A quantitative study of the bird fauna of some open peatlands in Finland

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The bird fauna of open peatlands was studied at Pyhäjärvi in the province of Oulu (63°52' N, 26°00' E) in the years 1966—1968. For the censuses the transect method and the sample area method were used. The density of bird life and the edge effect in different fen types is considered. Also the differences between the census years and between the present study and some earlier investigations carried out on some other peatlands is discussed.

Information about the bird fauna of Finnish peatlands can be found mainly in studies of single bogs (e.g. NORDSTRÖM 1955) or as parts of more comprehensive studies (e.g. TENOVUO 1955, MUSTAKALLIO 1959, SILVOLA 1966, HILDÉN 1967). Some short articles about particular species have been published (e.g. HYTÖNEN 1934, SEISKARI 1956, LAINE 1962, MUSTAKALLIO 1966). There are not many works dealing with the entire bird fauna of the peatlands of a wider area (AUER 1916, PAASIO 1932, SEISKARI 1954, SAMMALISTO 1955, HÄYRINEN 1965, PIHLASALO 1968). Of these studies only those by SEISKARI, SAMMALISTO and PIHLASALO contain any quantitative data. Even they are narrow in scope. The greatest need is for quantitative studies, but not even the distribution of some species is adequately known.

In order to collect data about the bird fauna of bogs I carried out censuses of bird populations in the largest open peatlands of Pyhäjärvi (63°52' N, 26°00' E) during the summers of 1966—1968. My purpose was to investigate the proportionate numbers of various bird species found in the open bogs of northern Suomenselkä. Due to the low density of birds, the openness of the country and the difficulty of traversing some fens the methods used in assessing the numbers of forest birds are not often applicable to censuses in open bogs without some modifications. I have therefore attempted to compare and study the merits of different counting methods in order to find out which are most suitable for various species.

Classification of bogs for ornithological purposes

Because of the great variety of the plant communities of open bogs a detailed botanical classification of bogs cannot be connected with bird censuses. Various types of peatland must be distinguished on the basis of a few main factors which best illustrate the ecological conditions and physiognomy of the bogs from an ornithological point of view. Among these factors are soil moisture, the size and number of hummocks and the amount of sedge. Using soil moisture as their criterion SEISKARI (1954) and SAMMALISTO (1955) have proposed the dichotomy of wet and dry bogs. SAMMALISTO has divided both groups into two subtypes: wet bogs consist of "rimpi" fens and sedge fens with hummocks; dry bogs consist of short sedge bogs with an even surface (or *Carex lasiocarpa* bogs) and *Sphagnum fuscum* bogs with large hummocks.

Because the peatlands studied for this paper are large in area and vary greatly in their smaller features i have carried further the classification of bogs into subtypes. Soil moisture has been retained ast the primary criterion for a threefold division of open bogs: 1) "rimpi" fens with pools of water, 2) other wet fens with no stretches of open water, 3) bogs with hummocks covering most of the surface. Each group has been further subdivided on the basis of the sedge, hummocks and trees present. This division has resulted in the following eight distinct types of open peatland:

I "Rimpi" fens
A. "Rimpi" fens proper with open water as dominant feature
B. Open "rimpi" fens with strings
C. "Rimpi" fens with strings and a few trees
II Other wet fens
A. Fens characterized by plenty of hummocks and sedge or undergrowth
B. Fens with a scant growth of sedge
III Drier bogs
A. Bogs with an even surface and plenty of sedge
B. Short sedge bogs
C. *Sphagnum fuscum* bogs with plenty of hummocks and a few trees

The counts

The censuses were carried out during the following periods: 27.5.—4.6.1966, 27.5.—23.6.1967 and 5.—12.6.1968. One could have started counting the early migrants (Lapwing *Vanellus vanellus,* Curlew *Numenius arquata,* Crane *Grus grus,* Sky Lark *Alauda arvensis,* Meadow Pipit *Anthus pratensis*) immediately after the middle of May, but for most waders and the Yellow Wagtail *Motacilla flava* it would have been too early. In particular the Jack Snipe *Lymnocryptes minimus* and Broad-billed Sandpiper *Limicola falcinellus* migrate so late in spring that individuals observed as late as the first days of June may in some cases still have been migrating.

