Monitoring bird populations in Finland

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The paper reviews current ornithological monitoring studies in Finland. These are examined in relation to an "ideal" monitoring system, whose object would be the regional population dynamics, i.e. population size in different habitats at different times of the year, and reproductive success and mortality. Usually only in the case of the most abundant bird species can all these aspects be monitored.

Many monitoring studies are already in progress in Finland. There are also many studies that can be adapted for use in monitoring. The oldest annual monitoring study is the winter bird census, performed throughout Finland since 1956/57. An August tetraonid census was started in 1964, and an annual census of breeding birds on permanent line transects in 1978. Many countrywide population studies of raptors and owls were started in the 1970s and 1980s. Bird stations have used standardised methods of observation and ringing since the mid-1970s. Except for few cases, no attempts have yet been made to organise annual monitoring of reproductive success, which can be based on the present nest record scheme. Monitoring of mortality requires intensification of ringing.

The results of the winter bird census revealed that 11 species had decreased significantly, two-thirds of which were non-passerines. Ten species had increased, nine of which were passerines. The population size of 17 species had not changed significantly. Most changes can be related to changes in the forest structure or in human attitudes. The results of different monitoring studies showed good accord.

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Introduction

Monitoring of bird populations has been discussed intensively in Finland in recent years (e.g. Järvinen & Väisänen 1979a,b, Järvinen 1983, Saurola 1982, 1983a, Hildén & Koskimies 1984, Tiainen 1984a,b, Vickholm et al. 1984, Väisänen 1984). Several monitoring schemes have already been started, but they do not form the coherent system needed for both detecting possible population changes and understanding their causes. In this paper, I review the monitoring studies in progress in Finland, and present suggestions ("an ideal monitoring system") for developing them.

By monitoring I mean continuous and regular quantitative research using standardised methods, which will reveal changes and causes of changes in the abundance and distribution of birds in all seasons and in the composition of bird communities. For practical reasons, the changes caused by human activities are of most interest, but the natural dynamics must also be studied, so that the two can be separated from each other. On the one hand birds can be used as indicators of environmental changes, and on the other hand changes in specific populations can be monitored. Hence the aim is to detect negative environmental changes and to follow trends in (potentially) endangered populations.

Finnish monitoring studies and their development

Censuses in the breeding season. At present, there are three country-wide monitoring projects based on *annual censuses* of breeding birds, (a) a study with permanent line transects, (b) a count of "night-singers", and (c) a sampling survey of raptors and owls. In addition, a new project based on point counts was started in 1984 (Hildén 1985). There are also some more local studies on birds of lakes, sea bays, and archipelagoes. Faunistic reports also give information for monitoring.

The main annual censuses of land birds (covering all common species) are made along line transects, which cover all the main habitats in approximately their true proportions (e.g. Järvinen & Väisänen 1981, 1983a,b). Earlier, Siivonen (1952, see also Väisänen 1984) tried to establish an annual census on permanent line transects, but his study functioned for only three years, in 1949–1951. The present censuses on permanent line transects were started in 1978 on a small scale (6 transects), and expanded in 1979 and especially 1983 (ca. 40 transects) (Väisänen & Järvinen 1981, Vickholm & Väisänen 1984, Vickholm et al. 1984, Väisänen 1984). The amount of transects censused annually should be increased for better representation of the whole country and all the main habitats. A five-fold increase could easily be realised (Vickholm et al. 1984, see also Järvinen & Väisänen 1979a). Other annual censuses of land birds, such as the point counts now, could also be used in Finland, if they provided concrete advantages for the whole monitoring system (e.g. more amateurs engaged).

The "night-singer" (*Botaurus stellaris*, rallids, *Luscinia luscinia, Locustella* and *Acrocephalus* warblers) counts were started in 1980 (Koskimies 1984a). They are not standardised like the line transect censuses. The counting effort seems to be fairly constant, however, and at least rough estimates of population changes are possible. This scheme yields valuable supplementary information on a bird group which would otherwise be insufficiently censused.

The sampling survey of raptors and owls was started in 1982 (Haapala & Saurola 1983, Saurola 1985). An attempt is made to seek and check all nest sites of raptors and owls in permanent squares of 10 × 10 km^2 annually; more than 100 such squares have been searched through since 1982. This study may be expected to provide fairly accurate and reliable information about the sizes and trends of the populations of Finnish raptors and owls.

Monitoring of birds of eutrophic and oligotrophic lakes is currently carried out only in Northern Savo in Eastern Finland (Kauppinen 1984a,b). This study was initiated in some lakes in the 1960s, and since the early 1970s has included 19 eutrophic lakes. Now some dozens of different kinds of lakes are censused annually. A fairly similar habitat is eutrophic sea bays. Locally, Siira & Eskelinen (1983) censused the water birds of Liminka Bay, northern Gulf of Bothnia, in 1954–1981. These studies, together with other censuses made in eutrophic lakes, sea bays, and archipelagoes in different years, seem to show that the "waterfowl populations in Finland as a whole increased from the 1940s until the early 1960s, after which they declined, only to increase again by the mid-1970s" and that "the numbers have been higher towards the end of the 1970s than at any other time within the last 40 years" (Siira & Eskelinen 1983, see also Kauppinen 1984a). Annual censuses should also be started elsewhere in Finland. Linkola (1959), Siira (1959) and Kauppinen (1983) have developed the necessary methodology.

