THE RANKING OF WILDLIFE HABITATS

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SUMMARY: Forested wildlife habitats identified in a broad field survey of Northland, New Zealand, have been ranked to determine their relative importance for indigenous wildlife. A numerical scoring system was devised after consideration of schemes used by other authors and after a preliminary examination of the survey data by step-wise multiple regression analysis. Twenty-five habitats were ranked according to the criteria of four authors, and significant agreement was found between the four sets of rankings. It is concluded that all habitat ranking systems employing sound ecological criteria would produce rankings which differ only slightly.

INTRODUCTION

The Fauna Survey Unit of the New Zealand Wildlife Service is currently surveying New Zealand for all wildlife "habitats of note", i.e. all natural or semi-natural areas which are important for one or more species of wildlife.

In similar surveys overseas, some of which incorporated floristic data as well, such areas have been variously termed "natural areas" (Gehlbach, 1975), "biological sites" (Ratcliffe, 1977), "biotic natural areas" (Tans, 1974), and "wildfowl habitats" (Williams, 1980). The New Zealand Wildlife Service's immediate concern is with fauna, and the choice of the term "habitat" reflects this emphasis; a wildlife "habitat" can be many hectares in area and will often comprise a number of biological communities.

In any land district, the wildlife habitats differ from each other in the variety, abundance, and distribution of species within them, in their physical shapes and dimensions, in their amounts of modification, and in many other respects. If sound decisions are to be made regarding the reservation, protection, and management of such habitats, or even if such areas are to be modified for other land uses, we need inventories of the biological resources and assessments of their relative values for conservation.

Various schemes have been described for assessing the values of habitats. Table 1 shows that many different criteria have been employed by various authors over the past 12 years. Total agreement is shown for only one criterion - "species attributes". Nevertheless, all schemes used some environmental criteria, and some schemes used factors such as a habitat's use for human recreation or education, or its availability for purchase. These variations reflect differences in the end-uses of the habitat information.

This paper discusses the results of two exercises in the ranking of wildlife habitats. Firstly, four schemes were selected to rank the same 25 habitats of note in Northland, New Zealand; a comparison was then made of the different rankings which resulted from variation between the criteria chosen and from the differences in weightings given to their numerical scores. As part of this exercise, a ranking system for habitats identified in the New Zealand Wildlife Service wildlife habitat surveys is discussed and compared with the results of alternative schemes. Secondly, this paper deals with the choices of criteria and the numerical weightings given to their scores for a scheme which was devised to rank some 360 forested habitats of Northland for their wildlife values.

Tile survey of wildlife habitats of Northland, made in 1978-79 by the New Zealand Wildlife Service, identified almost 700 habitats of note. These were mostly forests, freshwater lakes and swamps, and estuarine habitats. In the final analysis of wildlife data from Northland, only broadly similar types of habitat were compared and some different criteria were established for each comparison. This paper discusses the final choices of criteria for indigenous forest ranking only.

PRESENT HABITAT RANKING SYSTEMS

Of the authors whose ranking systems are summarised in Table 1, only Park and Walls (1978) have ranked "habitats" in New Zealand, and their survey was limited to aspects of vegetation and the flora in tall forest stands on lowland plains and terraces in the Nelson and Marlborough land districts. Park (1979) has since revised his ranking system to apply to a greater variety of plant communities.

Park and Walls (1978) scored each habitat on a numerical scale of values for each environmental criterion which was considered to be significant for the continued existence of the habitat (forest stand). The scores were totalled and a ranking of habitats was established. Similar methods were employed in

TABLE 1. *A Summary of Criteria used* in *Evaluation Schemes for Habitats*

Main Criteria	H	Rn	TB	Rt	T	Ge	Go	Wr	P_1	P_2
Size (includes buffer zone)	+	+	+	+	+	(+)	+		+	+
Habitat attributes (e.g. diversity, rarity)	+	+	+	+			+	+	+	+
Community attributes (e.g. diversity, limits of distribution)				+	+	+			+	+
Species attributes (e.g. diversity, rarity, distribution, populations)	+	+	(+)	+	(+)	+	+	+	+	+
Use (e.g. education and research, amenity)	+	+		+	+	+		+		
Degree of disturbance/naturalness		+	(+)	+	(+)	+		+	+	+
Threat				+	+	+		(+)		
Availability					+			+		
Accessibility	+				(+)	(+)		+		
Proximity to other sites		+								
Cash value of crop/product	+									
Recorded history				+				+		
Representativeness				+					+	+
Fragility				+						+
Unknown factor		+						+		
Other scientific features								+		
Other management features				(+)				+		