It is difficult to assess the numbers of Ruffs *Philomachus pugnax* during the early phases of the breeding season because Reeves may also, as part of their sexual behavious, fly around in all parts of the fen even after the first eggs have been laid. During the incubation season counting is difficult because incubating Reeves leave their nests only when the counter comes within a few metres of the nest. The best counting time for the Ruff and for most other waders seems to be the phase immediately after hatching has taken place — in northern Suomenselkä during the latter half of June — when the young are still near the nests. For the reasons mentioned the figures indicating the density of sandpipers and the Yellow Wagtail may be inaccurate. Observations of the Broad-billed Sandpiper and Jack Snipe during May have been disregarded.

Because the successful execution of counts in open bogs is not dependent on the diurnal activity patterns of birds to the same degree as in wooded habitats, I carried out counts at all times of the day except from noon till 3 p.m. and after 7 p.m.

The transect method

In addition to the different hours of the counts I departed from the basic version of the transect method (MERIKALLIO 1955, 1958) in the width of the belts used. In the summer of 1967 I used, depending on the weather, the following belts: 100 m (total length 7.8 km), 200 m (total length 10.9 km) and 400 m (total length 1.4 km).

One of the most important advantages of a wider belt is the rapid accumulation of data. An advantage for the technical execution of the count is that with a wide belt there is less interference from birds which come from habitats outside the belt to sound their alarm at the intruder. This is often the case with the Yellow Wagtail and Lapwing. With a narrow belt it is also often difficult to decide when to include observations of the species singing in flight (e.g. Wood Sandpiper *Tringa glareola,* Snipe *Capella gallinago,* Meadow Pipit). For these reasons I used no countig belts narrower than 100 m after experimenting with a belt of 50 m in the summer of 1966.

Because there is considerable difference in the degree of ease with which various species in the field can be observed, it is impossible to make any general recommendation about the best width for the belt. Further complications arise because different species have differing daily activity patterns and also different times for choosing their nesting-territories, for laying eggs, for incubating and for hatching. This is why one has to choose the belt which is individually best suited to different species. In Pyhäjärvi, however, I used the same belts for all species, which may have resulted in too low densities for some species which are difficult to observe (e.g. the Snipe and Meadow Pipit).

The method of sample areas

The bulk of the data about pure bog types has been collected using the method of sample areas (884 ha out of 1077 ha).

In deciding the size of sample areas species have been divided into two groups: 1) species which are easy to observe and have relatively small populations (Table 1), and 2) species

TABLE 1. The densities (pairs/km²) of some "prominent" species in various bogs. (The species counted in the whole of the open peatland area in 1968 only have been marked with an asterisk.)

Bog	Nurmes-neva		Vihta-neva		Vittouven-neva		Haudan-neva		Mesiäis-neva		Lampi-neva		Latva-neva
Area ha	360		350		236		160		140		65		62
Year of study	-67	-68	-67	-68	-67	-68	-67	-68	-67	-68	-67	-68	-67
Circus cyaneus	0.3	—	0.3	?	0.4	0.4	—	—	0.7	0.7	—	—	—
Grus grus	0.6	0.3	—	—	0.9	0.4	0.6	0.6	—	0.7	—	—	1.6
Vanellus vanellus	4.4	3.8	0.6	1.1	3.8	5.1	0.6	2.5	2.8	4.3	—	—	—
Pluvialis apricaria	—	—	—	—	—	0.4	—	—	—	0.7	—	—	—
**Capella gallinago*	?	1.7	?	2.0	?	1.7	?	2.5	?	1.4	?	—	—
Lymnocryptes minimus	0.3	0.3	0.3	0.3	—	—	0.6	1.3	—	—	—	—	—
Numenius arquata	1.7	1.9	0.3	—	0.9	1.3	0.6	—	—	—	4.6	1.5	—
Numenius phaeopus	0.3	0.3	—	—	0.9	0.4	—	—	1.4	0.7	—	—	—
Tringa nebularia	1.1	1.1	1.1	1.4	0.9	0.9	1.9	2.5	1.4	0.7	—	—	—
Limicola falcinellus	—	—	0.3	—	—	0.4	0.6	—	—	?	—	—	—
Larus argentatus	—	0.3	—	—	—	—	—	—	—	—	—	—	—
Larus ridibundus	—	—	—	—	5.9	1.7	—	—	—	—	—	—	—
Asio flammeus	—	—	?	—	0.4	0.4	—	—	—	—	—	—	—
Alauda arvensis	0.6	0.8	0.9	0.6	2.5	0.9	0.6	1.3	—	—	4.6	1.5	—
**Motacilla alba*	?	0.8	?	—	?	1.3	?	1.3	?	—	?	—	—
Lanius excubitor	—	—	—	—	—	—	0.6	—	0.7	—	—	—	—
Observed pairs total	33	41	13	19	39	36	10	19	10	13	6	2	1

