

# Diet of the White-tailed Eagle *Haliaeetus albicilla* in Finland

Seppo Sulkava, Risto Tornberg & Juhani Koivusaari

*Sulkava, S., Planeetankatu 2 D 24, FIN-02210 Espoo, Finland*

*Tornberg, R., Department of Zoology, University of Oulu, FIN-90570 Oulu, Finland*

*Koivusaari, J., West Finland Regional Environmental Centre, Koulukatu 19, FIN-65100 Vaasa, Finland*

*Received 24 September 1996, accepted 24 January 1997*



The White-tailed Eagle nests in the Åland Islands (and SW archipelago) and the islands of the Quark region in Finland, and also close to the large reservoirs in Lapland. Prey remains collected from nest sites in these areas in 1978–90 indicate that birds constitute on average 51% of the prey, fish 42% and mammals only 7%. Pike constituted some 33% of the prey. Some large regional differences were observed in the frequencies of given types of prey, the proportion of fish being as much as 67% in Lapland but only 32% in the Quark region and 27% in the Åland Islands, while the opposite trend was observed in the case of birds (29%, 59% and 65%, respectively). The birds were primarily composed of Anatidae, which constituted 51% of all prey in the Åland Islands and 17% in Lapland. Temporal differences also occurred in the diet, Eiders and gulls, for example, increased in the diet in the archipelago regions, in parallel with prey population changes.

## 1. Introduction

From the beginning of the 20th century up until the 1960s, Finnish White-tailed Eagles nested only along the coast of the Baltic Sea (von Haartman et al. 1963–72). Nesting in Lapland began in the 1970s, largely as a result of the construction of major reservoirs in the region. The Lokka reservoir was completed in 1967, and nesting eagles were discovered there in 1977 (one nest was found at Muonio even in 1970; Koivusaari 1980, Hyytiä et al. 1983, Stjernberg 1983). Eagles have been nesting in the Swedish Lapland for a longer period (Helander 1983), and in eastern Karelia and on the Kola peninsula White-tailed Eagles nest near large lakes and along rivers (von Haartman et al. 1963–72, Zimin et al. 1981).

The territories (hunting areas) of the White-tailed Eagle are largely composed of water in the

coastal region, but in inland areas lakes often constitute a minor part of the territory area. Differences also exist between the coast and inland regions in terms of the composition and quantity of available prey. Regional differences in prey availability are also suggested by the variation in nestling weights between coastal areas and inland (Lapland) in Sweden (in Lapland the weights are about 20% lower, Helander 1981).

In Finland, Kulves (1973) described the diet of the White-tailed Eagle on the Åland Islands, and Koivusaari (1980) has examined its nutrition biology in the Quark region since 1964. Helander (1983) made an extensive survey on White-tailed Eagle nutrition both in coastal Sweden and in Swedish Lapland. White-tailed Eagle nutrition has also been studied on the Norwegian coast (Willgohs 1961, 1984), in Central Europe (Oehme 1975, Fischer 1982), in Scotland (Watson et al. 1992) and in Greenland (Wille & Kampp 1983).



Fig. 1. Location of the study areas in Finland. A: the Åland Islands and the southwestern archipelago, B: the Quark region (archipelago), C: central Lapland around the reservoirs.

This paper presents the diet of the White-tailed Eagle in Finland with close attention paid to regional and temporal changes in the composition of the diet. The results are compared with those from other countries.

## 2. Material and methods

### 2.1. Collection of material and study areas

Food samples (prey remains) were usually collected from the nests once a year, mostly towards the end of the nestling season. Samples were mainly obtained from and under the nests, and under trees used for perching and roosting, and from feeding sites within 200–300 m around nests (as in Koivusaari 1980). The material also included pellets, scales, feathers, hairs and other non-digested elements. Many small prey animals are found only in pellets.

There is a small chance that some of the remains were produced by another predator outside the nesting season of the White-tailed Eagle. On the other hand, red foxes or raccoon dogs sometimes remove some of the remains lying on the ground (Helander 1983).

Occurrences of partly eaten or entirely uneaten prey in the nests were also recorded, and these were either left in place or removed and buried in the ground if they had already begun to decay. These findings will be discussed separately, as partly eaten prey may also be contained in remains collected at the same time or later. The sources of error are essentially smaller in the case of uneaten material than for remains. The storing of uneaten extra prey in nests is particularly common in the early summer (Koivusaari 1980, Helander 1983).

