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Dynamics of the status of threatened birds breeding in Finland 1935–1985*

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Lists were constructed of threatened birds in Finland in 1935, 1960 and 1985, and the changes were analysed in order to discern general patterns in the dynamics of the threatened status. The number of threatened species increased from 29 in 1935 to 38 in 1985; 48 of the 205 species breeding regularly in Finland before 1900 were threatened in at least one of the three periods. The status changes in 1935–85 were as follows: no change, 11 spp. (23%); deteriorated, 22 spp. (46%); improved, 15 spp. (31%). There were seven endangered species in 1935 and 1985, but three of the present endangered species were out of danger 50 years ago, and collapsed unexpectedly, whereas three of the species that were endangered in 1935 are no longer endangered. Protection seems to explain many of the improvements in status, whereas many declining species have suffered from alteration of their habitat. The effect of habitat is clearest in the case of special habitats that have been destroyed in recent decades. Of the out-of-danger species, as many as 6% per 25 years have become threatened. The rate of change increased from 1935–60 to 1960–85. Non-passerines were more frequently (20–29%) threatened than passerines (5–7%), partly because non-passerines are over-represented among the less abundant species that are most threatened. At present, migration strategy does not correlate with the probability of being threatened, but the proportion of short-distance migrants that are threatened has increased from 9% in 1935 to 18% in 1985. Forests, bogs and human-made habitats have consistently had fewer threatened species than aquatic habitats, shores, rocky outcrops and fells.

1. Introduction

It is one of the foremost goals of conservation biology to try to prevent extinctions (Soulé 1986, Wilson 1988). Therefore, data on changes in the degree of threat against species are valuable. Laurila & Järvinen (1989) found that life-history traits did not predict the globally endangered status of waterfowl (the only good predictor was restricted range, not surprisingly), but they were not able to examine changes in the status over time. In this paper, we will examine the Finnish lists of threatened bird species compiled over the past five decades. The most recent list (for 1985) comes from a national committee working under the auspices of the Ministry of the Environment (Rassi et al. 1986, Rassi & Väisänen 1987). Two other lists, for 1935 and 1960, were constructed by

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us using the same criteria, which was possible because of the long ornithological, including faunistic, tradition in Finland (e.g. Palmgren 1972). The years 1935 (50 yrs before 1985) and 1960 (25 yrs before) were chosen because sufficient information was available for the whole bird fauna, and for the purposes of the analysis it was necessary to have the study years evenly spaced.

Our main questions are relatively straightforward. What kinds of changes have occurred in the lists? Can general taxonomical or functional patterns be discerned, or are the lists merely a diverse array of specific cases? How frequent are dramatic collapses when the time span examined is 25 years? Has protection helped species to recover?

2. Definitions and classification of the species

The following status categories were used to classify threatened bird species breeding in Finland (quotations from Rassi & Väisänen 1987:16):

Disappeared (D). "Species whose actively reproducing populations have disappeared from Finland and which despite searches have not been encountered after 1960." As vagrants frequently occur far from the breeding grounds, to encounter here means to encounter when breeding more or less regularly. For 1935 and 1960, the time limit was put back 50 and 25 years, respectively.

Endangered (E). "Species whose actively reproducing populations are in danger of becoming extinct from Finland in the near future unless the reason for their decline is eradicated."

Vulnerable (V). "Species in which the long-term existence of actively reproducing populations in Finland is uncertain and which in the near future will become extremely endangered unless the reason for their decline is removed."

In need of monitoring (M): "Species whose development in Finland requires closely (*sic*) monitoring but which for various reasons have not been relegated to any of the above classes."

Category M has two subcategories that were used:

Declining (Md): "Species which have drastically declined in Finland but whose population(s) are not yet in any serious danger."

Rare (Mr): "Species which owing to their biological characteristics occur in Finland only within a limited area, or only at a very few sites, and whose population(s) for this reason is/are very small."

Species *out-of-danger* were denoted with O.

Admittedly, it was not always easy to decide to which category a species belongs. This was particularly true of the list for 1935; the data were not as extensive as would have been desirable. We used the 1985 list as a definitive guideline, trying to classify analogous cases identically. The classification was facilitated by the fact that the senior author was a member of the national committee and was therefore aware of the detailed reasons why the committee adopted one view instead of another.

In other respects we also followed Rassi et al. (1986) and Rassi & Väisänen (1987) as closely as possible. No species that have established themselves as regular breeders since 1900 were considered, excepting three cases that were accepted by Rassi et al. (1986), even though the establishment of their present populations before 1900 is in doubt: the Spotted Eagle *Aquila clanga* (not clear whether regular at all), the southern subspecies of the Dunlin *Calidris alpina schinzii* and the Terek Sandpiper *Xenus cinereus*. In order to ensure maximum comparability between the lists, we accepted the view of the national committee. A problematic case was the Dipper *Cinclus cinclus*. It was not included by the committee, because "the northern breeding grounds of the Dipper are not threatened to any marked extent, whereas the sporadic occurrence in southern Finland needs protection" (our translation). As the Finnish breeding stock is of the order of only 300 pairs and as our reading of the literature indicates a long-term decrease (e.g. Koskimies 1989), we would have wished to classify it as an *Md* species in 1960 and 1985. Finnish Dippers could be threatened because of changes in the wintering grounds mostly southeast of Finland, and now acid rain in northern Finland may deteriorate the breeding habitats.

We also wish to point out that species that are marginal in Finland for obvious habitat reasons (mainly the mountain habitats of northernmost Lapland) were not included as "rare", even if the population numbers are often low (e.g. the Ring Ouzel *Turdus torquatus*, a few dozen pairs). This followed the practice of the national committee. The logic of the committee was that no protection measures can be expected to lead to population changes within Finland's boundaries, but, in contrast, the Finnish population could decline despite intensive protection if something happens in the more central parts of the species ranges.