which are difficult to observe or are relatively numerous. For the first group the whole area of the open peatlands studied has served as a sample area. Of this group the Snipe, Jack Snipe and Broad-billed Sandpiper are the most difficult to count and the last two especially do not sing very often. But because they have a very conspicuous way of singing in flight and because the birds of each bog were observed at least for one whole day, it proved to be useful to use the whole bog as a sample area for them, too. For these "prominent" species the total sample area was 2684 ha, in other words the total area of the open peatlands studied in Pyhäjärvi. The average size of the sample areas is c. 206 ha.

Because counting the species of the second group requires a closer study of the sample area, smaller sample areas were used to assess the numbers of these birds. Smaller sample areas were used for prominent species, too, when the differences in density between various types of bog were studied, because even in large bogs there are not any large areas of one pure type. The largest sample areas of one type were 30—35 ha, the smallest 4—6 ha. The average size was c. 19 ha. The sample areas lay outside the edge effect of surrounding types and this naturally limited their size. I paid special attention to avoiding edge effect when there were trees growing on the surrounding types. In such cases it is a matter of argument what can be regarded as a sufficient distance to eliminate edge effect. I counted birds in several sample areas near the borders of bogs in order to estimate this effect.

Because the nests of most species are difficult to find and the sample areas were relatively large, the number of pairs has been estimated from the birds observed. The difficulty of traversing some fens makes it even more difficult to find nests.

It is general practice to carry out more than one count in sample areas. Because the figures obtained from the control counts did not differ significantly from the first counts and because the time available was limited, in only 183 ha of the sample areas of pure types was a count carried out twice; on the remaining 701 ha only one count was taken. However, in those cases where all the open peatlands formed the sample area prominent species were generally counted on two or three days.

Methodological differences

The various types of bog are unevenly represented in the material accumulated by the transect method. For this reason it is not possible to carry out any overall comparison of the results obtained by the two methods. Table 2 shows that in two different types of bog the overall densities obtained by both methods are approximately the same. For some

TABLE 2. The densities (pairs/km²) obtained using different methods (T = transect counts, S = sample areas) on "rimpi" fens with strings and a few trees (I C.=I) and on short sedge bogs (III B.=II).

Method	T	S	T	S
Type of bog	I	I	II	II
Studied area ha	64.0	157.5	68.0	59.0
Anas platyrhynchos	—	0.6	—	—
Anas crecca	—	1.3	—	—
Bucephala clangula	—	1.3	—	—
Grus grus	—	0.6	—	—
Vanellus vanellus	—	—	—	1.6
Capella gallinago	—	0.6	—	—
Lymnocryptes minimus	—	0.6	—	—
Tringa glareola	6.2	6.3	—	—
Tringa nebularia	—	2.5	—	—
Philomachus pugnax	1.6	1.9	—	6.8
Alauda arvensis	—	—	1.5	6.8
Anthus pratensis	21.8	17.0	14.7	6.8
Motacilla flava	12.5	13.9	8.8	—
Motacilla alba	—	1.9	—	—
Total density	42.2	48.9	25.0	22.0

birds of "rimpi" fens (Anatidae, Crane, Snipe) the data obtained using the transect method are inconclusive. It is, however, worth noticing that it is impossible to apply the transect method to actual counts in fens with very large pools of open water and, because these fens have the richest bird fauna, it is understandable that the counts of sample areas have given data about a greater number of species, especially in "rimpi" fens with strings and a few trees. But because methodological differences, especially in figures for more numerous species, are small, I have combined the data in most analyses.

The edge effect

To study the edge effect on the bird fauna of open peatlands (cf. SAMMALISTO 1955, 1957) I carried out both transect counts and analyses of sample areas near the edges of open bogs. The belts counted ran parallel to the border of the open bog and the birds were separately counted in one or two 50-metre belts on either side of the line followed by the counter. One of the outer belts bordered on the edge of a pine bog. Correspondingly the sample areas extended for 200 m from the edge of the open bog towards the centre of the bog.