The new prey samples (years 1978–90) discussed here were collected by members of the Finnish WWF (World Wildlife Fund) working group on the White-tailed Eagle regularly since 1978, from three areas in Finland (Fig. 1): 1. The Åland Islands and the SW archipelago off Turku between Åland and the southwestern coast of Finland (together as “Åland” in diet tables); 2. The archipelago of the Quark region; and 3. Central Lapland around the two large reservoirs.

1. In the archipelago of Åland and southwestern Finland the numerous islands are relatively high and rocky, and often have rather steep shores. The waters around islands are relatively deep. Pine forests dominate on the islands. Most of the Finnish White-tailed Eagles breed in this area. In 1992 there were 33 pairs in the Åland area and 14 in the other SW archipelago (Hildén & Hario 1993), which is more than twice that in the 1970s (13 and 9 pairs, Koivusaari 1983). Food samples were collected by several people, and the samples were of rather variable size.

2. The Quark archipelago, with its central part outside of the city of Vaasa but reaching to about 100 km N and S, includes many very low and stony islands. The shoreline is very unstable and the waters around the islands are usually very shallow. The forests are mixed, being mainly deciduous on the smaller and outer islands, but often spruce-dominated on the larger and inner islands (Koivusaari 1980). The White-tailed Eagle population has clearly grown here also, from 10–15 pairs in the 1970s to 23 pairs in 1992 (Koivu-

saari 1980, Hildén & Hario 1993). More extensive clearing of forests and the growing number of summer houses and roads have often disturbed breeding eagles (Koivusaari 1980, 1988). The samples were collected by one of the authors (JK and co-workers).

3. In central Lapland, White-tailed Eagles breed around two reservoirs, Lokka (max. 417 sq. km) and Porttipahta (max. 214 sq. km). There are many smaller natural lakes in this relatively flat area, which is also characterized by large open bogs. Forests are mostly dominated by pine, with some spruce. Nesting eagles were first observed here in 1977. Three pairs were seen in the late 1970s, and 14 in 1992 (Koivusaari 1983, Hildén & Hario 1993). Some nests are quite far from the lakes or reservoirs, and there are few roads in the vicinity of the nests. Several people took part in the collection of food samples.

## 2.2. Identification of samples

The species identification of the samples collected between 1978 and 1990 were carried out at the Zoological Museum of the University of Oulu, which has a reference collection of bones, feathers and fur from birds, mammals and fishes. In addition, the identification was based on guidebooks compiled for skeletal and other remains (e.g. März 1987).

The weights for the bird species were taken from handbooks (e.g. von Haartman et al. 1963–72), while the average weights of most mammals were calculated from records in the zoological museum and a few were taken from Siivonen and Sulkava (1994). Average weights of pike for different areas were calculated according to the ratio between weight and the length of the lower jaw, as presented by Koivusaari (1980). The average weights employed by Helander (1983) in Sweden were used for ide and bream.

## 2.3. Sources of error

The proportions of different species in the material may be biased. More identifiable remains such as large bones and feathers are left over from large birds and mammals than from smaller animals,

which may be swallowed whole. Traces of smaller birds and mammals, such as thrushes and water voles, are often only found in pellets. In addition, pellets containing hair and feathers remain solid and thus can easily be found on the ground (Koivusaari 1980).

Fish only contain few large, uneatable or indigestible elements, and the White-tailed Eagle is better able to crush the heads of most fish species than the hard skulls of mammals and birds. White-tailed Eagles usually reject the lower jaws of pikes, as these are too hard, large and contain sharp teeth, and often leave the entire head uneaten. White-tailed Eagles are capable of crushing the skulls of even large cyprinids, the most typical remains being their hard pharyngeal bones, which can be identified as to species (e.g. März 1987). Some of the fish are nevertheless brought to the nest without the head (Willgohs 1961, Wille & Kampp 1983), in which case not even the pharyngeal bones can be found.

According to Koivusaari (1980), the actual number of small fish such as roach and fairly small perch (average weight about 200 g) is difficult to estimate in the samples if these are eaten in large quantities. Few bones are left over from them, often only some scales, which may be difficult to find. Koivusaari did a test in which Baltic herrings were taken to a White-tailed Eagle's nest. The fact that no trace of the fish was found later indicates that the bones of such small fish are usually eaten and digested completely. For this reason, fish bones are seldom found in pellets (Oehme 1975). In addition, pellets containing harder bones of larger fish tend to break up easily and their remnants may thus be difficult to find (Koivusaari 1980). The percentages of fish species in the remnant material are thus lower than their actual occurrences, with the exception of pike. For pike, the percentage was twice as great in the remnant material as in reality. Based on direct observations, the remains of only about one-third of other fish species actually eaten were found in remnant material (Koivusaari 1980). The fish data presented here have not been corrected for the above sources of error.