Notes: (+)=considered with other features; H=HelliwelI (1969); Rn=Ranwell (1969); TB=Tubbs and Blackwood (1971); Rt=Ratcliffe (1971); T=Tans (1974); Ge=Gehlbac:1 (1975); Go=Goldsmith (1975); Wr=Wright (1977); PI = Park and Walls (1978); P2=Park (1979). Adapted and extended from Wright (1977).

the United States of America by Tans (1974) and in Great Britain by Wright (1977). Both these authors used information about the fauna as well as other environmental factors in their systems.

Not all authors gave comprehensive scoring systems for the criteria that they used to rank habitats. For example, Ratcliffe (197 J) stated criteria without scores and subsequently (1977) produced a ranked list and description of important habitats for the whole of mainland England, Scotland and Wales, but without giving the precise method by which this order was established.

New Zealand Wildlife Service's habitat survey involves ground examination of all lakes, swamps and estuaries of 0.5 ha or more, all forests 10 ha or more, and some dunes, shrubland and upland game habitats. Details of the survey method were given by Ogle and Anderson (1979). **In** brief, for each habitat surveyed so far, the presence is noted on a standard card of all species of birds, bats, lizards, and indigenous frogs and large land snails. Details recorded for each habitat include location, size, tenure, physical and biotic features, modification, public use, threats to the area's future,

recommendations for preservation, the survey officer's name and date visited. The locations of the habitats are shaded on 1: 63,360 topographical maps (NZMS 1). A qualitative and largely subjective assessment of each habitat's value is made by the survey officer. As outlined by Imboden (I978) and Ogle and Anderson (1979), this involves two sets of choices. Some changes have since been made to these, but the survey of Northland rated each habitat as being:

(a) of national, regional, or local significance for wildlife;
(b) of outstanding, high, moderate, or potential value for wildlife.

From their wildlife values, the habitats may be placed in an ordered list for any specific land area; e.g. a geographic region, or that area under an administrative body such as a catchment authority or a district, county, or regional council.

However, in Northland, New Zealand, the application of these scales differed from one Wildlife Service field officer to another. The significance of the ranks "regional" and "local" also tended to shift as the survey progressed; some species or habitats assumed to be rare in the early stages were found to be more common later, and *vice versa*. Seasonal and daily differences in the conspicuousness of species may have resulted in unintentional upgrading or downgrading of habitats.

A COMPARISON OF NUMERICAL RANKING SYSTEMS

Methods

Data from 25 of the habitats assessed during the Northland Wildlife habitat survey (Table 2) were used to compare the ranking systems of Tans (1974), Wright (1977), Park and Walls (1978) and Park (1979). These 25 habitats were selected only because they were the only ones known personally to the author at that time. This personal knowledge allowed judgement to be made on criteria about which the survey data provided no information. Some assumptions about and modifications to the criteria used for ranking habitats were made, particularly to those used by Park and Walls (1978) and Park (1979), whose schemes had not been designed to handle wildlife information, nor to deal with such a wide range of habitats as that contained in the Northland survey data.

Appendix 1 summarises the authors' criteria, the manner in which they were applied to the 25 habitats, and sources of information used. The authors' scales of numerical values were used for scoring, and on the sums of their scores for each author the habitats were ranked 1 to 25 (Table 2).

The system of rating used by Wildlife Service field officers was discussed above. The results are shown in Table 2. The field officers' ratings were actually part of the score for each of the other systems, a percentage contribution of 20% (Tans), 22% (Wright), 33% (Park and Walls) and 30% (Park).

Results and Discussion

The results of the four numerical ranking systems were similar (Table 2) and were compared using Kendall's Coefficient of Concordance, W, corrected for tied rankings (as outlined by Siegel, 1956). W can vary from 0 (no agreement between systems) to 1 (complete agreement). These ranking systems have a W value of 0.9, which when tested as chi-squared with 24 degrees of freedom, is a very highly significant result ($p < 0.001$). It is concluded that the differences between the four ranking schemes are insignificant.

