

Diet and breeding success of the Golden Eagle in Finland 1958–82

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The diet and breeding success of the Golden Eagle nesting in northern Finland has been studied yearly since 1958. The Arctic Hare and Capercaillie are the main prey species, about 25 % each. Tetraonids in total make up about 50 %. 9 % of the prey individuals are reindeer calves. The Capercaillie is captured relatively more often than the Black Grouse or Willow Grouse in relation to the densities of the respective populations. The yearly changes in tetraonid and hare populations induce corresponding fluctuations in their percentages in the food of the eagle. The reproductive success of the Golden Eagle in Finland was a little better in 1971–77 than in 1960–67. The brood size and breeding success per pair in Finland and Sweden correspond to figures for areas with rich prey resources in central Europe.

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1. Introduction

The Golden Eagle is a regular breeding bird in northern Finland and also breeds in some parts of western Finland, mostly near large open bog areas (Fig. 1).

The breeding success of the species has been checked yearly since 1958 by visiting its known nesting places at least once each summer. Summaries of the results have been published by Linkola (1962), P. Sulkava (1968) and Salminen & P. Sulkava (1976). Prey remnants and pellets were collected during these visits. Summaries on the diet of the species have been published by Sulkava (1959, 1966), Sulkava & Rajala (1966) and Huhtala et al. (1976).

Since additional material has also been collected in recent years, the aims of this report are to show and discuss some regional and long-term differences in the diet of the Golden Eagle, yearly changes in food and the main prey populations, and the changes in breeding success.

2. Methods and materials

2.1. Nesting success

The known territories (often with alternative nests) have been checked regularly by authorized ornithologists since 1958. This was organized at first by the Finnish Association for Nature Protection, but has been the responsibility of the Bureau of Natural Resources in the Ministry of Agriculture and Forestry since around 1970.

The number of nesting territories checked was mostly 30–50 per year during the 1960s, but 80–100 during the 1970s. About 160 occupied territories have been checked in Finland during 1970–82 (Salminen & P. Sulkava 1976, Rassi in litt.).

The nesting territories were classified as “black” (no sign of eagles), “green” (eagles have only rebuilt their nest), “breeding destroyed” or “successful nest” (large young in the nest).

2.2. Diet

During some visits prey remnants were collected from in and beneath the nests, and often also from under nearby resting trees and from feeding places. The pellets of the eagles were also important, as the remains of smaller prey

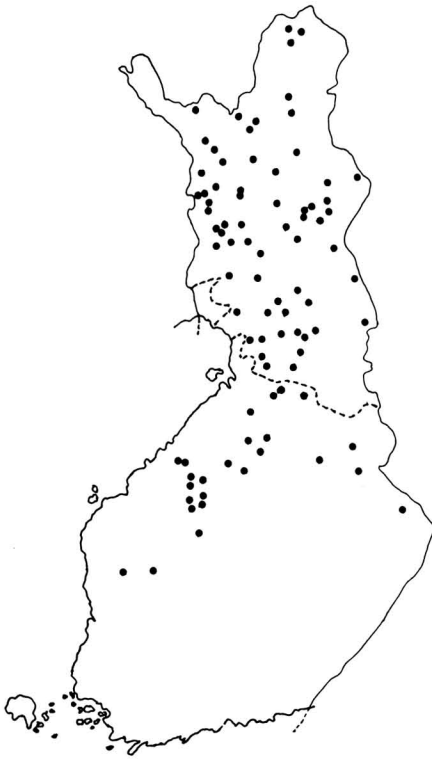


Fig. 1. Locations of the territories of the Golden Eagle where food samples were collected in 1957-82. The broken line indicates the southwestern border of the reindeer husbandry area.

species (e.g. red squirrel or water vole) are mostly found only in the pellets. 10-30 samples per year were sent to the authors at the Department of Zoology, University of Oulu and some were collected directly by them. As a rule these samples contained remains of 10-30 prey individuals, some even 50-80. Fresh and older remains were kept as separate groups.

2.3. Prey population

The description of changes in the population of the Arctic Hare (*Lepus timidus*) is based on the winter inquiries of the Game Division of the Finnish Game and Fisheries Research Institute (scale: 1 = below average, 2 = average population and 3 = above average). Fluctuations in tetraonid populations are described in the August-censuses carried out by the Game Division since 1964 (Rajala 1974, Rajala & Lindén 1982).