Wille and Kampp (1983), working in Greenland, and Watson et al. (1992) in Scotland, propose that fish are underrepresented in the remains collected from the nests of the White-tailed Ea-

gle. However Helander (1983), who compared materials of uneaten prey found in nests and prey remains in Sweden, found that the percentage of fish in the prey remnants was no smaller than the actual amount in the diet and that the percentages of the other prey categories were also more or less correct.

The 'miminum method' (Oehme 1975) was used to calculate the numbers of prey items in the samples of this study, which eliminates the problem of including large items twice when using both pellets and bones, for example.

### 3. Results

#### 3.1. Diet in Finland

White-tailed Eagles in Finland eat mostly birds (on an average 51.1%) and fish (42.1%), taking also some mammals (6.9%), i.e. the eagles are capable of catching a wide variety of prey. By far the most numerous prey species is the pike (32.5% of the prey), followed by the Eider, Black-headed Gull, Mallard, ide and muskrat (each of these five species made up only 3.4% to 6.1% of the diet). The percentages here are means of the areas in the Appendix, where the scientific names of the prey are also given.

Various species of waterfowl, most notably the Goosander, Eider, diving ducks (*Aythya* sp.) and Mallard, were the principal avian prey. Each of the above species constitutes on an average 4–7% of the prey, gulls 7.6% and gallinaceous birds only 2.5%. The muskrat was the most important mammalian prey species, constituting on an average 3.5% of the prey, while the proportion of hares was only 1.3%.

#### 3.2. Regional differences in diet in Finland

Considerable regional differences in the composition of prey were found between the Åland archipelago, the Quark area and Lapland (Table 1). The amount of fish was 2.1–2.5 times higher in Lapland than in the other two areas, and its frequency was significantly lower in the Åland Islands than in the Quark area ( $G = 5.5$ ,  $P < 0.05$ ). These regional differences are primarily attribut-

able to the proportion of pike, which constituted only 19% of the diet in the Åland Islands, 25% in the Quark area and 53% in Lapland. Despite the smaller figure for Åland, the pike was the most numerous prey species there as well. There were no marked differences in the rather small proportions (less than 5%) of the other fish species among the areas.

For the avian prey, the most pronounced regional differences were in the amounts of Eider, Velvet Scoter, Goldeneye, diving ducks and gulls consumed (Appendix and Table 1). The Eider was more important prey species in the Åland Islands than in the Quark area ( $G = 94.3$ ,  $P < 0.001$ ). The same applies to the Velvet Scoter ( $G = 19.7$ ,  $P < 0.001$ ) and Goldeneye ( $G = 18.9$ ,  $P < 0.001$ ). The consumption of *Aythya* sp. (mainly Scaup) was greater in the Quark area than in the Åland Islands ( $G = 29.5$ ,  $P < 0.01$ ). A similar but smaller difference was observed in the case of the Tufted Duck.

Mergansers were important prey species both in the Åland Islands and in the Quark area. The Goosander is prevalent in Åland and the Red-breasted Merganser in the Quark (see Appendix). Gulls were more frequent prey species in the Quark than in the Åland Islands ( $G = 68.6$ ,  $P < 0.001$ ). The percentage of Herring Gulls consumed was similar in both areas, but the Common Gull and Great Black-backed Gull were more numerous prey in the Quark.

In Lapland, several southern water bird species are lacking or so rare that they are missing in the diet (e.g. scoters, grebes, auks, Coot, Pochard) or constitute only a minor source of food. Some southern prey species exist in other prey groups too. The diet in Lapland was principally fish (pike), which also is seen in the very small food-niche value, 3.2 (8.3 and 10.6 in other areas, Table 1).

The White-tailed Eagle consumes more gallinaceous birds in the Quark (and in Lapland) than in the Åland Islands ( $G = 5.0$ ,  $P < 0.05$ ). The gallinaceous bird species eaten were mostly Willow Grouse in Lapland and Black Grouse farther south. Eagles preyed on waders and Teal more often in Lapland than elsewhere ( $G = 27.7$  and  $48.1$ ,  $P < 0.001$ ). The muskrat played a less prominent role in the diet in Lapland than in the other regions, whereas no distinct regional differences were observed in the (small) percentages of other mammals.