The use of Wildlife Service field officers' ratings as part of each score obviously gives a degree of correlation between the systems. Although no detailed analysis of its effect has been carried out, it is considered that the subjective field rating is well supported by the numerical systems and, in the absence of more objective criteria, an experienced surveyor can give a fair assessment of conservation values of a habitat. For the 25 habitats considered, in only two were the field officers' ratings at variance with the numerical scores (Table 2). In Omahuta and Trounson Park, the condition of the forest appears to have outweighed criteria such as area, and presence or absence of rare species. Consequently, Omahuta may have been under-rated, and Trounson Park over-rated, by the field officers.

It is concluded that any ranking system which uses a range of sound ecological criteria to obtain a scientific appraisal of a habitat would give results compatible with those of any other soundly-based system. The presence or absence of a few criteria, and small differences in weightings given to their scores, would be expected to produce rankings which differ only slightly.

THE RELATIVE IMPORTANCE FOR WILDLIFE OF SOME FEATURES OF FOREST HABITATS

Introduction and Methods

Despite the general concurrence of the results above, several habitats have markedly different ranks under different schemes. This could have arisen partly because vastly different habitat types were compared, and partly because some of the criteria are not as "ecologically sound" as is possible. For

TABLE 2. 25 *Northland habitats - results from* 4 *ranking systems compared with survey officers' assessments (see Appendix* 1).

Name of habitat (in order of mean rank)	T'74	W'77	P'78	P'79	Mean Rank	S.O. Rating	S.O. Rank
Waipoua S.F.	1	1	1	1	**1**	N/O	1
Ngunguru Estuary	4	5	3	4	**2**	R/O	7.5
Raetea S.F.	6.5	5	2	4	**3**	R/O	7.5
Mataraua S.F.	4	8.5	4	4	**4**	R/O	7.5
Puketi S.F.	6.5	5	5.5	4	**5**	R/O	7.5
Trounson Park (forest)	2	5	7	8.5	**6**	N/H	2
Manganui R. (wetlands, swamp, forest)	8.5	5	5.5	8.5	**7**	R/O	7.5
Warawara S.F.	4	12	8	4	**8**	R/O	7.5
Clear Ridge (forest)	11.5	2	11	11	**9**	R/O	7.5
Amahuta S.P.	11.5	10.5	9.5	8.5	**10**	R/H	14.5
Matapouri Estuary	8.5	8.5	16	8.5	**11**	R/O	7.5
Taikirau Swamp	11.5	14	9.5	12.5	**12**	R/O	7.5
Okahu Stream (wetlands, swamp, forest)	11.5	14	12	12.5	**13**	R/O	7.5
Waipu Gorge (forest)	15	16.5	13	15	**14**	R/H	14.5
Mt Auckland (forest)	14	14	17	18	**15**	R/H	14.5
Mt Maungatapere (forest)	18	16.5	14	18	**16**	R/M-H	17
Araparera Swamp	18	18	14	18	**17**	R/H	14.5
Matapouri Coastal Forest	20	10.5	19	20	**18**	L/H	18.5
Mahora Lake (dune lake)	18	20	21	15	**19**	L/H	18.5
Kaikanui Forest	21.5	20	20	IS	**20**	L/M	21.5
Waitangi Swamp	16	23	18	23	**21**	L/M	21.5
Whatatiri Bush	21.5	20	23	21.5	**22**	L/M	21.5
Mataia Coastal Forest	23	22	22	21.5	**23**	L/M	21.5
Maraeroa Swamps	24	24.5	24	24	**24**	L/P	24.5
Taranaki Peak (forest)	25	24.5	25	25	**25**	L/P	24.5

Notes: P'78, Park and Walls (1978); P'79, Park (1979); T'14, Tans (1974); W'77, Wright (1977).
S.O. Rating: Wildlife Survey Officers' Ratings (N, National; R, Regional; L, Local; O, Outstanding; H, High; M, Moderate; P, Potential).

example, the absence of "size of habitat" in Wright's scheme appears to be a deficiency in determining the values of an area of forest for indigenous birds.