Many local monitoring studies have been conducted in the Finnish Baltic archipelagoes (see Kilpi 1985). In 1949–1963, Grenquist (1965, 1966) performed censuses almost annually in six archipelagoes, from the eastern part of the Gulf of Finland to the northern part of the Gulf of Bothnia. Such censuses should be continued. The only data on water birds, waders and larids published over a period of several decades are those from Krunnit and Valassaaret in the Gulf of Bothnia and Tvärminne archipelago in southwestern Finland (Väisänen & Järvinen 1977a, Hildén et al. 1978, Valste & Palmgren 1984).

Rare and occasional birds cannot be counted reliably by any census method. Information on them is provided by faunistic reports and reports of the Rarities Committee (e.g. Koskimies 1984b, Mikkola 1984, Solonen 1985). The number of observations of rarities depends greatly on the activities of amateur ornithologists and their skill in species identification, both of which are known to have increased during recent decades (e.g. Hildén 1979).

Habitat censuses, repeated regularly, though not necessarily annually, can be a part of a monitoring system. An appropriate interval might be five years. Such schemes can partly be based on past or current studies. Some of these censuses are local, but others are performed country-wide.

Vickholm & Virolainen (unpubl. reports, Vickholm 1982) have made line transect censuses in Finnish national parks and strict nature reserves, which can easily be repeated after an appropriate interval (Vickholm et al. 1984). These data make it possible to compare population trends between protected areas and areas where modern forestry is practised. Some hundreds of censuses, both published and unpublished, have been made in mires (e.g Järvinen & Sammalisto 1976, U. Häyrinen unpubl.). Some older censuses have recently been repeated (e.g. Väisänen & Järvinen 1977b, Järvinen 1978, Väisänen & Rauhala 1983). However, there are no monitoring studies of birds in mires in Finland. A large-scale project is desirable, in which old censuses are repeated and a basis for future monitoring established in the same fashion as in the farmland bird census project in 1984 (see below).

The first large-scale census of the Finnish farmland avifauna was made in 1984 (Tiainen et al. 1985a, Piiroinen et al. 1985). Birds were counted on ca. 5600 ha of arable land at 276 sites throughout the country as a basis for future studies of changes. About 4300 ha of other arable land censused earlier in the 1930s to 1970s in six different areas was also censused in 1984 to examine population changes during the last 50 years (see Mehtälä et al. 1985, Tiainen et al. 1985b, Ylimaunu & Siira 1985, Yrjölä et al. 1985). On both mires and arable land, the most useful census method for monitoring is probably a modified mapping method with two field visits only (see Tiainen et al. 1985a).

A country-wide basis for large-scale monitoring of the avifauna of eutrophic and mesotrophic lakes already exists in Finland (Rassi 1977, Anon. 1981). Some 1300 lakes were censused in the 1970s. At least a sample of these lakes ought to be selected for habitat censuses made every five years (see below). Similar country-wide censuses have not been made in oligotrophic lakes. There are, however, five samples, consisting of a total of ca. 350 small oligotrophic lakes in southern Finland censused during the last 20 years (Löfgren 1967, Tiainen et al. 1981, 1984b), which could form a partial basis for future large-scale habitat monitoring. In archipelagoes, the present annual censuses (see above) probably cover the needs for large-scale habitat censuses, too.

Habitat censuses in open tundra and mountain birch forests have not been included in any present monitoring studies. Because of the strong annual fluctuations, and in some species, the marked four-year cyclicity in northern Fennoscandia (Järvinen 1979, Enemar et al. 1984, Svensson et al. 1984, see also Hansson & Henttonen 1985) these censuses pose difficult problems and should probably be made annually.

Counts in the post-breeding season. Since 1964 tetraonid route censuses have been carried out in August on 600–800 routes (20 000 – 30 000 km). These give information on tetraonid numbers, breeding success and the composition of the populations (ratio of adults and juveniles) in "good tetraonid areas" (Rajala 1974, Lindén & Rajala 1981, Rajala & Lindén 1984). This monitoring study shows that Finnish tetraonid populations have been declining during the past 20 years, though not steadily but fluctuating. In the case of *Bonasa bonasia*, at least, the size of the breeding population can probably be estimated fairly accurately from the late summer census (Pakkala et al. 1983).

Post-breeding censuses of other birds are mainly made at bird stations and other permanent observation sites. These are counts of passing, resting (see Palmgren & Hildén 1983), and mist-netted individuals. To be used for monitoring, the censuses must be based on standardised methods and a constant effort, as has been the case at Finnish bird stations since the early or mid-1970s (J. Palmgren, pers. comm.). Post-breeding and autumn censuses concern birds belonging to the local breeding populations (migrants before migration, stationary birds) and migrants from other areas. Most Finnish bird stations are situated on the Baltic coast or islands, but two are inland stations. In addition, there are permanent inland mist-netting sites long used by ringers, and popular points for observing migration on the coast and inland. Many annual reports, but no studies on long-term dynamics, have been published and mimeographed of the results of bird station activities. More inland bird stations must be founded, and reports on long-term trends and annual numbers must be published, before the full monitoring potential of the bird stations can be realised.