We based our classification of the species to different threat level categories (Table 1) mainly on handbook information (Kivirikko 1947–48, Merikallio 1958, Hildén & Linkola 1962, v. Haartman et al. 1963–72, Rassi et al. 1986 and Koskimies 1989). It may be noted that Kivirikko's handbook mainly covers the situation in the 1930s, as there was little ornithological activity in Finland during World War II. Appendix summarises our reasons for classifying the different species as we did. Detailed additional references are given only when necessary to supplement the information given in these standard references. We are aware that classifications like this are bound to be subjective, but in this case the committee list of 1985 was a helpful reference point. Its "correctness" can be and has been debated in details, but the relevant aspect here is the comparison between the lists of 1935, 1960 and 1985.

Table 1. The status of threatened birds breeding in Finland in 1935–1985. The symbols are as follows (see definitions in the text): D = disappeared, E = endangered, V = vulnerable, Mr = in need of monitoring because of rarity, Md = in need of monitoring because of reduced numbers, O = out-of-danger. The asterisks show that only the inland population has been considered threatened.

Species	1935	1960	1985
Gavia stellata	O	O	Md
G. arctica	O	O	Md
Cygnus cygnus	E	E	O
Anser erythropus	O	V	E
A. anser	O	Md	O
Tadorna tadorna	D	D	O
Aythya marila	O	Md*	V
Melanitta nigra	Md	Md	Md
M. fusca	Md	Md*	Md
Mergus albellus	V	V	Mr
Haliaeetus albicilla	E	E	E
Aquila clanga	E	E	E
A. chrysaetos	V	E	V
Pandion haliaetus	V	Mr	Md
Falco tinnunculus	O	O	Md
F. columbarius	O	O	Md
F. subbuteo	O	O	Md
F. rusticolus	V	V	V
F. peregrinus	O	V	E
Perdix perdix	O	O	Md
Coturnix coturnix	Mr	E	D
Crex crex	Md	V	V
Charadrius hiaticula (coast)	O	O	Md
Calidris temminckii (coast)	O	O	Md
Calidris alpina schinzii	Mr	Mr	V
Gallinago media	E	E	D
Limosa lapponica	E	V	Mr
Xenus cinereus	E	E	V
Stercorarius parasiticus	Md	Md	O
Larus fuscus	O	O	Md
Sterna caspia	Mr	O	V
Alca torda	O	Md	O
Columba oenas	O	O	Md
Bubo bubo	Md	Md	O
Nyctea scandiaca	E	E	E
Glaucidium passerinum	Mr	Mr	Mr
Strix nebulosa	O	Md	O
Caprimulgus europaeus	O	O	Md
Picus canus	Mr	Mr	Mr
Dendrocopos leucotos	Md	V	E
D. minor	O	O	Md
Lullula arborea	Mr	Mr	Md
Eremophila alpestris	O	O	E
Luscinia luscinia	Md	Mr	O
Ficedula parva	Mr	Mr	Mr
Nucifraga c. caryocatactes	Mr	Mr	Mr
Passer montanus	Md	Md	O
Carduelis cannabina	Md	O	O

3. Changes in the status

The species in Table 1 can be grouped as follows: no change in status, status deteriorated, and status improved.

3.1. No change

This group comprises 11 species (23% of the species in Table 1), if *Melanitta fusca* is included (only the inland population classified as *Md* in 1960). We also regarded changes between *Mr* and *Md* as no change (*Lullula arborea*). The species are as follows:

Melanitta nigra (Md)
M. fusca (Md)
Haliaeetus albicilla (E)
Aquila clanga (E)
Falco rusticolus (V)

Nyctea scandiaca (E)
Glaucidium passerinum (Mr)
Picus canus (Mr)
Lullula arborea (Mr/Md)
Ficedula parva (Mr)

Nucifraga c. caryocatactes (Mr)

Taxonomically, this is a miscellaneous group that includes a diversity of threat level categories (only *D* is missing). Geographically, both very northern (*F. rusticolus, N. scandiaca*) and southern (e.g., *P. canus, N. caryocatactes*) species are included. Some of the species have been persecuted or hunted, or their eggs have been collected extensively (*Melanitta* spp., *H. albicilla, F. rusticolus, N. scandiaca*), whereas others breed in rare habitats (*P. canus, F. parva, N. caryocatactes*). In addition, organochlorines have been implicated in the poor breeding success of *H. albicilla* in the 1970s and early 1980s, but this has been counteracted by protection and the banning of harmful chemical use. This is one case where active protection has presumably prevented a rapid deterioration of the status. In the late 1980s, fledgling success has clearly improved compared with the 1970s.

3.2. Status deteriorated

This group includes the following 22 species (46% of the species in Table 1). The symbols in parentheses indicate the change in status from 1935 to 1985.

Gavia stellata (O to Md)
G. arctica (O to Md)
Anser erythropus (O to E)
Aythya marila (O to V)
Falco tinnunculus (O to Md)

F. columbarius (O to Md)
F. subbuteo (O to Md)
F. peregrinus (O to E)
Perdix perdix (O to Md)
Coturnix coturnix (Mr to D)

Crex crex (Md to V)
Charadrius hiaticula (O to Md)
Calidris temminckii (O to Md)
C. alpina schinzii (Mr to V)
Gallinago media (E to D)

Larus fuscus (O to Md)
Sterna caspia (Mr to V)
Columba oenas (O to Md)
Caprimulgus europaeus (O to Md)
Dendrocopos leucotos (Md to E)

D. minor (O to Md)
Eremophila alpestris (O to E)

It is noteworthy that as many as 16 of these 22 species were out of danger in 1935, but have since declined to such an extent that their recent population development gives rise to serious concern. Mostly the new status is *Md*, but those that deviate from this pattern deserve special attention: *A. erythropus, A. marila, F. peregrinus*, and *E. alpestris*. All of them were reasonably common in 1935.