### 3.3 Composition of prey by weight

Since the White-tailed Eagle feeds mostly on prey in a rather small weight range, 0.5–1.0 kg, the weight-based percentages of the various species in its diet do not deviate appreciably from those calculated by number, especially in the case of most fish and bird species (Table 1).

The weight-based percentage of the hare is, of course, greater than that based on number, but the species constitutes a minor source of nutrition for the White-tailed Eagle even when examined

by weight, i.e. only 3 to 6%. The percentages of Eider and pike by weight are again greater than those calculated by number, because of their fairly high mean weights. This emphasises their importance in the diet of the White-tailed Eagle particularly in the Åland Islands, where the mean weight of pike eaten by White-tailed Eagles is greater than in the Quark area and Lapland (determined according to Koivusaari 1980, cf. 2.3.). As most gulls, diving ducks and Goldeneyes are fairly light in weight, smaller percentages by weight than by number were recorded.

Table 1. Predation by the White-tailed Eagle in the Åland Islands, the Quark region and Lapland by number (N) and weight (W) of prey species and categories in 1978–90. Niche (diet) breadths according to Levins' formula  $1/\sum p^2$  (Colwell & Futuyma 1971).

	Åland		Quark		Lapland	
	N %	W %	N %	W %	N %	W %
Pike	19.1	27.4	25.4	30.7	53.0	58.1
Ide	4.3	4.0	3.8	4.6	4.4	4.5
Other fishes	4.0	1.3	2.5	1.0	9.9	2.7
Fishes, total	27.4	32.8	31.6	36.3	67.2	65.2
Great Crested Grebe	2.8	1.9	2.1	1.9	–	–
Other grebes	0.7	0.4	0.6	0.3	–	–
Mallard	5.2	4.2	4.1	4.2	3.7	4.1
Goldeneye	5.1	2.8	1.9	1.3	0.4	0.3
<i>Aythya</i> sp.	5.2	2.8	10.3	7.5	0.9	0.5
<i>Melanitta</i> sp.	5.9	6.3	1.9	2.7	–	–
Eider	14.8	21.3	3.6	6.6	–	–
<i>Mergus</i> sp.	10.3	9.4	8.9	9.6	2.4	3.1
Other Anatidae	4.2	4.0	3.3	2.4	9.5	9.6
Anatidae, total	50.6	50.8	33.8	34.4	16.9	17.6
Tetraonidae	1.3	1.0	2.6	3.6	3.5	4.5
Laridae	5.0	2.0	15.0	6.0	2.9	1.6
Other birds	4.9	1.8	4.8	2.8	5.7	4.9
Birds, total	65.3	58.0	58.9	49.0	29.2	28.6
Muskrat	4.5	3.6	5.6	5.6	0.3	0.3
Hares	1.7	4.7	1.4	5.7	0.8	3.1
Other mammals	1.2	1.0	2.6	3.5	2.5	2.8
Mammals, total	7.4	9.6	9.6	14.7	3.6	6.2
Number of prey	1 331		1 071		750	
Niche breadth	10.63	6.91	8.34	7.54	3.23	2.79

### 3.4. Temporal changes in avian prey

The proportions of several waterfowl species in the diet of the White-tailed Eagle declined in both coastal regions from 1964 to 1990, however, some species remained fairly stable, and that of the Eider increased (Tables 2 and 3). Declines were observed in the Great Crested Grebe and Mallard in the Åland Islands, and in the Mallard and the Red-breasted Merganser in the Quark area. The percentage of the Great Crested Grebe was less in the Quark area during 1964–1972 than it has been since.

The significant increase in the percentage of Eider consumed in both the Åland Islands and the Quark area seems to have taken place primarily in the late 1980s in both areas. The total percentage of gulls in the diet of the White-tailed Eagle increased remarkably in the Quark area in the 1980s.

## 4. Discussion

### 4.1. Reasons for temporal changes in diet in Finland

Distinct changes were observed in the diet of the White-tailed Eagle in Finland during the last 30 years. Considerable changes have also taken place in the bird fauna of the Finnish archipelagos during this study (including the study of Koivusaari, 1980, from the years 1964 to 1977 in the same areas in the Quark area and southwestern archipelago). The populations of several waterfowl and gull species have increased, e.g., because of protected areas, the general eutrophication of the Baltic Sea, and for gulls the extra food found at large garbage dumps. The largest increases have been observed in the number of Eider and gulls (except the Lesser Black-backed Gull) (e.g. Hario & Selin 1986, Hildén & Hario 1993, Hildén et al. 1995).