Winter bird censuses. The oldest Finnish monitoring census was started in winter 1955/56 in the Helsinki district and expanded in winter 1956/57 to cover the whole country (Koskimies 1966, Sammalisto 1974, 1977a, Hildén 1984). In the beginning, it consisted of a Christmas count (26 Dec. — 10 Jan.), but in 1966 a late winter count and in 1976 a late autumn count were added. The routes are usually 10–12 km long. In the beginning, about 3000–4000 km were counted annually, but from 1968/69 this was increased to about

6000–7000 km. In their present form, the winter bird censuses give index densities (individuals/10 km of route). This makes it impossible to calculate, for instance, winter mortalities reliably, because the detectability of most species varies considerably between census periods due to changes in the environmental conditions and bird behaviour. The method should be so developed that at least part of the results can be expressed as individuals/km^2. The results would then be more comparable also with breeding time census results.

As no comprehensive analyses have been made of long-term population changes of winter birds since Sammalisto (1974, 1985), I include here the results of some regression analyses. The annual census results from 1960/61 — 1981/82 were obtained from Sammalisto (1974, 1976, 1977b, 1978, 1979, 1980, 1981, 1982) and Munne & Sammalisto (1975), where the methodology and material are described in more detail. The analyses are based on the Christmas count. These censuses are made in good weather conditions. All birds encountered along the route are recorded irrespective of the distance. There has been some turnover in the routes, but the habitat distribution has not changed significantly, at least before 1974/75 (Sammalisto 1974, Munne & Sammalisto 1975). There are several other sources of error which may affect the results. The habitats are not representative for all the species, and trends may differ between habitats. Long-term changes may differ between different parts of the country, where the choice of route may have varied somewhat. Long-term changes may be masked by fluctuations due to low temperatures and variation in the snow cover: there are weather-dependent migrations between habitats, e.g. in *Parus* species (Hietakangas 1976), and *Perdix perdix, Phasianus colchicus* and *Emberiza citrinella*, for example, are less detectable in mild winters when there is no snow at the time of the censuses than in other winters (Hildén & Koskimies 1969, Munne & Sammalisto 1975). Weather conditions also affect the flocking behaviour.

Data were available for 38 species wintering regularly in Finland, though in some years records were missing for some species. The regression analyses revealed significantly decreasing trends in 11 species (Table 1). Ten species had increased significantly. No significant trends were found in 17 species. The changes were most dramatic in *Tetrao urogallus* and *Perdix perdix*, whose winter populations had decreased in two decades to about 10 and 15 % of their former sizes, respectively, and in *Carduelis chloris* and *Parus caeruleus*, whose populations had increased about 50- and 6-fold, respectively. Two-thirds of the decreasing species were non-passerines, while five-sixths of the increasing species were passerines.

Table 1 also shows the factors probably responsible for the population changes. Most of these *ad hoc* explanations are related to changes in forestry and forests, and in human attitudes. Some species have probably also been affected by changes in agriculture or by "other factors".

Modern methods of forestry have caused considerable changes in Finnish forests during the last 30–40 years (for the effects on birds, see v. Haartman 1973, 1978, Järvinen & Väisänen 1978a, b, Järvinen et al. 1977, Haila et al. 1980). Decreasing species have presumably usually suffered from the decrease of old forests, the reduced proportion of older deciduous trees, and decreased habitat diversity. Many of the increasing species have probably benefited from the increasing proportion of spruce, whose seeds they eat. Drainage of mires has probably decreased the habitats of *Lagopus lagopus*, but there may also be other reasons for its decline (see below).

Changing human attitudes seem to be another major reason for population changes in winter birds. Winter feeding has become more and more popular, which may have resulted in increases in many species. It is possible, however, that the increases have been overestimated, because the censuses may have been made in areas where feeding of birds is more popular than elsewhere. The most probable reason for the inrease of *Corvus corax* and *Pica pica* is decreased persecution. *Pica pica* breeds more often in parks and gardens and elsewhere close to human settlement nowadays than two decades ago, because its nests are no longer destroyed.

Changes in agriculture have not affected winter populations as much as breeding populations (cf. Tiainen et al. 1985b, Yrjölä et al. 1985). E.g. *Corvus corone* has decreased according to breeding season censuses, but the winter population has not declined, which suggests that the migratory part of the population has decreased. Decreases in *Corvus monedula* and *Carduelis carduelis* can be related to a decreased food supply, due to changes in agriculture (fewer pastures and uncultivated edges of ditches and fields), but other factors may also be involved. The decreases in *Dendrocopos leucotos* and *D. minor* can be related to the cessation of forest grazing (fewer deciduous trees, fewer damaged or diseased deciduous trunks) and disappearance of the effects of former slash-and-burn cultivation. Cessation of slash-and-burn cultivation has also decreased the amount of *Calluna vulgaris* which may be a partial explanation for the decrease of its consumer, *Lagopus lagopus*, in Southern Finland.