The counts showed that the number of birds depends on what type of bog is bordered by a belt of pine bog. This is why I have treated edges of the "rimpi" fen type and drier edges where the soil gets wetter only in the completely treeless central parts of the fen separately. On the edges of the former type the nearness of the edge clearly raises the density of birds within 100 metres of the pine bog (Table 3). Inverse results on dry edges are due to the stronger influence of existing pools of open water in "rimpi" fens. In transect counts it is easier to observe birds in the belts on the same side as the open bog and this may have had some bearing on the figures.

TABLE 3. The densities (pairs/km²) obtained using transect counts (1967) and analyses of sample areas (1968) at different distances from the edge of wooded peatland in dry (A) and wet "rimpi" edges (B).

Method	Transect counts				Sample areas	
Distance from the edge m	0—100	101—200	0—100	101—200	0—100	101—200
Type of bog	A	A	B	B	B	B
Vanellus vanellus	—	—	5	9	6	6
Capella gallinago	—	—	14	9	4	4
Numenius arquata	—	—	—	—	4	2
Tringa glareola	—	11	5	9	13	4
Tringa nebularia	—	17	5	—	2	—
Limicola falcinellus	—	—	—	—	2	—
Philomachus pugnax	—	—	5	14	—	—
Anthus pratensis	14	28	32	14	26	13
Motacilla flava	10	17	32	5	24	2
Total density	24	72	95	59	82	32
Total no. of pairs observed	14	13	21	13	38	15
Studied area ha	58.0	18.0	22.0	22.0	46.5	46.5

TABLE 4. The total densities (pairs/km²) obtained in 1966—1968 and the total areas (ha) studied in various types. (The types have been indicated by the same symbols as in the classification on page 2).

Type of mire	I	IA	IB	IC	II	IIA	IIB	III	IIIA	IIIB	IIIC
Studied area ha	691	184	285	221	131	83	48	256	75	127	54
Total density p/km²	53	40	67	47	41	47	32	24	21	23	28

The degree of dependence of the edge varies with the species. Of the species in Table 3 only the Yellow Wagtail is greatly dependent on the proximity of the edge (cf. SAMMALISTO 1955); the most important reason for any high densities of this species which occur seems to be the presence of a few trees (cf. PIHLASALO 1968). The Meadow Pipit also obviously prefers edges with a few trees — especially edges with pools of open water where the Wood Sandpiper also has a higher density than in those corresponding fens which are completely treeless. The Lapwing and the Ruff are the species least affected by the edge effect. The Ruff's independence of the proximity of the edge is further illustrated by the fact that nearly all the nests found were over 100 m from the edge, often in the central parts of "rimpi" fens, which is contrary to some earlier ideas (v. HAARTMAN *et al.* 1966).

Total densities and species found in various types of bog

The list of all species includes a few species which nest on the edges of open bogs but which are ecologically dependent on the open bog in their feeding habits. The Goldeneye, Hen Harrier, Short-eared Owl and Great Grey Shrike are such species.

The average total density of birds in open bogs was calculated as 41.8 pairs/sq.km. The nine most common species form the following percentages of the total bird population:

Anthus pratensis	33.0
Tringa glareola	14.6
Motacilla flava ssp	13.9
Philomachus pugnax	12.2
Vanellus vanellus	6.5
Capella gallinago	3.1
Tringa nebularia	2.6
Numenius arquata	2.2
Alauda arvensis	2.2

In total densities (Table 4) "rimpi" fens have higher figures than other types. The difference is not statistically significant when "rimpi" fens are compared with other wet fens ($F = 2.68$, $P > 0.05$). The difference is significant when drier bogs are compared to "rimpi" fen ($F = 12.64$, $0.1 > P > 0.01$). The total densities of wet fens and open bogs differ significantly ($F = 5.18$, $0.5 > P > 0.1$).

The main reason for the greater total densities in "rimpi" fens seems to be that, due to the presence of open water, there are more species in "rimpi" fens than in other types of bog (cf. Table 5). There are twelve species, with a total density of approx. 9.9 pairs/sq.km, which were observed in "rimpi" fens only. An additional factor is that some waders met with in other types, too, are more numerous in "rimpi" fens (e.g. the Wood Sandpiper and Ruff).

Among the various types of "rimpi" fens the open fens with strings seem to have the largest bird populations (Table 4). The difference is not statistically significant. In "rimpi" fens proper the greater proportion of water in the total area seems to reduce the overall density of birds. Open "rimpi" fens with strings have a greater density of birds than fens with a few trees mainly because the Lapwing, Ruff and Curlew, which typically select open country for their habitat, are most numerous in the former type of bog.

