLE
Coprosma foetidissima	FOE
Coprosma rotundifolia	ROT
coprosma, small leaf	SCO
coprosma, large leaf	LCO
other divaricating shrubs	ODS
fern (various species)	FER
fuchsia *(Fuchsia excorticata)*	FUC
hinau *(Elaeocarpus dentatus)*	HIN
hutu*(Ascarina lucida)*	HUT
kahikatea *(Dacrycarpus dacrydioides)*	KAH
kaikomako *(Pennantia corymbosa)*	KAI
kamahi *(Weinmannia racemosa)*	KAM
kiekie *(Freycinetia baueriana)*	KIE
kowhai *(Sophora spp.)*	KOW
lancewood *(Pseudopanax*	LAN
lawyer *(Rubus spp.)*	LAW
mahoe *(Melicytus ramiflorus)*	MAH
manuka*(Leptospernum scoparium)*	MAN
mapou *(Myrsine australis)*	MAP
marbleleaf *(Carpodetus serratus)*	MAR
matai *(Prurnnopitys taxifolia)*	MAT
mingimingi *(Cyathodes juniperina agg.)*	MIN
miro *(Prurnnopitys ferruginea)*	MIR
mistletoe *(Peraxilla spp.)*	MIS
moss (various species)	MOS
mountain totara *(Podocarpus hallii)*	MTO
muehlenbeckia *(Muehlenbeckia spp.)*	MUE
olearia *(Olearia spp.)*	OLE
orchid (various genera)	ORC
parsonsia *(Parsonsia spp.)*	PAR
pate *(Schefflera digitata)*	PAT

pepperwood *(Pseudowintera colorata)*	PEP
pigeonwood *(Hedycarya arborea)*	PIG
pokaka *(Elaeocarpus hookerianus)*	POK
Pseudopanax edgerleyi	EDG
Pseudopanax simplex	SIM
rata, southern *(Metrosideros umbellata)*	RAT
rata, vine *(Metrosideros spp)*	RAV
rimu *(Dacrydium cupressinum)*	RIM
rohutu *(Neomyrtus pedunculata)*	ROH
senecio *(Senecio spp.)*	SEN
silver pine *(Lagarostrobos colensoi)*	SIP
supplejack *(Ripogonum scandens)*	SUP
three-finger *(Pseudopanax colensoi)*	THR
toatoa *(Phyllocladus glaucus)*	TOA
totara *(Podocarpus totara)*	TOT
treefem (various species)	TRE
tutu *(Coriaria arborea)*	TUT
wineberry *(Aristotelia serrata)*	WIN
unknown	UNK

16. HOST SPECIES

If the bird is recorded on an epiphyte the host plant species is also recorded.

17. DIAMETER AT BREAST HEIGHT (dbh) of the plant on which the bird is observed.

herbaceous	DB1
sapling <5 cm	DB2
5-10 cm	DB3
11-20 cm	DB4
21-40 cm	DB5
41-60 cm	DB6
61-80 cm	DB7
81-100 cm	DB8
101-200 cm	DB9
>200 cm	DB10
not applicable	NAP
unknown	UNK

18. STRATUM : A measure of level within the forest structure (Figure 2).

The height of each stratum will vary depending on forest type.

above canopy ; in flight	ABC
emergent; tree growing above the canopy	EME
unshaded canopy ; uppermost storey of tree crowns, unshaded by others	USC
shaded canopy ;upper storey of tree crown shaded by the canopy	SHC
upper understory; region below canopy tree crowns which includes tall shrubs, secondary larger trees, trunks of the canopy trees	UUN
lower understory; ;vegetation layer immediately above forest floor which includes shrubs, regenerating canopy trees, short tree ferns and lower tree trunks	LUN
ground	GRO
unknown	UNK

19. BIRD HEIGHT : Height at which bird was seen, in metres above forest floor.

0-5 m	BH1
6-10 m	BH2
11-15 m	BH3
16-20 m	BH4
21-25 m	BH5
26-30 m	BH6
31-35 m	BH7
36-40 m	BH8
41-45 m	BH9
46-50 m	BH10
>50 m	BH11
unknown	UNK

20. CANOPY HEIGHT

Height of canopy in the vicinity of the bird observation. The same height classes as BIRD HEIGHT were used but with the prefix CH. CH1- CH11.

21.PERCH TYPE

trunk	TRU
trunk -dead	TRX
large branch	LBR
large branch -dead	LBX
small branch	SBR
small branch -dead	SBX
twig	TWI
twig -dead	TWX
crook: branch-branch/branch-trunk axils	CRO
foliage	FOL
foliage -dead	FOX
frond (fern)	FRO
frond -dead	FRX
hole/crevice	HOL
vine/liane	VIN
ground – litter	LIT
ground - bare	GRB
ground - moss	GRM
rock/stone	ROC
aerial	AIR

22. FOOD TYPE

not applicable	NAP
seed	SEE
fruit	FRU
flower/nectar	FLO
honeydew (exudate of coccid insects, commonly on beech trees)	HON
leaf	LEA
bud	BUD
sap	SAP
moss	MOS
lichen	LIC
wood	WOO
invertebrate	INV
vertebrate	VER
unknown	UNK

23. SLOPE : Slope of ground, in degrees

not applicable (flat)	NAP
<10°	SL1
11-20°	SL2
21-30°	SL3
31-40°	SL4
41-50°	SL5
51-60°	SL6
>60°	SL7
unknown	UNK

24. ASPECT : Lie of the land (compass direction).

not applicable (flat)	NAP
north	N
north east	NE
east	E
south east	SE
south	S
south west	SW
west	W
north west	NW
unknown	UNK

25. ALTITUDE: in metres above sea level

0-100 m	AL1
101-200 m	AL2
201-300 m	AL3
301-400 m	AL4
401-500 m	AL5
501-600 m	AL6
601-700 m	AL7
701-800 m	AL8
801-900 m	AL9
901-1000 m	AL10
>1000 m	AL11

26. STATION NUMBER : Position on transect;

-the station number passed most recently is recorded.

APPENDIX II Procedure for defining tree species preferences by forest birds.

DEFINITION OF PREFERENCES

We have defined preferences using the following terms:

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

b) when use was statistically greater than expected, this was 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.

STUDY AREA: TRANSECT: OBSERVER:

DATE: WIND: CALM MODERATE STRONG LIGHT TEMPERATURE: COLD MILD HOT

WEATHER: SNOW, STORM, HEAVY RAIN, LIGHT RAIN, SHOWERS, OVERCAST, PARTLY CLOUDY, CLEAR,

TIME	BIRD SPS	NO BIRDS	SEX	OBS. NO.	ACT-IVITY	FOREST TYPE	PLANT SPS	HOST SPS	d.b.h.	STR-ATUM	BIRD HEIGHT	CANOPY HEIGHT	STA-TION	FOOD TYPE	SLOPE	ASP-ECT	ALTI-TUDE	STA NO.	COMMENTS