There are also other factors which may have been important for wintering bird species. Nest predation by *Nyctereutes procyonoides* on *Perdix perdix* may have become more severe, and may partially explain the sharp decrease, together with habitat deterioration. The decrease in *Corvus monedula* may largely be due to reduction of nest sites due to modern forestry (correlation with *Dryocopus martius*!) and prevention of access to old buildings by restoration. That no decrease was found in *Parus cinctus* (cf. Järvinen & Väisänen 1979c) may be related to increasing winter feeding, which brings more birds to human settlements where the census routes are. In addition, very few routes are located within the main range of *P. cinctus*. *Carduelis flammea* is a species in which the increasing trend found here is not necessarily certain. Due to its dependence on seed crops (especially that of birches), its numbers fluctuate greatly, and an exceptionally high and long peak in the late 1970s may just be one of these fluctuations and not indicate a permanent increase.

Spring counts. Spring counts concern only migratory birds before they settle in the breeding grounds. These counts may be important for monitoring rare species which concentrate in a few resting places or narrow migratory routes, and possibly also some other species. The methodology is the same as in autumn. Most springtime censuses are made at bird stations. Only a few reports have been published on long-term dynamics (Saario 1980, 1984).

Monitoring reproductive success. Reproductive success has been neglected in the present Finnish monitoring studies (however, see population studies below), but there are several methods available for different groups of birds. These are based on nest records and on estimation of the ratio of adults to juveniles after the breeding season. Some of the methods are connected with the censuses presented above.

The Finnish nest record scheme, started in 1954 (v. Haartman 1969, 1974), was intended for basic studies of avian breeding biology. However, it could also be used for estimating the annual reproductive rates with the Mayfield method (see Johnson 1979), if the nests are visited at least twice, and all nests, both successful and unsuccessful, are recorded (Tiainen & Piiroinen 1985). It should be possible to collect sufficiently many complete nest cards for a number of abundant bird species (e.g. O'Connor 1985). The number of nests and the numbers of broods, nestlings, or breeding adults could also be used for monitoring, if the searches for nests and ringing effort are standardised, at least in restricted sample areas (Saurola 1983b, see also 1982). The sampling survey of raptors and owls (see above)

Table 1. Regression analysis of Finnish winter bird population changes between 1960/61 and 1981/82. Population density (ind/10 km) in 1960/61 is given as a prediction of the regression. The significance of the regression coefficient (RC) was tested with the t-test, r = the correlation coefficient and N = the number of years for which data were available. The index of the population change was calculated as 100 x the prediction for 1960/61 per prediction for 1980/81. Probable explanations of the population changes are indicated as follows: changes in forestry (F), in agriculture (A), or in human attitudes (H), or other reasons (O).

Species	1960/61	RC	t	r	N	Index	Explanation
Decreasing							
Tetrao tetrix	6.62	–0.1401	–2.423*	–0.476*	22	189	F
T. urogallus	0.62	–0.0278	–8.307***	–0.880***	22	1111	F
Bonasa bonasia	0.72	–0.0181	–3.723**	–0.640***	22	200	F
Lagopus lagopus	0.50	–0.0190	–4.652***	–0.721***	22	417	F
Perdix perdix	1.57	–0.0671	–4.445***	–0.705***	22	667	A, O
Dendrocopos leucotos	0.014	–0.0004	–2.927**	–0.557**	21	233	F, A
D. minor	0.085	–0.0025	–2.304*	–0.499*	18	244	F, (A)
Corvus monedula	20.60	–0.7752	–7.271***	–0.852***	22	400	A, O
Perisoreus infaustus	0.085	–0.0034	–5.316***	–0.790***	19	476	F
Parus cristatus	3.23	–0.0598	–2.969**	–0.553**	22	159	F
Carduelis carduelis	0.40	–0.0130	–2.427*	–0.477*	22	286	A
Increasing							
Denrocopos major	1.07	0.0580	2.273*	0.453*	22	48	F?
Corvus corax	0.48	0.0361	5.796***	0.807***	20	40	H
Pica pica	8.63	0.3221	7.487***	0.864***	22	58	H
Parus major	35.41	0.5768	2.351*	0.465*	22	75	H
P. caeruleus	0.81	0.1831	7.680***	0.864***	22	18	H
Carduelis chloris	0.11	0.3059	9.220***	0.900***	22	2	H
C. flammea	0.66	0.8382	2.232*	0.447*	22	33	F
Pyrrhula pyrrhula	8.20	0.4141	3.922***	0.659***	22	50	F, H
Emberiza citrinella	34.54	1.2903	3.440**	6.610**	22	57	O
Passer domesticus	28.60	2.7346	6.677***	0.872***	16	34	H?, O
No significant trend							
Accipiter nisus	0.18	0.0002	0.127	0.028	22	98	
A. gentilis	0.089	0.0014	1.556	0.344	20	76	
Phasianus colchicus	1.08	0.0111	0.725	0.160	22	83	
Picoides tridactylus	0.024	0.0017	1.882	0.449	16	41	
Dryocopus martius	0.21	–0.0036	–1.814	–0.384	21	154	
Corvus corone	30.03	–0.0833	–0.464	–0.103	22	106	
Garrulus glandarius	1.74	0.0043	0.396	0.088	22	95	
Parus ater	1.27	–0.0107	–0.600	–0.133	22	120	
P. montanus	11.11	–0.0231	–0.368	–0.082	22	104	
P. cinctus	0.017	0.0017	1.972	0.442	18	33	
Aegithalos caudatus	0.89	–0.0100	–0.556	–0.123	22	130	
Certhia familiaris	0.66	–0.0026	–0.321	–0.072	22	109	
Cinclus cinclus	0.20	0.0012	0.659	0.158	19	89	
Regulus regulus	4.82	0.0836	1.131	0.245	22	74	
Carduelis spinus	3.70	0.0414	0.207	0.046	22	82	
Pinicola enucleator	0.42	0.0047	0.311	0.017	21	82	
Loxia curvirostra	2.09	0.0039	0.041	0.0092	22	96	