Various "rimpi" fens are fairly similar in their bird species. Species typical of, in particular, "rimpi" fens proper are the Jack Snipe and Broad-billed Sand-

TABLE 5. The average density (pairs/km²) of various species in "rimpi" fens (I), other wet fens (II) and drier bogs (III).

Studied area ha	690.0	130.5	256.0
Type of bog	I	II	III
Anas platyrhynchos	0.4	—	—
Anas crecca	0.6	—	—
Anas acuta	0.1	—	—
Bucephala clangula	0.6	—	—
Grus grus	0.1	—	—
Vanellus vanellus	5.8	7.7	0.4
Pluvialis apricaria	0.1	—	—
Capella gallinago	1.6	—	—
Lymnocryptes minimus	0.6	—	—
Numenius arquata	1.2	0.8	—
Numenius phaeopus	0.1	0.8	0.4
Tringa glareola	8.8	1.5	1.2
Tringa nebularia	1.7	—	—
Limicola falcinellus	0.1	0.8	—
Philomachus pugnax	6.7	3.0	2.0
Larus argentatus	0.1	—	—
Larus ridibundus	3.6	—	—
Alauda arvensis	0.4	3.0	2.0
Saxicola rubetra	—	—	0,4
Anthus pratensis	13.3	19.1	12.5
Motacilla flava	6.4	4.6	4.7
Motacilla alba	0.4	—	—
Total density p/km²	53.0	41.2	23.6

piper. The high densities of the Ruff, Lapwing and Wood Sandpiper in open "rimpi" fens with strings are worth noticing. It is surprising that in "rimpi" fens there are so many observations of the Sky Lark, which is generally a species found in drier bogs. The presence of the species in some wet fens is apparently accounted for by other factors than merely the type of bog. Newly-excavated draining ditches may have acted as stimuli in the choice of habitat for this species which generally lives in corn fields.

High densities of the Meadow Pipit and Yellow Wagtail are typical of "rimpi" fens with strings and a few trees. The Yellow Wagtail is not so numerous in other types of bog. A few trees seem to be the main condition required for its higher density. In addition to the presence of a few trees, the chief factors conducive to the greater numbers of both species are high dry strings, often with undergrowth on them and, on the other hand, fairly sizable pools, partly covered with sedge, which is an important ecological factor as a source of food. This combination of various features seems to form the type generally preferred by birds of open bogs.

The data about other wet fens are too small for any detailed comparisons. As a special feature one could mention the high occurrences of the Meadow Pipit and Sky Lark. The Lapwing is a typical inhabitant of fens with a scant growth of sedge: in all the five fens where the species was recorded it had chosen this habitat, which was regularly near large pools of water. It seems that the proximity of pools is an ecological factor important for the Lapwing because they provide a feeding area and also because they resemble flooded meadows (SEISKARI 1956).

The data about the subtypes of drier bogs are limited. The sample areas have, of necessity, been located near the borders of the bogs and the edge effect has raised the densities of some birds, especially that of the Yellow Wagtail. The Ruff does not occur in dry bogs; all of the individuals in Table 5 have been observed in the vicinity of watery depressions which have induced the birds to nest in otherwise dry bogs.

Sporadic species

Sporadic observations were made of the Pintail *Anas acuta,* Golden Plover *Pluvialis apricaria,* Broad-billed Sandpiper, Herring Gull *Larus argentatus* and Great Grey Shrike *Lanius excubitor* nesting on the large open peatlands of Pyhäjärvi. I saw one wandering Herring Gull in 1967 and in 1968 one pair bred in the Nurmesneva bog. The other species — with the exception of the Pintail — were observed on several occasions during the breeding season. The Whooper Swan *Cygnus cygnus,* Bean Goose *Anser fabalis* and Peregrine *Falco peregrinus* were seen only once during the breeding season (there is no proof of nesting).

TABLE 6. The number of species (the species of the edge areas included) and the percentages of the different groups on the particular mires. (The percentages have been counted from the total density of birds on each mire.)