F. peregrinus collapsed unexpectedly because of DDT and related pesticides. Equally unexpected was the decline of *A. erythropus*; habitat changes in the wintering grounds are the prime suspect. The almost total disappearance of *E. alpestris* from Finland is enigmatic. As regards *A. marila*, hunting and oil spills in the wintering grounds have been suggested as the main culprits in the decline. Recent data from the Gulf of Bothnia indicate that the population there is larger than previously thought (M. Haldin, pers. comm.), so *A. marila* seems to be a less dramatic case. But the three other species illustrate an important principle: within 50 years (in *E. alpestris*, within 25 years), the status of a species can change drastically and unpredictably from "out of danger" to "endangered": almost half (3/7) of the present endangered species were out of danger as little as 50 years ago. *D. leucotos* is another alarming example: from *Md* to *E* in 50 years. Wrote Bruce Chatwin (1988), "... history is always our guide for the future, and always full of capricious surprises."

The other deteriorating trends seem more or less elementary: many rare or declining species tend to become more threatened than before, largely owing to human-caused habitat changes. This observation shows that the category M does mean what it says: "in need of monitoring". Some of those species will undoubtedly change their status for the worse within the next 25 years, so monitoring is worthwhile.

3.3. Status improved

The following 15 species (31% of the total 48 spp.) have improved their status in recent decades:

Cygnus cygnus (E to O)
Anser anser (Md to O)
Tadorna tadorna (D to O)
Mergus albellus (V to Mr)
Aquila chrysaetos (E to V)

Pandion haliaetus (V to Md)
Limosa lapponica (E to Mr)
Xenus cinereus (E to V)
Stercorarius parasiticus (Md to O)
Alca torda (Md to O)

Bubo bubo (Md to O)
Strix nebulosa (Md to O)
Luscinia luscinia (Md to O)
Passer montanus (Md to O)
Carduelis cannabina (Md to O)

Two-thirds of the species (= 10) in this group are species that are now out of danger, mostly coming from category *M*, with two exceptions: the protection of *C. cygnus* led to a dramatic recovery, and *T. tadorna* has been able to recolonize Finland in the 1960s. Even some endangered species may change their status for the better: almost half (3/7) of the species that were endangered in 1935 are no longer endangered, and one of them (*C. cygnus*) is now out of danger altogether.

Protection seems to be the keyword for understanding most of the improvements in the status of species: waterfowl suffered from hunting, birds of prey and *S. parasiticus* from persecution, and rare waders from egg hunting, but efficient protection in recent decades has led to recoveries. It is also worth noting that the human population in Finland has undergone dramatic urbanization between 1935 and 1985 (the rural population has decreased from about 3 million people to less than two million). Whatever the demerits of urbanization, there is the advantage that most birds breed in non-urban environments, and it presumably helps those that suffer from persecution.

A few of the species tell a different story. *A. torda* exemplifies the problems of recovery for a long-lived, slowly reproducing species (e.g., Mertz 1971): the recovery from the population crash of the early 1940s took several decades. As regards the three recoveries of threatened passerines, habitat changes seem to have led to recent population increases and range expansions (see Appendix).

4. The temporal distribution of the changes

Table 1 gives an opportunity to examine how many and in which directions changes have taken place in 1935–60 and 1960–85. As a first approximation we calculated a Markovian transition matrix (Table 2) to show the probabilities of different

Table 2. Transition matrix showing probabilities of status changes over a period of 25 years for the 205 species of the pre-1900 Finnish breeding bird fauna. The data are based on the changes reported in Table 1; for the 157 species not included there, there were 2×157 = 314 "transitions" from out-of-danger to out-of-danger. The threat codes are: O = out-of-danger, M = in need of monitoring, V = vulnerable, E = endangered, D = disappeared. The numbers under the code for earlier status show how many species had that status in 1935/1960; after the code for new status, the figures are the corresponding numbers for 1960/1985. Along the diagonal (*italicized*), the transition is to the same status as before. Above the diagonal, the changes are for the better; below the diagonal, for the worse. The figures (in parenthesis) after the probabilities show how many such transitions there were.

	Earlier status									
New status	O (176/172)		M (17/17)		V (4/7)		E (7/8)		D (1/1)	
O (172/167)	*0.94*	(328)	0.26	(9)	–	(–)	0.07	(1)	0.5	(1)
M (17/22)	0.05	(16)	*0.59*	(20)	0.27	(3)	–	(–)	–	(–)
V (7/7)	0.01	(3)	0.12	(4)	*0.36*	(4)	0.20	(3)	–	(–)
E (8/7)	0.00	(1)	0.03	(1)	0.36	(4)	*0.60*	(9)	–	(–)
D (1/1)	–	(–)	–	(–)	–	(–)	0.13	(2)	*0.5*	(1)

status changes over a period of 25 years. In order to do that, we included all pre-1900 species that have not been threatened during the 1935–85 period; there are 157 of them, the total number of pre-1900 species being 205. (Transition probabilities are constant in a Markov chain. We will examine the realism of this assumption of constancy below.)

At first sight the result looks reassuring: the above-diagonal probabilities (transitions for the better) tend to be higher than below the diagonal. It is misleading, however, to compare the probabilities: the group "out-of-danger" includes the bulk of species, and even small probabilities of transition from that group to a threatened status imply a relatively large absolute number of species. As the out-of-danger species tend to be abundant and common, we find it remarkable that as many as 6% of them per 25 years have made the transition to some threat category; translated into a tentative prediction, ten of the 167 species now out of danger will be threatened in 2010. On the other hand, the transitions from some threat category to out-of-danger would contribute less: the probabilities of Table 2 imply that six or, more likely, seven of the present 38 threatened species will be out-of-danger in 2010. During our study period the balance was slightly different: 20 transitions from out-of-danger to some threat category, but only 11 transitions in the opposite direction. Numbers in other transition classes are so small that a more detailed analysis would not be useful.

Instead, we call attention to an important point that is masked by our Markovian transition matrix: the temporal distribution of the transitions is *not* constant.