Increases in Eider populations (at least for some years of the last three decades) have been recorded for the areas of Söderskär (south of Helsinki) and the Quark. In these areas, the Eider population has continuously increased 2 to 3-fold from the 1960s to the early 1990s (Hario & Selin 1988, Hildén & Hario 1993). In the diet of the

White-tailed Eagle, the increase in the number of Eider consumed seems to parallel the population increase only in the 1980s (Tables 2 and 3).

Of the gulls, especially the populations of Herring and Great Black-backed Gulls have increased in the breeding areas of the White-tailed Eagle in the southwestern archipelago and the Quark. In the Quark area the Common Gull has also increased in numbers. The Black-headed Gull is common in the inner archipelago, but its population has decreased since the 1980s, as has the Common Gull population in the southern archipelagos (Bergman 1982, Hildén & Hario 1993). Exact numbers of the increases (or decreases), however, do not exist.

Most gulls in the diet of the White-tailed Eagle are Black-headed and Herring Gulls, few are Common Gulls. The percentage of gulls in the diet has — more or less parallel to the increase of the important gull populations — grown significantly in the Quark area (in 1965–1990 over two-fold, Table 3) and obviously (but not significantly) also in Åland.

Table 2. Principal avian prey species (more than 10 occurrences recorded during one period examined) as percentages of the total number of avian prey items in the food material from the Åland Islands in 1973–77 (from Koivusaari 1980), 1978–84 and 1985–90. Test of change: P-values of chi square if  $< 0.05$ .

	1973 –77 %	1978 –84 %	1985 –90 %	P
Great Crested Grebe	11.9	7.6	2.8	< 0.001
Mallard	14.9	10.8	6.7	< 0.024
<i>Aythya</i> , total	6.0	8.8	7.8	
Tufted Duck	3.0	6.7	5.1	
Goldeneye	10.4	9.0	7.6	
Velvet Scoter	9.0	9.4	6.9	
Eider	16.4	16.6	24.8	< 0.022
<i>Mergus</i> , total	13.4	17.0	15.5	
Red-breast. Mergans.	11.9	4.5	4.4	< 0.026
Goosander	1.5	8.1	8.3	
Black Grouse	1.5	0.9	2.8	
<i>Larus</i> , total	4.5	4.5	7.4	
Herring Gull	–	1.8	2.8	
Black-headed Gull	–	1.3	3.9	
Corvidae	1.5	2.7	2.8	
Other birds	10.5	12.7	14.9	
Number of birds	67	223	568	

The decrease in the percentage of Great Crested Grebe found in the food material in the Åland Islands (Table 2) was consistent with the increase in the percentage of Eider found. Here, the change may be partly attributable to the fact that the late 1980s data contain more sample material from the outer archipelago, where larger numbers of Eiders are found, but very few Great Crested Grebes (Ulfvens 1988, Hildén & Hario 1993), and to the spread of the White-tailed Eagle (and the material collected) to the outer archipelago (H. Wallgren, pers. comm.).

#### 4.2. Prey selection by the White-tailed Eagle in Finland

The prey selection by the White-tailed Eagle can be roughly estimated in the Åland Islands and the southwestern archipelago, and in the Quark area by comparing its diet (Appendix) with the total numbers of breeding "archipelago birds" (here species breeding only in the archipelago), which are reported for these areas by Hildén and Hario (1993). The number of breeding pairs of archipelago bird groups and their distribution in the diet of the White-tailed Eagle are shown in Table 4. Medium-sized waterfowl species (here *Mergus*,

*Melanitta* and *Aythya marila*, mean weight 1 197 g) are, according to this comparison, the preferred avian prey species in the Finnish outer archipelagos. Their percent distributions in the diet are here 4–8-fold higher if compared with the corresponding percentages in the "archipelago bird fauna" (Table 4).

The most important avian prey species, the Eider, is preferred in the Quark area (chi square = 19.9,  $P < 0.001$ , Table 4), but it seems not to be preferred in the southwestern archipelago (proportion in diet is significantly smaller than in "archipelago bird fauna", chi square = 32.3,  $P < 0.001$ ). This may, however, be related to the fact, that a considerable number of White-tailed Eagles of this area breeds in the inner archipelago, where the proportion of the Eider of the "archipelago bird fauna" is relatively small.