Mire	Nurmes-neva	Vihta-neva	Vittou-venneva	Haudan-neva	Mesi-äisneva	Lampi-neva	Latva-neva
Area ha	360	350	236	160	140	65	62
Number of species	18	19	23	18	13	5	6
Northern species (%)	42.2	20.6	24.7	36.3	29.9	—	11.9
Southern species (%)	17.5	4.8	23.2	5.4	7.7	25.5	—
Indifferent species (%)	40.3	74.6	52.1	58.3	62.4	74.5	88.1

Differences between the individual bogs

The largest bogs seem to have the largest number of species. (Table 6, the species of the marginal areas have been included).

The number of observed species correlates with the size of the area interspersed with pools of water. In the Nurmesneva and Vittouvenneva bogs the great fertility of the soil further increases the number of species. In these two fens the draining ditches on the edges of the fens have added the Sky Lark, Wheatear *Oenanthe oenanthe* and White Wagtail *Motacilla alba* to the nesting populations. The Mesiäisneva bog has fewer species than Haudanneva, which is about the same size but has a larger area interspersed with pools.

In the peatlands studied the majority of birds belongs to northern species. Of the 28 species observed the following twelve belong to the northern group: the Pintail, Bean Goose, Whooper Swan, Golden Plover, Jack Snipe, Whimbrel *Numenius phaeopus,* Wood Sandpiper, Greenshank *Tringa nebularia,* Broad-billed Sandpiper, Ruff, Short-eared Owl *Asio flammeus* and Great Grey Shrike. Purely southern in their distribution are the Lapwing, Curlew, Black-headed Gull *Larus ridibundus* and Sky Lark. The percentages of these two groups and those of neutral species in particular bogs can be seen in table 6.

Haudanneva, Vihtaneva and Latvaneva bogs appear to be the most northern in their character. They are situated in the northeastern corner of Pyhäjärvi where most of the local fens are to be found and where many forest birds belong to the northern category. These three bogs have in common both large stretches of "rimpi" fen proper and a few trees in their open parts. The percentage of northern species is considerable in Vittouvenneva, Mesiäisneva and Nurmesneva, too, but also southern species are quite numerous. These bogs are completely treeless and more fertile than other fens. It is apparently these features which are responsible for the great numbers of the Lapwing, Curlew and Black-headed Gull. On the other hand the populations of the Wood Sandpiper and Ruff are also large. It is interesting to note that the Whimbrel (northern distribution) and the Lapwing (southern distribution) live in the same habitats near the water pools of the fen. One can infer that northern species have been influenced in their choice of habitat not only by the microclimate, which is different from that of the surrounding country, but also by the typical physiognomy of "rimpi" fens and their nutritional features. This is why both northern and southern species seem to prefer the same large mesotrophic "rimpi" fens.

Differences between the years 1967 and 1968

For the study of annual fluctuations there are enough data only for the years 1967 and 1968. The densities of various species seem to remain fairly constant from year to year. There are few changes which are not accidental. There were fewer Wood Sandpipers and Ruffs in 1968 than in 1967, even though the times of the counting periods almost coincided (the density of the Wood Sandpiper: 7.2 pairs km² in 1967 and 5.2 pairs/km² in 1968; that of the Ruff: 6.1 and 4.8 respectively). Conditions at the time of the census in 1968 were, however, exceptional. The reason was an exceptionally cold period with snow at the end of May (Ojanen 1970), which possibly destroyed many nests with newly-laid eggs. Birds started laying eggs again and so incubation lasted late into the summer. The two species mentioned are more difficult to count during the incubation time. The different figures for the Snipe, too, may have been caused by methodological factors. The species can be counted more accurately when the sample area, as was the case in 1968, comprises the whole of the studied bog. Of the figures for waders only those for the Lapwing seem to indicate a real change. The populations rose in four of the five bogs. The following numbers of pairs were recorded:

Bog	Nurmes-neva	Vittou-venneva	Mesi-äisneva	Vihta-neva	Haudan-neva
1967	16	9	4	2	1
1968	14	12	6	4	4

The greatest annual fluctuation is in the numbers of the Meadow Pipit (17.4 pairs/km² in 1967 and 10.6 pairs/km² in 1968). The reason for this too is the cold period in the May of 1968. The cold and snow cover reduced the numbers of birds which had already arrived at their nesting places; the Meadow Pipit was among the six species which suffered the largest losses (Ojanen 1970). The Yellow Wagtail migrated so late that the main body of the population had not arrived at the time of the snow cover.

TABLE 7. The densites (pairs/km²) of some species foud in "rimpi" fens and other wet fens in Southern Suomenselkä (SAMMALISTO 1955) and in Pyhäjärvi.