We observed 31 changes to a poorer status (Tables 1–2); of them, 10 were in 1935–60 and 21 in 1960–85. Of the 17 improvements, four were observed in 1935–60, but 13 in 1960–85. No changes were observed in the status of 34 species in 1935–60, and of 14 species in 1960–85. Using percentages, the figures can be expressed as follows (100% = the 48 spp. of Table 1):

Period	Deteriorated	Improved	No change
1935–60	21%	9%	71%
1960–85	44%	27%	29%

The distributions are highly significantly different ($\chi^2 = 17.0$, $P = 0.0002$, d.f. = 2).

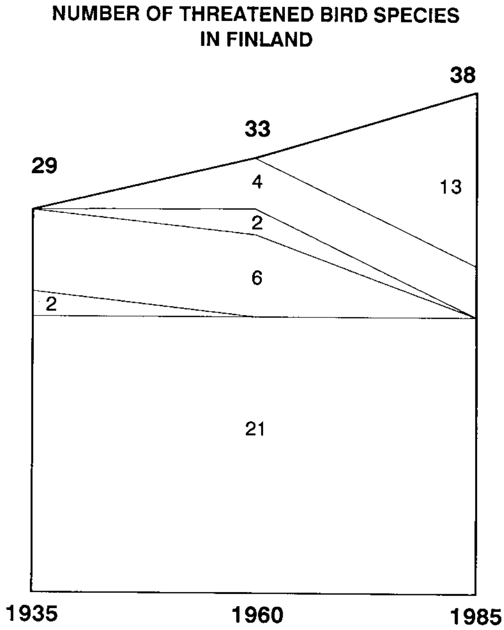

Fig. 1. The number of threatened bird species in Finland in 1935–1985. The diagram indicates the numbers of species whose status has changed from out-of-danger to any threat category or vice versa during the study periods. A total of 21 species have been threatened all the time. Two species were threatened in 1935 but no longer in 1960, and six species were threatened in 1935–60, but no longer in 1985. Two species were threatened only in 1960. Four species were not threatened in 1935, but have been threatened since 1960. Thirteen species were not threatened in 1935–60 but became so in 1985. The total number of threatened species has increased from 29 in 1935 to 38 in 1985.

The balance between changes in different directions shows that there have been more transitions for the worse than for the better (six more in 1935–60 and eight more in 1960–85). Also, we observe that many more changes, in both directions, took place in the later period than in the earlier: 14 in 1935–60 but 34 in 1960–85 ($\chi^2 = 7.52$, d.f. = 1, $P < 0.01$; Yates' correction used when d.f. = 1 throughout this paper). Similarly, Fig. 1 shows that the number of changes from out-of-danger to some threat category and the number of threatened species have been on the increase in recent decades. These results echo the finding by

Järvinen & Ulfstrand (1980) that species turnover in Fennoscandian bird faunas has been much more rapid in recent decades than in the late 19th century or early 20th century. Likewise, as regards the Finnish insect fauna, Väisänen (1988) suggested that there has been "increasing instability in the abundance relationships of different faunal elements", but the data on insects are not detailed enough for a quantitative assessment.

These observations are disturbing. The simple Markovian chain approach (Table 2), based on time-independent transition probabilities, predicts a steadily eroding status for the pre-1900 fauna (6–8 more transitions being negative than positive). More importantly, the fact that the number of transitions was significantly higher in 1960–85 than in 1935–60 implies a system in turmoil: oscillations up and down have not only been somewhat out of balance but their amplitude has increased. This observation recalls Pfister's (1988) point on the climatic cooling in Europe more than 600 years ago: "The evidence suggests that the shift from the warm climate of the High Middle Ages to the full brunt of the "Little Ice Age" did not take much more than two decades. The end of the transitory period in the 1330's stands out by an extreme variability: five late summers out of ten were either much too cold or much too warm..."

5. Taxonomic aspects

There are threatened species in all the bird orders breeding in Finland (Table 3), except four orders poorly represented in the Finnish pre-1900 avifauna: Podicipediformes (3 spp.), Ardeiformes (1 sp.), Cuculiformes (1 sp.) and Apodiformes (1 sp.). Eight orders had threatened species in 1935–60, but 11 in 1985. The proportion of threatened species is much higher in non-passerines (20–29%) than in passerines (5–7%), and it has increased considerably in non-passerines: in 1985 almost a third of the non-passerine species were threatened. As many as 41 non-passerines (35% of the species) have been threatened at least sometimes in 1935–85, whereas only seven (8%) of the passerines have been so (χ^2 = 18.4, P < 0.001). There is no significant heterogeneity among non-passerine orders (χ^2 = 5.93, d.f. = 3, P > 0.1; the analysis was based on the three most species-rich orders and a fourth group comprising all the rest put together).

The plight of non-passerines was also observed by Järvinen & Ulfstrand (1980) in their study of turnover events in the Fennoscandian bird faunas in 1850–1970: non-passerines had a 12% chance of becoming extinct in at least one of the countries studied, whereas the corresponding proportion for passerines was only 2%.

Why should non-passerines be more prone to become threatened than passerines? One obvious hypothesis is that non-passerines tend to be less abundant (see also Terborgh & Winter 1980). Solonen (1985) has classified Finnish breeding birds according to logarithmic abundance classes from 1 = less than 100 pairs to 6 = over one million pairs (present abundance). We used these classes in constructing Table 4 (the recent literature indicates that some of the abundance classes given by Solonen should be modified, but the overall results of our analysis would not be affected). None of the species having hundreds of thousands of

Table 3. The proportion (%) of threatened species in different orders in 1935–85. Four small orders with no threatened species excluded from the table but included in the calculations (see text). The figure in parentheses after the order name gives the number of species in that order in the pre-1900 breeding bird fauna of Finland. The percentages for the smallest orders in parentheses. The figures in the table refer to threatened status in Finland, not globally. Only three of the Finnish breeding species are included in the global list (Collar & Andrew 1988): *Anser erythropus*, *Haliaeetus albicilla* and *Crex crex*.