The importance of habitat size in the conservation of animal species diversity has been established by MacArthur and Wilson (1967) and Diamond (1975) as part of the theory of island biogeography. Dawson and Hackwell (1978) and Hackwell and Dawson (1980) demonstrate its relevance to isolated mainland forest habitats in New Zealand. Some of the discussion in Hackwell and Dawson (1980) resulted from an analysis of Wildlife Service habitat survey data from Northland. These data were subjected to a multiple regression analysis (Dawson, pers. comm.), in a search for parameters which could influence the final choice of ranking criteria. Written details of the method and results are in preparation.

Results and Discussion

Before 1800, Northland was largely forested, but agriculture has reduced the continuous forest to "insular" habitats, of which only about 25 exceed 1000 ha. It is sufficient to record here that of all parameters tested from 177 of these insular forests in Northland, "size" accounted for approximately 28 % of the total variability in the number of indigenous forest bird species of those forests. Halving the size of a forest was predicted to cause a 6 % loss in the number of bird species. While habitat size per se might not be regarded as an ecological criterion, it evidently operates on individuals, populations, or communities to influence species diversity. Since the nature of this relationship is unknown, "size" is a measurable index of this phenomenon.

The other parameters which were found to

account for some variability by the multiple regression analysis were:

(a) the amount of other forest near the forest "island" (4 % of the variability). The analysis supported biogeographic theory, which predicts that the more similar habitat existing near an island, the greater the variety of species on that island.
(b) the presence of stock and/or goats (2% of the variability).

Criteria such as "plant community structure and integrity" of Tans (1974) and "modification" of Park and Walls (1978) and Park (1979) might be related to the significance of stock and / or goat presence which was found by this analysis.

Except for noting the presence or absence of fencing, field officers' methods of recording habitat modification were insufficiently standardised to test statistically. (Fencing showed almost no correlation with the variety of birds, which may reflect a common practice of using fences to keep animals inside the forest rather than outside. No large forest areas of the region were effectively fenced.)

A similar argument to that advanced above regarding the criterion of "size" as an ecological ranking criterion is made for "species rarity". In itself, "species rarity" is not an ecological factor, but the presence of locally, regionally, or nationally rare fauna is regarded as an indicator of some favourable conditions in that habitat which are possibly not covered by other ranking criteria; for example, low numbers or absence of predators, or the presence of particular foods or microclimatic conditions.

THE WILDLIFE RANKING SCHEME

A selection was made of generally accepted criteria of other authors, with support from biogeographic principles and evidence from the analysis above. These are summarised in Appendix 2. Approximately 360 forest habitats of Northland have been scored according to this formula. The scores have been converted to a linear five-point scale for the Wildlife map in the report of the interdepartmental Northland Land Use Study, to be produced by the Department of Lands and Survey. This was done because:

1. the Wildlife section of the Northland Land Use Study Report should be compatible with similar reports on other regions of New Zealand;
2. cartographic problems were created by a wider scale of values;
3. the subjective nature of parts of the scoring system means that little reliance can be placed on small differences in score between one habitat and another, and it is undesirable that such scores be published and possibly misused. Bracketing ranges of scores to reconstitute five different categories avoids this problem.

Advantages of the wildlife ranking scheme

1. It is a uniformly applied scheme, which minimises individual observers' differences in making subjective assessments.
2. It uses all the most widely used criteria which have been used internationally and which the current state of ecological knowledge suggests are important for wildlife survival.
3. The criteria reflect, at least in part, biogeographic principles which state the most important considerations for long-term conservation of species in isolated patches of habitat.
4. A ranked grouping of habitats permits wise regional planning decisions, in that *all* habitats which could be located were compared, regardless of current tenure, and priorities for wildlife conservation are shown.
5. Unregistered forests of Northland can be ranked in the field with the existing scheme and ranks of registered habitats can be revised as more is known about them.

Limitations of the wildlife ranking scheme

1. The eight criteria chosen cannot be regarded as the final answer for wildlife ranking of forests. For example, as more is known of the specific uses made of forests by birds and other animals, as more objective means are found to assess modification and other factors, and as research is done on "weighting" scores to reflect more precisely their relative importance, so new or modified rankings would replace this one.
2. Some criteria are almost entirely subjective. Habitat diversity and modification proved particularly difficult to quantify.
3. Parts of the ranking system were derived largely from bird survey data and these do not necessarily reflect values of the forests for other wildlife; they are even less likely to predict values for plant conservation. As an example, small stands of kahikatea *(Dacrycarpus dacrydioides)* swamp forest did not rank highly in the wildlife scheme, but because they are so rare in Northland they must have high regional value as plant communities.