Year of study	1954		1966—68	
Region of study	Southern Suomenselkä		Pyhäjärvi	
Type of bog	"Rimpi" fens	Other wet fens	"Rimpi" fens	Other wet fens
Grus grus	0.8	0.8	0.1	—
Tringa glareola	4.6	1.0	8.8	1.5
Tringa nebularia	0.8	—	1.7	—
Saxiola rubetra	—	1.3	—	—
Anthus pratensis	6.1	10.4	13.4	19.1
Motacilla flava	3.8	5.3	6.4	4.6
Total density p/km²	19.0	21.3	53.0	41.2

Comparison with earlier studies

The nearest corresponding quantitative study was conducted in 1954 in bogs which lie to the south of the region studied for this paper (SAMMALISTO 1955 in the bogs of Karstula, Soini, Alajärvi and Perho). The results of that study differ to a surprising degree from the ones I have obtained. Almost all densities are definitely higher in my paper. Accordingly the difference in the total density is considerable: the average of the years 1966—1968 is 41.8 pairs/km² in Pyhäjärvi and SAMMALISTO has the figure 14.5 in a more southern part of Suomenselkä. Because my figure is partly based on transect counts and on sample areas counted only once, it is probably even lower than the actual number of birds. In both studies the three most common species are the same and the Meadow Pipit, unlike the Wood Sandpiper and Greenshank, is in "rimpi" fens less numerous than in other wet fens (Table 7). The lower density of the Yellow Wagtail in my study of wet fens is due to the fact that I have taken special care to avoid the edge effect and that these sample areas were completely treeless.

The two studies differ greatly also in the species observed. Only the Wigeon *Anas penelope* and Great Snipe *Capella media* of the birds recorded by SAMMALISTO in 1954 were not found in the bogs of Pyhäjärvi. On the other hand, the Goldeneye *Bucephala clangula,* Whooper Swan, Golden Plover, Jack Snipe, Whimbrel, Broad-billed Sandpiper, Ruff, Blackheaded Gull, Short-eared Owl, White Wagtail and Great Grey Shrike were observed in Pyhäjärvi only. There was only one observation of the Lapwing in 1954. It is worth noticing that, with the exception of the Goldeneye, Lapwing, Black-headed Gull and White Wagtail, the species mentioned have a northern distribution.

When one considers the different observations of these two studies it is clear that definite changes have taken place in the bird fauna of peatlands in northern Suomenselkä during the last ten years. One of the most important changes is an increase in the numbers of northern species. According to SAMMALISTO 17 % of the bird fauna belonged to northern species and 0.5 % to southern species in 1954. The corresponding percentages calculated from my material are 32.1 and 12.4. The growth of the

TABLE 8. The densities (pairs/km²) of some species in open raised bogs (SEISKARI 1954 and PIHLASALO 1968) and in Pyhäjärvi.

Year of study	1951—52	1964—68	1966—68
Region of study	Raised bogs	Raised bogs	"Aapa" fens
Vanellus vanellus	0.2	6.9	2.7
Pluvialis apricaria	0.2	6.9	0.1
Tringa glareola	0.7	2.9	6.1
Tringa nebularia	—	—	1.1
Philomachus pugnax	—	—	5.1
Larus argentatus	2.1	1.1	0.0
Anthus pratensis	7.7	11.2	13.8
Motacilla flava	3.5	25.0	5.8
Total density p/km²	18.7	74.0	41.8

northern group is above all a result of the growing populations of the Ruff and Whimbrel. Only the Wood Sandpiper is a more common wader than the Ruff and in some vast remote bogs the Whimbrel is often more numerous than the Curlew. Another marked change is the expansion into peatlands by such southern species as the Lapwing and Black-headed Gull (cf. SEISKARI 1956, KOMONEN 1963, MUSTAKALLIO 1966 and PIHLASALO 1968). Of the waders the Lapwing has the third largest population and, like the Ruff, it has become a typical species of "rimpi" fens. These changes have raised the total density of birds in open bogs.

The bird fauna of raised bogs seems to differ considerably from that of the peatlands I have studied (Table 8). Southern species are clearly more numerous on raised bogs (SEISKARI 1954, PIHLASALO 1968). In accordance with this some northern species found in open fens do not breed (the Greenshank and Ruff) or are only sporadically observed (the Wood Sandpiper) in raised bogs. One can infer that the expansion of northern waders has not, to any great degree, affected results obtained in the area of raised bogs. An exception to this is the Golden Plover, which is definitely more numerous in raised bogs than in the open fens of Ostrobotnia (HÄYRINEN 196, PIHLASALO 1968).