Order (spp.)	1935	1960	1985
Gaviiformes (2)	–	–	(100)
Anseriformes (22)	23	36	23
Falconiformes (15)	33	40	60
Galliformes (7)	14	14	29
Gruiformes (5)	20	20	20
Charadriiformes (40)	15	15	20
Columbiformes (3)	–	–	(33)
Strigiformes (10)	30	40	20
Caprimulgiformes (1)	–	–	(100)
Piciformes (7)	29	29	43
Non-passerines (118)	19	24	29
Passeriformes (87)	7	6	5
All (205)	14	16	19

pairs or more was threatened in 1935–85, but there were only 13 non-passerines versus 47 passerines in that abundance class. Slightly over 10% of both non-passerines and passerines having tens of thousands of pairs are, or have been, threatened; the proportion is slightly over 30% for those having thousands of pairs. The low frequency of passerines in the two lowest abundance classes makes the calculations less reliable, but there is a tendency for non-passerines in these classes to fare poorly. Indeed, 84% of them are or have been threatened, as opposed to 1/8 (12%) of the passerines. Furthermore, in the abundance class "Thousands", 10/44 of the non-passerines have deteriorated in status in 1935–85, but the ratio among the passerines is 0/13 ($\chi^2 = 3.57$, $P = 0.059$). Abundance is thus an important, but not the sole reason for the difference in the proportion of threatened species between non-passerines and passerines.

6. The wintering areas of threatened species

We classified the species in Table 1 into three groups according to their main wintering quarters:

1) sedentary or irruptive species wintering mainly in Finland or nearby,
2) short-distance migrants wintering in Europe (including species that winter in the Mediterranean region), and
3) long-distance migrants wintering mostly in trans-Saharan Africa or in Southeast Asia.

Boundary cases were decided according to the shorter alternative: partial migrants were regarded as sedentary, and species wintering in the Mediterranean and in (sub)tropical areas were regarded as short-distance migrants. The numbers and percentages (in parentheses) of threatened species in the different categories were as follows:

	1935	1960	1985
Sedentary and irruptive (54 spp.)	10 (19)	11 (20)	10 (19)
Short-distance migrants (106 spp.)	10 (9)	14 (13)	19 (18)
Long-distance migrants (45 spp.)	9 (20)	8 (18)	9 (20)

The only trend here is that more short-distance migrant species have become threatened; nine of the 13 species that were threatened in 1985 but not in 1935–60 winter in Europe (in the broad sense). Chiefly waterfowl, but also half of the diurnal birds of prey and waders, are short-distance migrants. The great majority of the endangered and vulnerable species winter in Finland or elsewhere in Europe; tropical species in these groups are only *Pandion haliaetus, Coturnix coturnix, Crex crex, Gallinago media, Xenus cinereus* and *Sterna caspia*. It seems unlikely that habitat changes in the tropics (e.g. Svensson 1985) are a major factor affecting these species, with the possible exception of *S. caspia*. In contrast, habitat changes in Finland (and in the neighbouring countries) are a threat to *Haliaeetus albicilla, Aquila chrysaetos* and *Dendrocopos leucotos*.

At present, the migration strategy does not correlate with the probability of being threatened: one-fifth of the species in each group is threatened. This is in contrast with the patterns found in quantitative studies of more abundant species. For example, Väisänen et al. (1986) examined population trends from the 1940s to the 1970s in 43 abundant species in Northern Finland. They re-

Table 4. The changes in the threatened status of non-passerines/passerines (118/87) in relation to their present abundance class (from Solonen 1985). The numbers in the Table are the numbers of species in each category.

Abundance class	Out-of-danger	Improved	Stable	Deteriorated
<100 pairs (12/1)	2/1	1/–	4/–	5/–
Hundreds (13/7)	2/6	8/–	1/–	2/1
Thousands (44/13)	29/9	3/1	2/3	10/–
Tens of thousands (36/19)	31/17	–/2	1/–	4/–
More (13/47)	13/47	–/–	–/–	–/–

ported that sedentary species have suffered most: among the decreased species 69% (out of 16 spp.) were sedentary, among the stable species 45% (11 spp.), but among the increased species only 19% (16 spp.; $\chi^2 = 8.12$, d.f. = 2, $P < 0.02$). The contrast between the patterns in abundant and sparse species was also noted by Haila & Järvinen (1990), who observed that the species composition in Finnish boreal forests has remained fairly stable during the past century, whereas the quantitative changes in the densities of the abundant species have been dramatic.

7. Habitat affinities of the threatened species

Rassi et al. (1986, see also Rassi & Väisänen 1987) classified the threatened species according to breeding habitats. In many cases they gave several habitats for a species, but in the following analysis we have used only the first (= main) habitat in their list. To check whether some habitats are disproportionately represented among the threatened species, we classified the breeding habitats of the non-threatened species, trying to follow the principles adopted by Rassi et al. (1986).

7.1. General

If all habitats had the same proportion of threatened species, one would expect 14% of the species in 1935, 15% in 1960 and 19% in 1985 to be threatened in each habitat, but there is some variation (Table 5). Forests, bogs and human-made habitats have consistently had fewer threatened species than expected, whereas aquatic habitats, shores, rocky outcrops (only 2 spp.) and fells have been over-represented. The variation is not significant, however ($\chi^2 = 8.3$, n.s., d.f. = 5, rocky outcrops excluded; note that the test is not strictly correct, since three of the expected values are as small as 2.5–4.0). The habitats that have been drastically modified have fewer threatened species than others, whereas less modified habitats have an excess of threatened species. To us, the most likely interpretation is that the habitat classes used here are so broad that they do not properly express the specific habitat requirements of the threatened species. We therefore examined our data using the more detailed habitat classes of Rassi et al. (1986), adding the subclass "coniferous forest" among the forest subclasses. As the numbers of species per habitat class tend to be small, we will restrict ourselves to pointing out the most striking results.

In the *forest* subclasses, all the three species classified as birds of primaeval forest were threatened in 1935–85. Four (27%) of the 15 species of deciduous forests were threatened in 1935–85; these tended to be species requiring decaying deciduous trees (three woodpeckers). None of the 33 species of coniferous forest was threatened in 1985 (1 or 2 species were in 1935/60). The message seems clear: species requiring unusual forests are threatened, but those breeding in more typical forests are seldom threatened.