gives the annual number of nests of these birds fairly accurately in more than 100 10-km squares. Annual reports on owl nests in Finland are obtained in the questionnaire issued by the Association of Ornithological Societies to all those actively interested (Jokinen et al. 1983). Results combined from the nest questionary and sampling survey give the ideal information that is needed for monitoring of population dynamics of owls in Finland.

Ringing and recapturing of ringed birds by intensive mist-netting after the breeding season but before the autumn migration allows estimation of the adults:juveniles ratio in common passerine species. This should be done with permanent net sites and constant catching effort. If real ratios are wanted instead of indices comparable between years only, all main habitat types must be included, because habitat selection by adults and juveniles may be different after the breeding season. Monitoring of the reproductive success by mist-netting can probably be done most effectively on the mainland. Few results are yet available (e.g. Salminen et al. 1984).

The adults:juveniles ratio in tetraonids has been studied in the annual late-summer route censuses (see above), and from wing samples and statistics of the annual tetraonid bag (see Helminen 1963, Lindén 1981). The adults:juveniles ratio in anatids can also be monitored with brood censuses, wing samples and bag statistics (see Pirkola & Lindén 1972). The annual adults:juveniles ratio of migratory raptor species can also be studied; Forsman (1984) provides the basis for age determination in field.

Estimation of annual mortality rates. Estimation of annual mortality rates is usually possible only in intensive population studies. The recoveries of ringed birds are at present usually too low to allow estimation of annual mortalities. Intensification of ringing of nestlings and breeding adult birds and ringing and recapturing of ringed birds after the

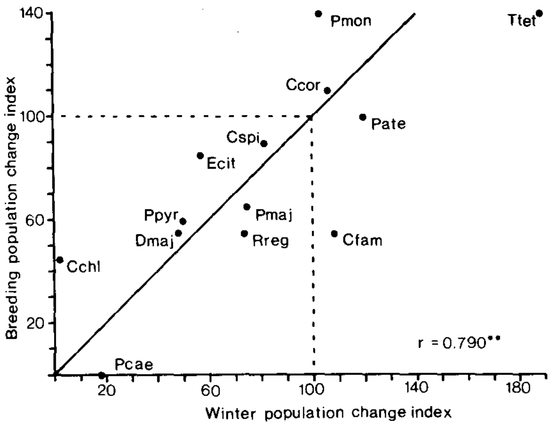

Fig. 1. The correlation between two population change indices for 13 species. The breeding population change indices (southern Finland; from the 1950s to the 1970s, which is indicated with 100) were taken from Järvinen & Väisänen (1978a), and the winter population change indices from Table 1 (the index value of 100 represents 1980/81). The line indicates the same change in the two indices. The species abbreviations are formed from scientific names which appear in full in Table 1.

breeding season might increase the number of recoveries so much that the annual mortalities could be estimated for some species. The work should be directed to the surroundings of inland bird stations and other permanent mist-netting sites.

Population studies in monitoring. Studies of population dynamics are concerned with population size, natality and mortality, and emigration and immigration. These have already been considered above, but this section will deal with special studies. Detailed studies of population dynamics are so laborious that they can seldom be made for monitoring purposes alone. The applicability and form of population studies depend on the species. Full counts of nests and marking of all young and possibly all adult birds can be performed only for rare birds in which many amateur ornithologists are interested, or in local studies.

Population studies have been used in monitoring some raptors and owls. Most nests of *Pandion haliaetus, Falco peregrinus, Haliaetus albicilla* and *Aquila chrysaetos* in Finland have been checked annually and the nestlings ringed since the late 1960s or early 1970s (see Saurola 1985). As these studies are based on large samples or almost full counts, their results are quite exact. There have also been a special country-wide study on *Falco tinnunculus* (Kuusela 1979, 1983) and a study on *Accipiter nisus* (Solonen 1984), which showed that the population changes in these species during the last few decades can at least partly be explained by varying reproductive success in different and changed habitats or in different periods. Similar studies have been made, e.g., on *Bubo bubo* since the 1960s.