As stated in Appendix 2(H), the habitats for some invertebrate populations received low scores, even where the animals were known to be endemic to Northland. In the final Land Use Study Report, 12 areas which scored poorly but

had rare invertebrates were ranked more highly, entirely subjectively. The most significant deviations from the actual scores were for forest pockets of the isolated Far North (Cape Reinga to North Cape), which contain collectively more than 20 named invertebrates endemic to that area.

4. The ranking for any area can be regarded as "correct" only for the time of survey. Changes to the habitat or adjacent areas produce a need for continual up-dating of the rankings. The loss of larger forest areas can be expected to lower the values of all nearby forests. Conversely, although exotic forests have not been surveyed, the planting of existing open country in forest could raise the ranking of adjacent habitats, at least so long as the exotic forest remained.
5. Some of the criteria are not independent and thus, to some degree, reinforce each other. Large forests tend to be more diverse and less modified than small forests. To some extent these effects may be offset by the lower level of detailed knowledge concerning fauna of larger forests and also by the fact that only smaller forests are fenced. Field officers' ranks (A_1-A_3) reflect, consciously or otherwise, many of the other criteria (B-H) and again reinforce scores given to other criteria.
6. The scoring is insufficiently flexible to distinguish between so many habitats; hence the need to convert final scores to broader groupings for the Northland wildlife report.
7. The scores for some criteria have been derived from Northland data and may not be applicable to other regions of New Zealand. Specifically, the derived relationships between forest area and the number of species, and between habitat isolation and number of species, are for Northland. Northland's forest avifauna is relatively impoverished when compared with much of New Zealand. Whiteheads *(Mohoua albicilla),* robins *(Petroica australis)* and bellbirds *(Anthornis melanura)* became extinct in the region last century (although vagrant bellbirds are known), and riflemen *(Acanthisitta chloris)* are not known to have been present. Before a similar ranking was made of forests in another region, it would be necessary to do a multiple regression analysis of data from that region and perhaps to establish new or revised criteria and scores.

FUTURE DIRECTIONS OF BIOLOGICAL RANKING SYSTEMS

The majority of criteria finally chosen for ranking forests of Northland put high values on those habitat features which would retain a diversity of animal species. Obviously there are other considerations in conserving forest faunas. Management, including availability for purchase, accessibility to human users, fragility of the habitat, and educational and cash values have all been used in schemes of some authors (Table 1), but the Northland survey was to find wildlife and their habitats; ease of management is a subsequent matter.

Rather than preserving an area with the broad objective of maintaining species diversity, a given patch of forest may be conserved for its actual or potential value as habitat for a particular species. Kushlan (1979, p. 287) considered single-species management to be the more realistic aim for continental wildlife reserves. No doubt when more is known of the specific requirements of New Zealand's forest fauna such strategies will become possible, but with the present paucity of autecological knowledge the preservation of habitats for species richness has been retained as the basis for the ranking system. The type of research currently being undertaken on the kokako *(Callaeas cinerea)* by a team from Wildlife Service, Royal Forest and Bird Protection Society, and Forest Service, may point to other methods for assessing the values of New Zealand's forest habitats.

A similar analysis to that used for Northland's forests is currently being made on data from wetlands of Northland collected during the same survey. A modified set of criteria is being prepared to rank these. The rankings of all the forest and wetland habitats of note will appear in the inter-departmental Land Use Study of Northland referred to earlier.

Ideally, a total biological ranking of habitats is needed, rather than one based on wildlife values alone. A current survey by DSIR Botany Division of forest remnants of Northland should allow some correlations to be made between wildlife and vegetation data. A recently completed wildlife survey of the Waimea and Golden Bay Counties, Nelson, by Wildlife Service staff can also be compared with the botanical rankings of forested habitats determined by Park and Walls (1978). Future work in this area should be co-ordinated at the field survey stage, and criteria tested subsequently for ranking habitats for conservation of fauna and flora.