Of the threatened bog species, all (1–2) were birds of treeless *Sphagnum* mires, but threatened

Table 5. The numbers of threatened species in different habitats in 1935–85. The habitat classification is based on the Finnish Red Data Book for threatened species (Rassi et al. 1986, Rassi & Väisänen 1987). The percentages indicate the proportion of threatened species among species breeding in that habitat.

Habitat	1935	1960	1985	Total spp.
Forest	8 (11%)	9 (12%)	10 (14%)	73
Bogs	1 (5%)	2 (9%)	2 (9%)	22
Aquatic	8 (19%)	10 (23%)	9 (21%)	43
Shores	3 (21%)	3 (21%)	5 (36%)	14
Rocky outcrops	1 (50%)	1 (50%)	1 (50%)	2
Fells (mountains)	3 (21%)	4 (29%)	5 (36%)	14
Human-made habitats	5 (14%)	4 (11%)	6 (16%)	37

for other reasons than habitat modification. Most ditching of Finnish mires and bogs has been on pine mires, but this has had little effect on the birds, as few species are restricted to this habitat (in the pre-1900 fauna one species).

The *Baltic Sea* has many threatened species (3 of the 10 aquatic species and 4 of the 8 shore species in 1985). We will return to this point presently. Three of the four species of oligotrophic lakes were threatened in 1985. In *human-made habitats*, the species of cultivated land were more threatened than others (5 of 27, or 19%, in 1985), except for the wet meadows (one species only).

The above analyses seem to indicate that the clearest habitat effects relate to special habitats that have been severely modified in recent decades. In the following, we examine species depending on aquatic habitats in greater detail (more detailed analyses of other habitats did not add to the previous observations, or the sample sizes were too small).

7.2. Aquatic habitats

Many species are restricted to the Baltic coast and the archipelago in Finland. In addition, there are species that are archipelago species in Southern Finland, but occur inland in Northern Finland. These two groups were here regarded as *archipelago birds*, but species that commonly breed inland in Southern Finland were not included. The classification was based on the maps of the Bird Atlas (Hyytiä et al. 1983).

Of the 19 archipelago species (pre-1900 avifauna), 12 were among the threatened species in Table 1. Because of the difference in the proportion of threatened species between non-passerines and passerines (above), we analysed the two groups separately. Two-thirds (12/18) of the archipelago non-passerines were threatened, which differs significantly from the proportion (21/100) among other non-passerines ($\chi^2 = 9.60$, $P < 0.01$). The reason why archipelago birds are easily threatened is probably that their range is rather restricted and, particularly in earlier times, has been extensively affected by the human population in the archipelago (egg hunting, hunting, persecution; e.g., see Väisänen & Järvinen 1977); at present, the archipelago is used intensely for recreation. The group includes three wader species threatened by the ingrowth of a special habitat, coastal shore meadows on the flat west coast of Finland (see Appendix).

On the other hand, it seems that geographically less restricted wetland birds are rarely threatened. We defined *generalist wetland birds* as those that breed commonly along the Baltic coast or in the archipelago, but also inland in Southern Finland. According to the Atlas maps, there are 27 such species (25 non-passerines). Of these, only *Pandion haliaetus* and *Larus fuscus* are threatened. The proportion among non-passerines (8%) is far smaller than average ($\chi^2 = 8.57$, $P < 0.01$). The number of wetland species breeding commonly inland in Southern Finland, but not along the coast, is too low for meaningful tests. These results confirm our previous conclusion that species in special habitats tend to be particularly vulnerable.

8. Interaction of variables

In the above analyses, we found a number of possibly interdependent variables that correlated with the vulnerability of the species. We made a number of multiple regression analyses, using dummy coding for habitat variables and taxonomic affinities (PAS: passerines vs. non-passerines) and obvious codes for other variables considered (population size: from 1 to 6 corresponding to <100 to >1 million, migration: from 0 = sedentary to 2 = tropical). The results suggest that population size was by far the most important variable, and taxonomic affinity also contributed to vulnerability. When abundant species were excluded (population size over 100000), population size (POPUL) and taxonomic affinity (PAS) accounted for 34.6% (adjusted R squared) of the variance in the degree of threat (0 = out-of-danger to 2 = vulnerable, endangered or disappeared). The model was

$$\text{THREAT} = 1.88 - 0.44\ \text{POPUL} - 0.25\ \text{PAS},$$

where both independent variables were significant (POPUL: $P < 0.001$, PAS: $P < 0.05$). Other models that were tried also emphasized the importance of population size, but it should be remembered that in these models the habitat classification used was coarse (cf. section on habitat affinities).

9. Conclusions

Conservation of biodiversity is one of the main tasks for the future. Lists of threatened species indicate the most critical species. As this paper shows, such lists change with time. It is not unexpected that the number of threatened species has increased from 29 in 1935 to 38 in 1985, but it is perhaps more surprising that as many as 10 species that were threatened either in 1935 or in 1960, are no longer threatened. Rapid changes in both directions were observed; most importantly, there has been a small (1%) probability that an out-of-danger species will be vulnerable or even endangered after such a short period as 25 years, and it seems that rates of change have recently increased markedly. It is disturbing to think that a handful of those species now classified as "out-of-danger" will be among the top priority species in 2010. This shows that conservation of biodiversity can never be restricted to crisis programmes for threatened species, but one must also conserve the whole fauna, e.g. by protecting unusual and threatened habitats and by effective legislation against persecution.

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Selostus: **Uhanalaisuuden muutokset Suomen pesimälinnustossa 1935–1985**

Uhanalaisten eläinten ja kasvien suojelutoimikunta luokitteli Suomen pesimälinnuston uhanalaiset lajit 1985. Tutkimme uhanalaisuuden muutoksia laatimalla kirjallisuuden perusteella — käyttäen mahdollisimman tarkoin samoja kriteerejä kuin suojelutoimikunta — vastaavat luettelot vuosille 1935 ja 1960. Vuonna 1935 uhanalaisia lajeja oli 29, 1960 33 ja 1985 38; kaikkiaan 48 lajia ennen vuotta 1900 pesimälinnustoomme kuuluneista "alkuperäisistä" lajeista (205) on ollut uhanalainen jossakin vaiheessa vuosina 1935–85.