Population studies in small areas have the disadvantage that they possibly reflect only local trends (e.g. Tiainen 1983), but such studies could be used for monitoring a species if they were conducted in different parts of Finland at the same time. This would be easiest for hole-nesting species, but in *Ficedula hypoleuca*, for example, the sociability of the species may mask variations in population size in areas with a large supply of nest-boxes (see Alatalo et al. 1982, Tiainen et al. 1984a). Three studies on *F. hypoleuca* in different parts of Finland, however, have shown parallel population changes (Järvinen 1980, Tiainen et al. 1984a, Virolainen 1984).

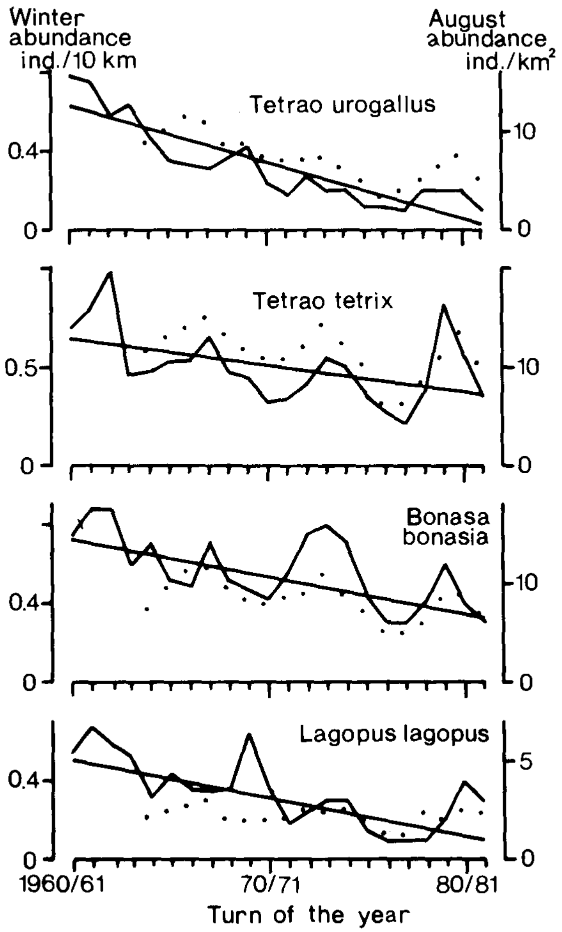

Fig. 2. Population changes of tetraonids according to the winter bird censuses (continuous line; from Sammalisto 1974, ..., 1982) and the August route censuses (dots; from Lindén & Rajala 1981, Rajala & Lindén 1983). For regression lines, see Table 1.

Atlas studies. The field work for the first breeding bird atlas in Finland was done in 1974–1979, and the book published in 1983 (Hyytiä et al. 1983). Atlas studies can be used for monitoring ranges. Atlases could be improved by using a more quantitative basis. A good example of a semiquantitative approach is Schuster et al. (1983). Quantitative or semiquantitative atlas studies with a small grid size could be used fruitfully for local monitoring in areas of rapid change. For example cities, towns or villages, or sections extending from their centres to the countryside could be covered with grids of appropriate size, and monitored at suitable time intervals.

Consistency of results of different monitoring studies

Some studies allow testing of the consistency of population trends or other changes. Such tests are important for assessing the applicability of different methods of monitoring.