3. General composition of the diet

The general composition of the diet of the Golden Eagle in Finland is shown by the total material. This includes both fresh and old prey

Table 1. Diet (%) of the Golden Eagle in Finland (1957-66, 1970-75) and Sweden (1975-79, Tjernberg 1983). — R = reindeer area; S = south of reindeer area.

	Finland R	and S	Sweden R
<i>Tetrao urogallus</i>	25.8	26.7	31.1
<i>Lyrurus tetrix</i>	12.3	20.2	7.5
<i>Lagopus lagopus</i>	8.6	7.2	15.2
<i>Tetrastes bonasia</i>	0.0	0.2	0.1
Tetraonidae, total	47.8	55.5	54.1
<i>Anas platyrhynchos</i>	2.3	3.0	1.3
<i>Anser fabalis</i>	2.4	1.4	0.4
Other Anatidae	1.2	1.4	2.1
<i>Grus grus</i>	1.7	5.5	0.6
Owls and hawks	0.9	0.8	2.0
Corvidae	2.0	1.0	4.3
Other birds	1.5	1.3	1.4
Birds, total	59.8	69.8	65.9
<i>Lepus timidus</i>	25.8	23.6	20.7
Reindeer calves	9.0	-	8.1
Reindeer ad. (carc.)	0.3	-	-
<i>Martes martes</i>	0.6	0.7	1.2
<i>Vulpes vulpes</i>	0.9	0.7	1.7
<i>Ondatra zibethica</i>	0.8	1.1	0.1
<i>Sciurus vulgaris</i>	1.0	2.6	0.4
Other mammals	1.8	1.6	2.0
Mammals, total	40.1	30.3	34.1
<i>Vipera berus</i>	0.2	0.1	-
Sample size, ind.	3766	1796	2803

remains (Table 1), which give about the same picture of the main diet (Sulkava 1966). Tetraonids are the most numerous prey, accounting for about half of the individuals, the Capercaillie being the most important. The Black Grouse is preyed upon more often south of the reindeer husbandry area. The main mammalian prey, the Arctic Hare, is eaten in equal numbers with the Capercaillie in the reindeer area (26%), and therefore constitutes the most important prey species by weight.

Reindeer calves are also relatively important to the eagles in the reindeer breeding area (9% of the prey individuals), while cranes, both young and adult, are eaten more often in the southern area (5.5%). Also waterfowl may have some value as food (the Mallard and, especially in northern Lapland, the Bean Goose).

The Short-eared Owl is the most common predatory victim, but several other owls and hawks have also been recorded. Among the mammalian predators, eagles have captured red foxes, pine martens and stoats. Some of these predators (the Goshawk, Fox and Marten) are at least potential competitors for the eagles.

In Sweden (Table 1) the tetraonids also make up about a half of the prey individuals (54 %), but in different proportions by species. This may be caused mainly by the partly different environment, since many of the eagles studied by Tjernberg (1983) were living in mountain areas where the Willow Grouse is more numerous and the Black Grouse less so than in forest areas. Similarly, less Anatidae and cranes were recorded as prey, but more Corvidae. Reindeer calves occupied about the same percentage as in Finland.

Prey selection between the tetraonid species can be compared on the basis of the densities of tetraonids given by the August route censuses. These densities are a little larger than the real values (Rajala 1974), but give a reliable guide to the proportions of the species. The percentages of tetraonids in the following table are means for the districts of Oulu and Lapland (1964-75) and the percentages of the diet apply to the whole area inhabited by eagles (1957-66 & 1970-75).

Tetraonids (%):	Density in Oulu and Lapland	In diet of Golden Eagle of all prey of tetraonids	
Capercaillie	29.0	26.3	52.0
Black Grouse	31.2	16.3	32.2
Willow Grouse	21.5	7.9	15.6
Hazel Hen	18.5	0.1	0.2

The Golden Eagle clearly hunts relatively more capercaillie than black grouse, and perhaps less willow grouse than black grouse. These relations suggest that the larger species of tetraonids are selected more often than the smaller one. The Hazel Hen, which keeps mostly to dense forests, is only seldom caught.