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Selostus: **Avosoiden linnustosta Oulun läänin Pyhäjärvellä Suomenselän pohjoisosassa.**

Suoritin vv. 1966—68 suolinnustolaskentoja Pyhäjärven avosoilla. Menetelminä olivat linjaarviointi ja ruutuanalyysi, joista viimeksi mainittu näyttää parhaiten soveltuvan suolinnuston takseeraukseen. Eri menetelmin saatujen tulosten välillä ei ole merkitseviä eroja, vaikka koealamenetelmä antaa lajistosta täydellisemmän kuvan (taulukko 2). Arviointilinjoista oli pääosa 200 m:n levyisiä. Ruutuanalyysiä käytettäessä laskettiin eri lajit erilaisen havaittavuutensa vuoksi eri suuruisilta koealoilta, "näkyville" lajeille (taulukko 1) oli koealojen (useimmiten koko avosuon pinta-ala keskimäärin 206 ha ja muille lajeille keskimäärin 19 ha.

Linjat ja koealat pyrittiin sijoittamaan reunavaikutteisen alueen ulkopuolelle. Kyseisen vyöhykkeen leveyden määrittämiseksi suoritettiin takseerauksia, joissa 100 m osoittautui keskimäärin riittäväksi etäisyydeksi rämeen reunasta. Rimpisillä reunoilla reunan läheisyys kohottaa linnustotiheyttä (taulukko 3). Kuivilla reunoilla rimpien puuttuminen on voimakkaimmin vaikuttava tekijä; tiheys oli pienempi kuin nevojen keskiosissa.

Tutkitut suot (7; avosuoala yhteensä n. 1373 ha) sijaitsevat pitäjän harvaan asutuissa koillis- ja pohjoisosissa. Ne olivat kahta lukuunottamatta luonnontilaisia. Useimpien keskellä on laaja rimpineva-alue. Yksityiskohdissaan suot olivat niin vaihtelevia, että olen jakanut ne seuraaviin alatyyppeihin:

I Rimpinevat
A. Varsinaiset rimpinevat, joilla vesipinta on vallitseva
B. Avoimet jänteiset rimpinevat
C. Harvapuiset jänteiset rimpinevat
II Muut märät nevat
A. Mättäiset runsassaraiset tai -varpuiset nevat
B. Niukkasaraiset nevat
III Kuivat nevat
A. Tasapintaiset runsassaraiset nevat
B. Lyhytkortiset nevat
C. Harvapuiset mättäiset rahkanevat

Yksilötiheys on suurin rimpinevoilla (taulukko 4). Tämä johtuu lajirunsaudesta (taulukko 5). Muiden märkien nevojen erityispiirteenä on niittykirvisen ja kiurun runsaus. Kuivilla nevoilla on reunavaikutteisuus kohottanut etenkin keltavästäräkin tiheysarvoa.

Vuosien 1967 ja -68 väliset erot ovat vähäiset ja johtuvat pääasiassa laskentamenetelmällisistä syistä. Suurin todellinen ero on niittykirvisen tiheydessä: v. 1967 17.4 ja v. 1968 10.6 paria/km². Ero johtunee vuoden 1968 toukokuun lopussa sattuneesta takatalvesta.

Aineistosta ilmenee selvästi pohjoisten lajien, mm. suokukon ja pikkukuovin, yleistyminen Suomenselällä viime vuosina. Toisaalta puhtaasti eteläisen aineksen määrä on moninkertaistunut töyhtöhyypän ja naurulokin levitessä soille; ensin mainittu on kolmanneksi yleisin kahlaaja ja rimpisoiden tyyppilajeja (taulukko 6). Nämä seikat ovat osaltaan nostaneet myös nevojen kokonaistiheyttä (Pyhäjärvellä vv. 1966—68 41.8 ja eteläisellä Suomenselällä v. 1954 14.5 paria/km²).

Erot 1950-luvun puolivälin suolinnustotutkimuksiin ovat suuret. Tämä koskee sekä lajistoa että kvantitatiivista puolta (taulukot 7 ja 8). On aivan ilmeistä, että suolinnustossa on Suomenselällä tapahtunut viimeisten kymmenen vuoden aikana suuria muutoksia.

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