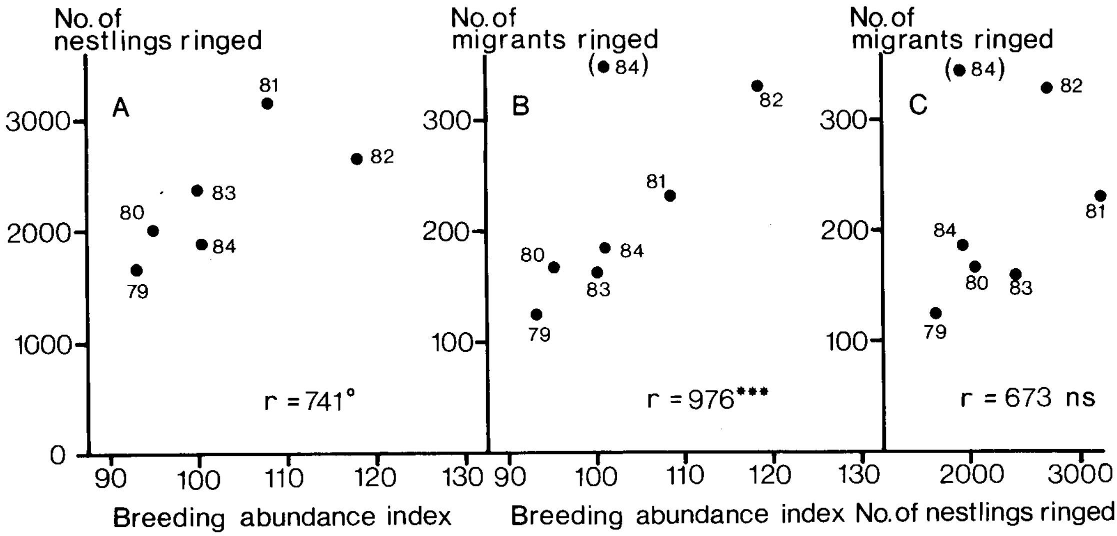

Fig. 3. Correlations of three abundance indices of *Turdus iliacus* in Finland. The breeding abundance index, calculated from permanent line transects, was taken from Vickholm et al. (1984) and Väisänen (1984). The ringing numbers were taken from the unpublished material of the Zoological Museum of the University of Helsinki. The number of migrants ringed is the sum of birds caught with permanent mist-nets at seven bird stations in September and October. The bird stations (Tauvo, Tankar, Säppi, Lågskär, Jurmo, Hanko and Rönnskär) are widely distributed on the Finnish Baltic coast and islands. In 1984, the number of migrants ringed in Tauvo strongly exceeded that of previous years (sum of all stations in parentheses), and was substituted with the mean of the previous years for the correlation analyses.

Fig. 1 shows the correlation between the change indices of winter populations (from Table 1) and breeding populations (from Järvinen & Väisänen 1978a) of species common in both studies (N = 13). Järvinen & Väisänen's (1978a) data are from 1952–63 and 1973–77, i.e. about two decades as in the winter bird population data. This analysis shows high consistency between the studies (see also Järvinen 1984).

Fig. 2 shows good consistency between winter population trends in four tetraonid species and those in the late summer brood censuses. Even the annual changes are mostly fairly consistent, except in *Tetrao urogallus* in the mid-1960s and in *Lagopus lagopus* (*L. lagopus* has its main range in Lapland, where the number of winter census routes is small). It is not known to what degree the winter results are affected by the winter temperatures and snow cover, which determine the diurnal feeding behaviour and extent of roosting in snow cavities in these birds. When Järvinen & Väisänen (1984) compared tetraonid densities obtained with line transects and late summer brood censuses made in different parts of Finland in the same years, they found fairly good consistency between the results.

Fig. 3 shows correlations between some abundance indices of *Turdus iliacus*. There is mostly good accord between the breeding abundance index, the number of nestlings ringed and the number of autumn migrants ringed at seven bird stations. The main discrepancies emerge in the years 1981 and 1982, when the number of nestlings ringed declined, but the breeding abundance and the number of migrants ringed increased, and in 1984, when the number of migrants ringed considerably exceeded the mean of the five previous years at one station but not at the others.

An "ideal" monitoring system

Many monitoring studies are conducted in Finland, and many others could be modified for use in monitoring, but the present studies are not coordinated and do not form a coherent system. I therefore wish to present an "ideal" monitoring system, outlined in Table 2 (see also Tiainen 1984a).

The *"ideal" monitoring system* deals with (1) the *regional population dynamics* and (2) *the structure of the bird communities*. Combining all the monitoring studies, it follows the population sizes in all seasons, breeding success, and mortality, so that the factors responsible for changes can be studied. It may be difficult to relate changes in single populations to environmental changes, but monitoring the populations of all species may make it possible to recognise the environmental changes and to evaluate their significance, as species with a similar ecology are likely to react in a similar manner (see e.g. Haila et al. 1980). The use of groups of ecologically similar species reveals environmental changes most easily and reliably.

Problems are posed by the ideal system. Population dynamics can usually be monitored in suggested

Table 2. Structure of an ideal monitoring system, designed for monitoring the population dynamics. Only in a small number of species can all aspects of the population dynamics be monitored and not all methods can be used for all species, but anything more than mere counts of populations contributes to elucidating possible changes, i.e. their causes, and the seasons or areas in which they have occurred.

Object	Common land birds	Raptors and owls	Water birds, shore birds, larids	Rare land birds
Population size in				
– breeding season	Line transect censuses Point count censuses Habitat censuses	Counts in permanent 10 × 10 km squares Faunistic reports	Censuses in lakes and achipelagoes Faunistic reports	Special counts (e.g. 'night singer' counts) Faunistic reports
– post-breeding season and autumn	Tetraonid route censuses Counts of passing, resting and mist-netted migrants	Counts of passing migrants	Counts of passing migrants	Counts of passing, resting and mist-netted migrants
– winter	Winter bird censuses (autumn, mid-winter and late-winter counts)	–	–	Winter bird censuses
– spring	Counts of migrants	Counts of migrants	Counts of migrants	Counts of migrants
Natality (reproductive success)	Nest cards Adults:juveniles ratio in – mist-netted passerines – tetraonid families – tetraonid bag	Population studies Adults:juveniles ratio in autumn migration	Nest cards Adults:juveniles ratio of waterfowls in – families – bag	–
Mortality	Ringing recoveries and recaptures (?)	Ringing recoveries (?)	–	–

detail in the most abundant species, and not all censuses give commensurable results (e.g. densities) allowing population changes to be studied directly within the annual cycle.

The present monitoring studies form a basis for the ideal coherent monitoring system. The next steps towards the ideal system should be: (1) practical organization of the system; (2) development of the methods in such a way that all the results can be combined, and it is possible to determine the relevance of all those studies that cannot be included in the system; and (3) basic studies, e.g. on the habitat selection of birds, which are necessary for understanding the effects of environmental changes.