4. The effect of yearly changes in prey populations on the diet

The tetraonids in the food material are almost all adult birds. The changes in their density (ind./km²) are therefore shown by the August route-censuses of the previous year. Some inaccuracy may be caused, however, by the possible differences in mortality in different winters (Lindén 1981). The main tetraonids, the Capercaillie, Black Grouse and Willow Grouse, are taken together in this comparison (Fig. 2).

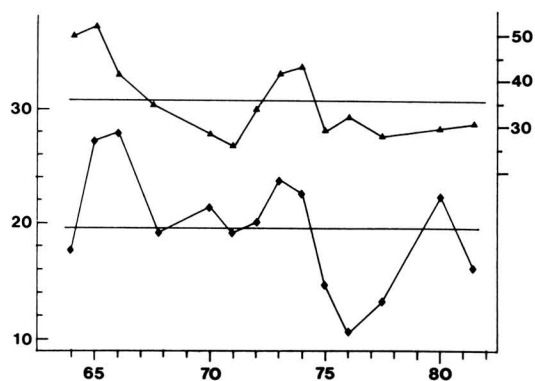


Fig. 2. Changes in the density (ind./km²) of tetraonids and the percentage of tetraonids in the food of the Golden Eagle in the Finnish reindeer husbandry area 1964-82.

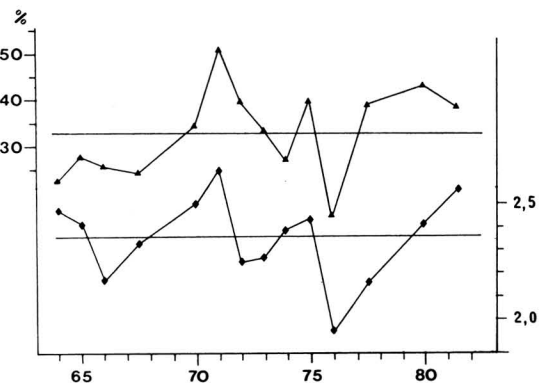


Fig. 3. Changes in the relative abundance of the Arctic Hare and the percentage of the Arctic Hare in the food of the Golden Eagle in the reindeer husbandry area 1964-82.

The yearly changes in tetraonid populations and their percentage in the food follow each other rather well. There are nevertheless some exceptions and the correlation is not quite significant ($P < 0.10$). The fluctuations in the Arctic Hare population correlated significantly ($P < 0.05$) with changes in the diet (Fig. 3).

5. Reproductive success of the Golden Eagle in Finland

The breeding success of the Golden Eagle in Finland for two periods, 1960-67 and 1971-77, is given in Table 2. The figures are mean values for the years concerned.

Table 2. Breeding success of the Golden Eagle in Finland.

	1960-67	1971-77
Breeding territories checked	30	82
Territories occupied as % of those checked	68	83
Large young per successful nest	1.27	1.31
Large young per occupied breeding territory	0.48	0.54
Large young per active nest (eggs laid)	0.67	0.95
Destroyed nests as % of active nests	49	27
Mean tetraonid density (ind./km ² , 1964-68)	22.3	17.7
Mean index of arctic hare abundance	2.33	2.31

The brood size in the successful nests was the same during both periods, and the main prey resources were also of about the same size. The mean brood size in the occupied territories was only a little larger in the 1970s (0.54), but this mean value was diminished by the figure for 1976, which was only 0.20 (compared with 0.63 in other years). Unusually, many eagle pairs (57%, in other years 25% which is significantly less, $\chi^2 = 9.10$, $P < 0.01$) did not breed

in 1976 (nests were only "green"). The better success in the 1970s is seen especially in the larger brood size in active nests (0.95), which was mainly the result of a decrease in the destruction of nests. Also a larger proportion of the territories were occupied, already indicating a slight increase in the population.

The breeding success in the 1970s was about the same in Finland as in Sweden, 1.21 young/successful nest and 0.64 young/pair (Tjernberg 1983). In Scotland and Switzerland (the Alps) the success depends to some extent on prey availability, the corresponding figures being 1.24 and 0.66 for areas with rich prey resources, and 1.04 and 0.48 for poor prey resources (Haller 1982). The success in Finland and Sweden thus corresponds to areas with a relatively rich prey availability. With respect to the food resources, the Golden Eagle populations in Finland and Sweden could thus probably be denser than they are now.

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