Other bird groups — gulls, terns, alcids and waders — are not preferred prey (the proportions in diet are significantly smaller, Table 4). Terns and waders are obviously too small prey species for the White-tailed Eagle, and perhaps also too difficult to catch. The alcids and gulls are also on average lighter (570 and 889 g) than the medium-sized waterfowl above (1 197 g). The effect of large size on prey choice is clearly seen in that there is only one swan in the diet material, even

Table 3. Principal avian prey species (more than 10 occurrences recorded during at least one period examined) as percentages of the total number of avian prey items in the Quark region in four periods during 1964–90 (1964–77 from Koivusaari 1980). Test of change: P-values of chi square if  $< 0.05$ .

	1964–71 %	1972–77 %	1978–83 %	1984–90 %	P
Great Crested Grebe	1.9	12.2	3.4	5.7	< 0.001
Mallard	14.2	12.2	7.8	6.0	0.013
<i>Aythya</i> , total	25.9	22.3	18.4	16.3	
Goldeneye	4.3	5.0	3.5	2.8	
Velvet Scoter	6.2	1.4	2.3	3.6	
Eider	2.5	2.2	2.6	10.3	< 0.001
<i>Mergus</i> , total	22.2	12.2	15.0	15.2	
Red-breasted Merganser	16.7	5.0	4.9	8.5	< 0.001
Goosander	5.6	7.2	4.9	5.0	
Black Grouse	3.7	5.0	3.2	3.9	
<i>Larus</i> , total	10.5	17.3	24.1	24.1	< 0.001
Herring Gull	1.9	0.7	3.2	4.3	
Common Gull	0.6	1.4	1.7	3.9	
Black-headed Gull	6.2	12.2	18.4	15.3	
Other birds	8.6	10.2	19.7	12.1	
Number of birds	162	139	348	282	

though Mute Swans (*Gygna olor*) are easy to see from long distances, and are common nesters in the open archipelago (in total 1 500 pairs in these areas, Hildén & Hario 1993).

The size differences between gull species seem to result in the Herring Gulls (size, 860 g, only a little smaller than that of the preferred waterfowl) being preyed upon much more by the White-tailed Eagle (46 ind. in the material) relative to the smaller (415 g) Common Gull (21 ind., chi square = 9.33,  $P < 0.01$ ), even though the number of Common Gulls is over two-fold greater in these archipelago areas (26 000 vs. 9 000 pairs, Hildén & Hario 1993).

### 4.3. Role of diet in the territorial expansion to the Finnish and Swedish Lapland

The territorial expansion of the White-tailed Eagle to Finnish Lapland occurred after the construction of the large reservoirs in the 1970s (Koivusaari 1980). Earlier there were perhaps too few suitable waters for fishing by the eagle. Because of the very few human settlements around the reservoir area, there was now also a relatively undisturbed area for hunting and nesting. In Swedish Lapland the White-tailed Eagle population has been established longer, and the breeding areas are at higher elevations, partly near fells, where human settlements are very scattered (Helander 1983), and the eagles are less disturbed than in Finnish Lapland.

The diet of the White-tailed Eagle in both Finnish and Swedish Lapland differs in many respects from those of the eagles of the Baltic coasts (Table 5). For example, the pike is a more important prey in both Lapland areas than in the northern Baltic areas, and some southern or coastal species are (almost) absent in prey remains from Lapland (Coot, grebes and Eider, and bream in fishes). The main prey groups and partly also the main species are, nevertheless, the same in Lapland as on the coasts. There are, however, also differences between the two Lapland areas. In Finnish Lapland the eagles eat more fish because fewer pike are found in Swedish Lapland (chi square = 12.1,  $P < 0.001$ ). In Sweden the eagles eat more birds, both waterfowl and gallinaceous birds (chi squares = 16.7 and 4.56,  $P < 0.001$  and  $P = 0.03$ ). More mammals are found in the diet in Swedish Lapland (chi square = 18.2,  $P < 0.001$ ), for example, more reindeer fawns and several recorded cases of reindeer carcasses being eaten.

The differences in prey fauna and hunting grounds from those in the Baltic area and other coasts have obviously not resulted in any special hunting problems for White-tailed Eagles in the Lapland area. Eagles have, for example, in Lapland preyed more on terrestrial birds and fish, but the regional differences in diets are for the most part attributable to the different prey fauna available (Helander 1983).