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Selostus: **Katsaus linnuston seurantaan Suomessa**

Maahamme on viime vuosina pyritty luomaan toimivaa linnuston seurantajärjestelmää. Seurannalla ymmärretään jatkuvaa ja toistuvaa lintujen kvantitatiivista tutkimusta, jonka avulla voidaan todeta runsauden ja levinneisyyden muutokset. Toisaalta seurataan ympäristöjen muuttumista lintuja indikaattoreina käyttäen ja toisaalta seurataan eri lintulajien kantojen muutoksia.

Meillä on jo nyt käynnissä useita linnuston seurantatutkimuksia tai seurantaan soveltuvia tutkimuksia. Vanhin niistä on talvella 1955/56 Helsingin seudulla ja 1956/57 koko maassa alkanut talvilintulaskenta, johon on alusta lähtien kuulunut vuodenvaihteen laskenta, vuodesta 1966 kevättalven laskenta ja vuodesta 1976 myös loppusyksyn laskenta. Vuodesta 1964 lähtien on vuosittain tehty myös valtakunnallinen loppukesän kanalintujen poikuearviointi. Vuodesta 1978 lähtien on ollut käynnissä pesimäaikainen vakioreiteillä tehty linnuston laskenta. Kaikki nämä tehdään linjalaskentatyyppisillä menetelmillä. Näiden lisäksi meillä on pitkä perinne rengastustoiminnassa, lintuasematoiminnassa ja pesäkorttien keruussa. Uudempia seurantatutkimuksia ovat myös useiden uhanalaisten petolintujen populaatiotutkimukset ja äskettäin aloitettu petolintujen ja pöllöjen valtakunnallinen seuranta yli sadalla pysyvällä neliöpeninkulman ruudulla.

Kirjoituksessa kehitellään ajatusta "ideaalisesta" linnuston seurantajärjestelmästä, jonka avulla saadaan selville lintujen lukumäärien muutokset vuosikierron eri vaiheissa. Seurannan kohteena on populaatiodynamiikka. Tietoa tarvitaan pesimäkantojen vahvuuksista, pesinnästä, populaatioiden ikärakenteesta loppukesällä sekä syys- ja talvikantojen vahvuuksista ja jakautumisista erilaisiin ympäristöihin. Näiden tietojen avulla voitaisiin paitsi havaita kantojen muutokset, myös etsiä muutosten syitä oikeasta suunnasta. Seurannan kohteena on myös lintuyhteisörakenne. Yksittäisten lajien kannan muutokset eivät vielä välttämättä paljasta ympäristömuutoksia; ekologialtaan samankaltaisten lajien samanaikaiset kannan muutokset tekevät sen varmemmin.

Nykyisin käynnissä olevat seurantatutkimukset muodostavat ideaalisen seurantajärjestelmän rungon — tai idean. Niiden kaikkien toiminnat eivät kuitenkaan ole riittävän laajoja ja järjestelmällisiä. Niitä ei liioin ole kytketty toisiinsa kiinteästi. Niistä voidaan kuitenkin kehittää kattava seurantajärjestelmä. Ideaalisen seurantajärjestelmän yhteenveto on koottu taulukkoon 2, jossa ovat mukana nykyiset seurantaohjelmat sekä sellaiset tutkimusohjelmat, joita olisi kehitettävä edelleen, jotta ne tuottaisivat seurannassa tarvittavaa tietoa. Tällä hetkellä olisi paneuduttava voimakkaimmin esim. viiden vuoden välein toistettavien laajojen biotooppikohtaisten laskentojen (suurten suojelualueiden metsät, suot, pellot, järvet, saaristot), lisääntymistuloksen seurannan (pesintätulos pesäkorttien avulla, aikuisten ja nuorten lintujen lukumääräsuhde mantereen lintuasemilla) ja muuttolaskenta-aineistojen hyväksikäytön kehittämiseen.

Kirjoituksessa on myös esitetty talvilintulaskentojen tuloksia julkaistujen tietojen perusteella (taulukko 1). Yhdentoista lajin talvikannat ovat vähentyneet 1960-luvun alusta merkitsevästi; näistä kaksi kolmannesta on ei-varpuslintuja. Runsastuneita lajeja on kymmenen, joista yhdeksän on varpuslintuja. Seitsemäntoista lajin kannassa ei ole merkittävää muutosta (em. lajit mukaan lukien). Tärkeimmät selittävät tekijät näyttävät olevan metsien muuttuminen ja muutokset ihmisen suhtautumisessa (lisääntynyt talviruokinta, vähentynyt vaino).

Eri menetelmillä eri vuodenaikoina saadut kuvat kannanmuutoksista osoittautuvat vertailuissa sangen samanlaisiksi (kuvat 1–3). Kuvassa 1 esitetään 13 lajin kannanmuutos n. 20 vuoden ajalta linjalaskentojen ja talvilintulaskentojen perusteella. Kuvassa 2 verrataan kanalintujen kannanmuutoksia elokuisten poikuelaskentojen ja talvilintulaskentojen perusteella. Kuvassa 3 tutkitaan punakylkirastaan kannanmuutoksia vakiolinjalaskentojen, pesäpoikasrengastusten ja lintuasemien vakioverkkorengastusten valossa.

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