ACKNOWLEDGMENTS

I thank Dr M. Crawley of New Zealand Wildlife Service, Dr D. Dawson of Ecology Division and Dr G. Park of Botany Division, DSIR, for their comments on drafts of this paper. I am indebted to members of

the Fauna Survey Unit, New Zealand Wildlife Service, who gathered the data on habitats in Northland, and to Miss R. Leamy and Dr D. Dawson who subjected the data to multiple regression analysis.

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APPENDIX 1

CRITERIA OF FOUR AUTHORS USED TO COMPARE THE WILDLIFE HABITAT VALUES OF 25 SITES IN NORTHLAND (SEE TABLE 2)

1. *Tans* (1974, *pp*. 35-39)

The 25 habitats were scored for biological and physical characteristics only, not management. Minimum to maximum score range = 5 to 27.

A: Quality: measured by diversity of native species, plant community structure and integrity, significance of human interference. Scale: 8, 6, 4, 2.

B: Commonness: both community and species considered for rarity in regional sense. Scale: 6, 4, 2.

C: Community Diversity: the number of plant communities or other natural features. Scale: 5, 3, 1.

D: Size and buffer: the minimum sizes recommended for plant community types, and type and extent of buffer zones. Subjective judgements were made on the suitability, in the New Zealand context, of "adequate size" and "excellent buffer". In the light of an analysis carried out by Dr D. G. Dawson later, some incorrect assumptions were probably made, although it is unlikely that these would change the total score by more than 10% . Scale: 8, 6,4,2, 0.

2. *Wright* (1977, *pp. 300-303)*

The 25 habitats were scored for the "scientific appraisal" section only, not "management". Minimum to maximum score range = 6 to 24.

A: Representativeness of ecosystem, regionally. Scale: 3, 2, 1.

B: Representativeness of geological region: omitted.

C: Habitat and community diversity. Scale: 6, 5, 4, 3, 2, 1.

D: Plant species diversity and species rarity: indigenous animals were substituted for plants in both criteria. Scale: 6, 5, 4, 3, 2, 1.

E: Landscape category: NZMS 1 maps, aerial photographs, and own observations were used. Scale: 3 (most natural), 2, 1.

F: Sensitivity to disturbance. Scale: 3 (least sensitive), 2, 1.

G: Recorded history: the amount of documentation on the habitat. No intensive search was made, but a few areas are described in well-known published accounts, and it was assumed that there are N.Z. Forest Service data for areas under their control. Scale: 3 (well-documented), 2, 1.

3. *Park and Walls* (1978. *p*. 9)

Minimum to maximum score range = 97 to 360.

A: Representativeness of stand: interpreted more widely as representativeness of the habitat, both locally and regionally. Scale: 120 (best available) 100, 80, 60, 40.

B: Size: Park's scale was not used, and a procedure was adopted as in I (D) above. Differences from Dr D. G. Dawson's analysis were unlikely to exceed 5 % of the total score. Scale: 60 (greatest size), 48, 36, 24, 12.

C: Species rarity: considered at national, regional, and local levels. Scale: 60 (most rare), 40, 20.

D: Landscape category: as for 2(E) above. Scale: 60, 45, 30, 15.

E: Modification: Scale: 60 (most intact), 50, 40, 30, 20, 10 (most modified).

4. *Park* (1979. 4 *pp.)*

Minimum to maximum score range = 9 to 27.

A: Representative quality: at each of county, regional, national levels. Scale: 3 (best area), 2, 1, at each level (maximum score = 9).

B: International representative quality: omitted.

C: Diversity of both physical habitats and plant communities. Scale 3 (most diverse), 2, 1, for each (maximum score = 6).

D: Diversity and rarity of species: interpreted for animals only. Scales: 3 (most diverse), 2, 1; and 3 (most rare), 2, 1 (maximum score = 6).

E: Rarity of vegetation sequences and communities: omitted, through lack of information, although partly considered in parts 4(C), 4(F).

F: Naturalness of landscape surroundings: interpreted and scored as in 2(E). Scale: 3, 2, 1.

G: Modification: Scale: 3 (least modified) 2, 1.