Fish resources have obviously been relatively rich in the reservoirs in Finnish Lapland, where abundant fish populations are found and around

Table 4. The estimated numbers of breeding pairs of the archipelago bird groups (and the Eider) in the archipelagos of SW Finland, the Åland Islands and the Quark area in the early 1990s (Hildén & Hario 1993), their observed numbers and percent distributions in the diet of the White-tailed Eagle in 1978–90, and the mean weights of the species. *Anser* sp. = *Anser anser*, in diet *Anser* sp.; Other Anatidae = *Mergus* sp., Velvet Scoter, Scaup, Shelduck; Gulls = *Larus canus*, *fuscus*, *argentatus* and *marinus*; Waders = Oystercatcher, Turnstone, Redshank.

	SW-archipelago + Åland				Quark area				Mean weight g
	Breeding popul.		Diet		Breeding popul.		Diet		
	Pairs	%	Ind.	%	Pairs	%	Ind.	%	
Eider	150 000	68.4	197	42.0	3 500	7.2	38	16.3	2 365
Other Anatidae	13 245	6.0	216	46.1	8 032	16.5	133	57.1	1 197
Gulls	24 500	11.2	28	6.0	14 160	29.1	45	19.3	889
Terns	17 000	7.8	7	1.5	13 500	27.7	—	—	113
Alcidae	10 300	4.7	10	2.1	7 050	14.5	14	6.0	570
Waders	4 100	1.9	3	0.6	2 390	4.9	1	0.4	230
Total	219 145	100	461	100	48 632	100	213	100	



which most of the White-tailed Eagles here breed. Consequently, a considerable amount of uneaten fish has been reported at several nests along with the nestlings (S. Ojala, pers. comm.). In Swedish Lapland (where corresponding reservoirs do not exist), the food resources in summer (during the nestling time of the eagle) are less abundant than on the Swedish Baltic coast, and therefore the young of the White-tailed Eagle in Swedish Lap-

land weigh less than the coastal nestlings (Helander 1983).

One example of the flexibility in prey choice by White-tailed Eagles breeding in inland areas is shown by the pair which nested in Taivalkoski (NE Finland) during 1990–1992 in isolation from other pairs. This sample was excluded from the foregoing data since this territory consisted of forest areas with only a few small lakes. The 58

Table 5. Diet of the White-tailed Eagle in the Åland Islands, the Quark area and Lapland in Finland, on the Baltic coast and Lapland of Sweden (Helander 1983), on the coast of Norway (Willgohs 1961) and in Germany (Oehme 1975) by the number of prey species and categories (more than 3.0% in some area).

	Åland	Quark	Baltic Sweden	Lapland Finland	Lapland Sweden	Norway	Germany
	%	%	%	%	%	%	%
Pike	19.1	25.4	25.6	53.0	38.6	–	16.7
Burbot	0.2	0.1	0.7	4.5	6.8	–	0.1
Grayling	–	–	–	–	4.3	–	–
Bream	0.7	0.3	19.0	–	–	–	1.0
Ide	4.3	3.8	6.8	4.4	–	–	–
Perch	0.8	0.8	2.6	2.9	1.4	–	4.2
<i>Gadus</i> sp.	0.2	0.4	–	–	–	9.5	0.1
<i>Anarhichas</i> sp.	–	–	–	–	–	7.2	–
<i>Cyclopterus</i> sp.	–	–	–	–	–	9.9	–
<i>Pleuronectes</i> sp.	0.5	–	–	–	–	2.7	–
Fishes, total	27.4	31.7	60.1	67.2	52.9	33.5	37.8
<i>Podiceps</i> sp.	3.5	2.7	4.5	–	0.1	–	5.5
<i>Phalacrocorax</i> sp.	–	–	–	–	–	5.7	0.1
Mallard	5.2	4.1	3.8	3.7	5.1	0.1	6.5
Teal	0.2	0.5	0.2	3.9	1.3	–	0.7
Goldeneye	5.1	1.9	1.0	0.4	2.4	–	0.7
<i>Aythya</i> sp.	5.2	10.3	2.0	0.9	4.1	–	2.3
Eider	14.8	3.6	7.3	–	0.1	16.6	–
<i>Mergus</i> sp.	10.3	8.9	3.6	2.4	3.8	–	0.8
Coot	0.5	0.2	3.1	–	–	–	15.7
<i>Uria</i> sp.	–	–	–	–	–	4.9	–
Waterfowl, total	54.2	36.8	26.3	17.2	25.7	28.3	26.1
Tetraonidae	1.3	2.6	0.4	3.5	5.7	0.8	0.1
<i>Larus</i> sp.	5.0	15.0	4.8	2.9	1.6	9.4	1.1
Birds, total	65.3	58.9	38.4	29.2	38.3	53.5	52.4
Muskrat	4.5	5.5	–	0.3	–	–	0.2
<i>Lepus</i> sp.	1.7	1.6	0.5	0.8	1.1	0.9	3.5
Reindeer fawn	–	–	–	0.5	2.3	–	–
Reindeer, carcass	–	–	–	0.9	4.8	0.3	–
Mammals, total	7.4	9.6	1.4	3.6	8.9	7.4	9.8
Number of prey	1331	1071	2649	750	800	2138	1626
Niche breadth	15.87	7.64	8.27	3.43	5.93	14.95	15.72