Uhanalaisuuden aste ei muuttunut 11 lajilla (23%) vuodesta 1935 vuoteen 1985. Aikaisempaa uhanalaisemmiksi muuttui 22 lajia (46%) ja 15 lajin (31%) tilanne parani. Nopeatkin muutokset ovat mahdollisia: vuonna 1985 erittäin uhanalaisiksi luokitelluista lajeista kolme ei ollut lainkaan uhanalaisia 1935 (kiljuhanhi, muuttohaukka, tunturikiuru). Toisaalta vuonna 1935 erittäin uhanalaisina olleet joutsen, ristisorsa (kokonaan hävinnyt) ja punakuiri eivät ole enää uhanalaisten lajien luettelossa. Aktiivinen suojelu selittää useimmat parannukset, kun taas elinympäristöjen tuhoutuminen on pääsyy uhanalaisuuden asteen kasvulle. Erityisen uhattuja ovat harvinaisia biotooppeja (esim. vanhat metsät, iäkkäät lehtimetsät) asuttavat linnut.

Muutokset uhanalaisuuden asteessa vauhdittuivat jaksolla 1960–1985 verrattuna vuosiin 1935–1960. Varpuslintulajeista 5–7% on ollut jossain vaiheessa uhanalaisena, mutta ei-varpuslinnuista peräti 20–29%. Muuttotapa ei selitä uhanalaiseksi joutumista, joskin uhanalaisten lajien osuus lyhyen matkan muuttolinnuista on kaksinkertaistunut 50 vuodessa. Uhanalaisten lajien osuus on korkeampi vesi-, ranta- ja tunturilinnustossa kuin metsissä, soilla ja ihmisen muokkaamissa ympäristöissä pesivässä lajistossa. Aikaisemmin yleisenkin lajin mahdollisuus joutua nopeasti erittäin uhanalaiseksi osoittaa, että lajistonsuojelu ei saa rajoittua vain pahimmin uhattujen lajien hätäohjelmiin, vaan koko lajisto on otettava huomioon mm. suojelemalla harvinaisia elinympäristöjä.

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Appendix. Summary of the population changes in Finnish threatened bird species in 1935–85

Gavia stellata. Seems to have declined mostly in recent decades (although earlier status not known exactly). Threats include drainage of lakes and disturbance.

G. arctica. Declined in recent decades due to disturbance and water regulation. Breeding success seems to be low in many large lakes.

Cygnus cygnus. Persecution up to World War II and even later, almost extinct in the 1940s and 1950s (although Merikallio's 15 pairs probably an underestimate). Since the 1950s intensive protection (now almost 1000 pairs).

Anser erythropus. Declined rapidly for unknown reasons since the 1950s (deterioration of wintering and migration habitats?). Less than 20 pairs remain.

A. anser. Declined in the 1940s and 1950s owing to hunting, disappeared from many previous breeding grounds. Recovery in the 1960s and 1970s.

Tadorna tadorna. Disappeared from the breeding fauna after the 1880s, re-colonization since 1960s, now about 50 pairs with a slow upward trend.

Aythya marila. Poorly known, but the northern inland population seems to have declined up to 1960. The Baltic population increased up to the early 1970s, but declined considerably thereafter.

Melanitta nigra. Breeding range and population size decreased since the last century, probably owing to overhunting.

M. fusca. Northern inland breeding range considerably smaller than in the 19th century; numbers declined steadily (overhunting, fishing nets?). Baltic populations have increased in this century, but during recent decades have declined, breeding success at least locally poor (disturbance).

Mergus albellus. Threatened by intensive egg collecting in the late 19th and early 20th century. Recovery in recent decades.

Haliaeetus albicilla. Heavily persecuted for a long time. Organochlorines disrupted breeding success from the 1960s to the early 1980s. Intensive protection has led to improvement of breeding in the 1980s (in view of the good production of young in recent summers, the species may soon be transferred to the vulnerable category).

Aquila clanga. Breeding status in Finland unclear (0–2 pairs a year?), no known changes during the past 100 years.

A. chrysaetos. A steady decline of numbers and shrinking of the breeding range since the 19th century owing to persecution. Forestry removes sufficiently robust breeding trees and causes disturbance (Tjernberg 1986). The numbers seem to have been lower in 1960 than in 1935 and in 1985.

Pandion haliaetus. A population low in the 1920s to 1940s due to persecution, a rapid increase since the 1950s (lessened persecution); lack of suitable nest trees due to modern forestry poses a new threat to the population, which would probably be only a fraction of the present numbers without active protection (construction of artificial nests).

Falco tinnunculus. A rapid decline since the 1960s due to pesticides; the population has not been able to recover, at least partly due to considerable changes in the agricultural landscape.

F. columbarius. No clear evidence of declining numbers before 1960; pesticides are probably a major threat.

F. subbuteo. As *F. columbarius*; wintering conditions in the tropics may also have deteriorated.

F. rusticolus. No marked change in the status of the species in this century; major threat (egg collecting) already important in the late 1800s; stealing of eggs and young is still a threat.

F. peregrinus. Global threat of pesticides since the late 1950s and early 1960s leading to a dramatic decline. There seems to have been a clear recovery since the 1970s.

Perdix perdix. A recent decline due to changes in the agricultural landscape (e.g. feeding conditions of the young have deteriorated because of lack of weeds providing insect food).

Coturnix coturnix. The actual status unclear; we are not sure whether the species has ever been a regular breeder (see e.g. Järvinen & Ulfstrand 1980). As the national committee regarded the species as disappeared, we have nevertheless accepted it as a former breeder. The majority of nests and other observations back were reported inthe 19th century; there are much fewer verified nesting observations from this century.