APPENDIX 2

THE FINAL CHOICE OF CRITERIA FOR RANKING NORTHLAND'S FORESTS FOR WILDLIFE

A. *Representativeness*

	Field Officer's Ranks (one figure selected)			
	Potential	Moderate	High	Out - standing
A_1 *Representativeness* at local level	0	1	2	3
A_2 *Representativeness* at regional level	3	4	5	6
A_3 *Representativeness* at national level	6	7	8	9

B. *Size* (including tall scrub buffer zones)

>10 000 ha = 5 50-249 ha = 2

1000-9999 ha = 4 10- 49 ha = 1

250- 999 ha = 3 <10 ha = 0

C. *Amount of forest near the habitat* (i.e., degree of isolation)

Each habitat received an "isolation index" derived from the sum of scores for the proportion of forested land (measured in 1/64ths of the total area) within (a) a circle of 5 km radius; and concentric annuli within the ranges (b) 5-10 km, (c) 10-20 km, (d) 20-40 km, (e) 40-80 km of the habitat. Dawson's multiple regression analysis indicated the greatest correlation occurred between the number of bird species and the amount of adjacent forest when the "isolation index"

$$= 0.25a + 0.34b + 1.02c + 3.2d + 10.8e$$

For ranking, an "isolation index" ≥ 120 (i.e. much forest nearby) = 2

"isolation index" 50-119 = 1

"isolation index" <50 = 0

D. *Habitat diversity*

Scores determined from evidence collected by the field officer, NZMS 1 maps, aerial photographs, and Ministry of Works Land Resource Inventory Worksheets.

(a) within the habitat:

(i) Relatively uniform = 0

(ii) 2 or 3 forest/tall scrub types = 1

(iii) >3 forest/tall scrub types) *or* a small wetland, large stream) etc. *within* the habitat) = 2

(b) outside (but adjacent to) the habitat:

(i) No natural area contiguous

(ii) Adjacent to unregistered or local-potential rated river, swamp, coast, etc. = 1

(Hi) Adjacent to higher rated river, swamp, coast, etc. = 2

Summary of Diversity Scores

Outside	Within 0	1	2
0	0	1	2
1	1	2	3
2	2	3	4

E. *Habitat Modification*

(i) >50% of forest area unmodified (all strata) = 4

(ii) <50% of forest area unmodified (all strata) *or* canopy intact with) understorey lightly modified *or* intact mature 2° (secondary) forest) = 3

(iii) >50% canopy intact) understorey much modified) *or* intact young 2° forest) *or* intact tall shrubland on) ridges, intact forest in gullies) = 2

(iv) >50% canopy intact, understorey) absent) *or* <50 % canopy intact, understorey) much modified or absent) *or* intact tall shrubland with) emergent young trees) = 1

(v) much devastated canopy and) understorey) = 0

F. *Number of Indigenous Forest Bird Species*

> 9 species = 2

5-9 species = 1

< 5 species = 0

Where poor weather conditions prevented the field officer obtaining a bird list at time of survey, the score of '1' was allotted. For this index, shining cuckoos *(Chrysococcyx lucidus)* were assumed to be present in all forests in season, regardless of the actual time of the survey.

Rarity of Indigenous Birds

National rarity: e.g., kokako, or at least two regional rarities = 4

Regional rarity: e.g., bellbird[1], kaka *(Nestor meridionalis),* parakeets *(Cyanoramphus* spp.), pied tit *(Petroica macrocephala toitoi),* or at least two local rarities = 3

Local rarity: e.g., North Island brown kiwi[2] *(Apteryx australis mantelli),* long-tailed cuckoo *(Eudynamis taitensis)* = 2

Good range of more common birds = 1

Poorer range of more common birds = 0

H. *Rarity of Other Fauna*

National rarity = 2

Regional rarity = 1

Nothing unusual = 0

The inclusion of two indices for "fauna rarity" (G, H) may be undesirable, but was considered necessary to give some recognition to smaller forest areas which often rated poorly for birds, but which contained large land snails *(Placostylus* spp., *Paryphanta* spp.), green geckos *(Naultinus* spp.), bats *(Chalinolobus tuberculatus.* and *Mystacina tuberculata),* Hochstetter's frog *(Leiopelma hochstetteri).* or others. As discussed earlier, the scoring system is weighted heavily for birds and is not totally suited for ranking important habitats for other fauna.

MAXIMUM TOTAL SCORE (CRITERIA A TO H) = 32

[1] The bell bird is extremely rare in Northland, and may not breed there at present.

[2] The North Island brown kiwi probably has its greatest abundance in Northland, and cannot be regarded as a regional rarity there.