Crex crex. A steady and large-scale population decline (mechanized agricultural practices) since the beginning of the present century; more or less stable during recent decades.

Charadrius hiaticula (coastal population). A clear decline in recent decades (disturbance, regrowth of open shores due to cessation of grazing).

Calidris temminckii (coastal population). As *Ch. hiaticula*, but regrowth of breeding habitat probably most important.

C. alpina schinzii. A growing but small population up to the 1960s, thereafter a marked decline owing to regrowth of shore meadows.

Gallinago media. A catastrophic decline in the late 19th century due to overhunting and probably habitat loss caused by agricultural practices (Tiainen 1987).

Limosa lapponica. Seems to have disappeared more or less totally between the 1910s and the 1940s (egg collecting?), but has recovered since then.

Xenus cinereus. Although nesting has not been confirmed between the 1920s and 1940s, a small population may have existed (a population low?); a recent increase (from about 10 to 30 pairs) starting in the 1970s.

Stercorarius parasiticus. The population has declined since the early 20th century due to persecution; pairs in marginal areas have disappeared. Recovery in recent decades due to ceased persecution and increased foraging opportunities (gull colonies!).

Larus fuscus. Common and numerous with no indications of a decline up to the 1960s; a rapid decline since then due to poor breeding success (predation and perhaps competition by Herring Gulls, persecution, disturbance, changing fishing practices).

Sterna caspia. A growing but still small population (200 pairs) in 1935; thereafter a continuous increase (600 pairs in the 1950s, 1200 in early 1970s); a rapid decline due to persecution of larids by laymen and increased winter mortality in Africa (now about 900 pairs).

Alca torda. A temporary population low in the 1940s and early 1950s due to oil spills, persecution and perhaps cold winters (but note that the cold winters of the 1980s did not entail a conspicuous decrease in Razorbill numbers); a marked increase (doubled?) since the early 1960s (now 3000 pairs).

Columba oenas. Although scarce all the time, no hint of a decline, actually signs of expansion in the first half of this century; a recent decline due to modern forestry (removal of hole trees).

Bubo bubo. Persecuted since the late 19th century, scarce up to the 1960s, a rapid increase especially in the 1970s and 1980s due to protection and behavioural adaptation to feeding (and nesting) on open garbage dumps and clearcut areas.

Nyctea scandiaca. Population fluctuations according to cycles of lemmings and voles in larger regions (nomadism). The status has not changed in this century; earlier there seem to have been good breeding populations in many years; massive egg collecting in the early 20th century may have played a role in the decline.

Glaucidium passerinum. Status poorly known, although the species seems to have remained scarce and mainly restricted to old forests, which are threatened by forestry.

Strix nebulosa. Occurrence dependent on the dynamics of vole populations, but after having been a "common" breeder the species more or less disappeared from Finnish forests in the 1930s but recovered in the mid-1960s for unknown reasons.

Caprimulgus europaeus. A rapid decline beginning in the 1960s and 1970s (traffic, wintering grounds?).

Picus canus. Status has not changed markedly in this century; suffers from modern forestry.

Dendrocopos leucotos. The population has continuously decreased due to modern forestry (incl. regrowth by spruce of the former slash-and-burn birch forests) since the late 19th century; only about 30 pairs remain.

D. minor. Suffers from forestry; declined mainly since the 1960s.

Lullula arborea. Remained more or less stable up to the 1950s, after which a rapid decline for unknown reasons (wintering conditions? pesticides?).

Eremophila alpestris. A catastrophic and baffling decline since the 1960s (Hildén 1987, Svensson 1988).

Luscinia luscinia. A clear population low from the 1910s to the early 1950s (reasons unknown), thereafter a rapid increase (cessation of cattle grazing in lush woods).

Ficedula parva. Status has remained more or less the same at least since the 1920s. Major threat forestry (the species favours mature forests in Finland).

Nucifraga c. caryocatactes. Status has remained about the same, a slight increase possible.

Passer montanus. Most of the old records come from the last century and early 20th century, a population low from the 1920s to the 1960s, a very rapid increase since then (intensified winter feeding; continuous immigration?).

Carduelis cannabina. A rapid decline and shrinking of the range at the turn of the century, a population low in the 1920s and 1930s due to modernized agriculture discriminating against the food plants of the species. Recovery due to new opportunities for foraging in abandoned fields and urbanized areas.

Virolaisen ornitologian 70-vuotisjuhla

VIII virolais-suomalainen ornitologikongressi

Virolaisen lintutieteen 70-vuotisjuhlien ja VIII suomalais-virolaisen ornitologikongressin merkeissä suomalaiset lintutieteilijät ja harrastajat kutsutaan Tarttoon 1.–5.5.1991. Mukaan sopii 40 vikkelintä. Kokouksessa voi esittää poikkeuksellisesti vain postereita (muu ohjelma rakentuu järjestäjien kutsumien esitelmöitsijöiden varaan). Jos lähtijöitä on ylenmäärin, annetaan etusija posterin esittäjille.

Kokouskielinä ovat viro ja suomi, hätätilassa englanti. Posterin esittävät liittäköön ilmoittautumiseensa 200 sanan yhteenvedon.

Alustava ohjelma: 1.5. saapuminen ja majoittuminen, 2.5. veneretki Emajokea pitkin Peipusjärvelle, 3.5. juhlakokous ja kongressi, 4.5. bussiretki Viron eteläosissa, 5.5. paluu kotiin.

Syyskuun lopulla oli arvioitu maksimihinta n. 1000 mk, johon sisältyvät kuljetukset Helsingistä Tallinnan kautta Tarttoon, majoitus, ruokailu ja kaksi retkeä.

Ilmoittautumiset viimeistään 20.2.1991 mennessä osoitteella SLY/Esa Lammi, Eläintieteen laitos, P. Rautatiekatu 13, 00100 Helsinki. Ilmoittautumisia käsitellään sitovina ja osallistujilta peritään maksut kevättalven kuluessa.