prey individuals identified indicated that mammals (22.4%) and gallinaceous birds (20.7%) occupied a much more prominent position in the pair's diet than in that of other White-tailed Eagles in Finland, whereas the role of fish (13.8%) was markedly less pronounced.

#### 4.4. Breeding season diet in other countries (areas)

White-tailed Eagles on the coast of Sweden consumed much more fish (60%) than in Finland (27–32%, Table 5), whereas Finnish coastal White-tailed Eagles took more birds than Swedish White-tailed Eagles (59–65% vs. 38%). The most marked regional difference in the occurrence of fish in the diet was the large percentage of bream eaten on the Swedish coast. The percentage of pike in the Åland Islands' material was less than in the other areas both in Sweden and Finland.

Primarily the same species such as mergansers, Mallard and grebes constitute the bulk of the avian prey along all Baltic coasts. In the Åland Islands, Eiders, Goldeneyes and *Melanitta* species constitute more important prey than in other coastal areas, while Coots were more common in the diet on the Swedish coast, and the Quark stands out in terms of the prominent role of the gulls. The percentages in the diet of such groups as gallinaceous birds and corvids usually were less throughout the above areas.

Mammals occupy a minor position in all areas, a regional difference being the absence of the muskrat in Sweden, where the species was only encountered in the northwestern coastal area of the Bothnian Bay (Siivonen & Sulkava 1994). Hares were a minor source of food for the White-tailed Eagle on the Swedish coast, where the total percentage of mammals was particularly small (1.4%).

In Germany the proportions of fish, birds and mammals taken by White-tailed Eagles were close to the average levels observed in Finland (figures obtained for the Quark, Table 5), and there were only a few distinct differences in the range of species. The pike constitutes the most important fish species also in Germany (16.7% of all prey items), but its proportion is less than in Finland, and the proportion of ducks corresponds to that observed in inland areas of Finnish Lapland. Of the aquatic

birds, the Coot is the most important prey in Germany (15.7%).

On the Atlantic coast of Norway, fish (33.5%) and mammals (13.0%) occupy a somewhat more prominent position in the summer diet of the White-tailed Eagle (Willgohs 1961, 1984) than on the Finnish coast (Table 5), and birds a correspondingly smaller one. There are some deviations in the range of species between these areas; because of differences in their availability the fish and also birds in Norway are largely marine species which are not or only occasionally found breeding on the Finnish coasts, e.g. Guillemots (*Uria* sp.) and Cormorants (*Phalacrocorax* sp.).

Further west, the diet of the White-tailed Eagle differs even more from that in Finland and Sweden, the proportion of fish, for example, being much less in Scotland, only 5.4% in summer (Watson et al. 1992), but that of mammals markedly higher (31.2%). Two-thirds of the latter are mountain hares, which constitute 20.3% of the diet, as opposed to a mere 1–2% in Finland and Sweden. In Greenland, fish constitute the main source of nutrition, approximately 90% of the total prey (Wille & Kampp 1983).

#### 4.5. The White-tailed Eagle as a predator

Many birds of prey (e.g. Golden Eagle, Goshawk, Eagle Owl and Ural Owl) hunt both avian and mammal species, although catching prey presupposes different hunting techniques. One type of prey may be preferred, but the predator has the ability to survive or even breed (mostly with lower success rates) by using alternative prey species (e.g. Korpimäki & Sulkava 1990). Versatile predators are often opportunistic hunters, which hunt prey that are easy to catch and provide the best in energy economy (good size and catchability). Opportunists also can easily shift to other (alternative) prey types.

The White-tailed Eagle is an extremely versatile predator. It catches prey from under the water (fish) and on the water surface (waterfowl), but it can also catch prey on land and in the air. In addition, it sometimes harasses other birds such as gulls, crows and Ospreys in order to rob them of their prey (Helander 1983), and it scavenges carcasses as a common source of nutrition (especially

in winter). Birds are mostly caught from the water surface, and it is rare for it to catch a bird in flight, although even this has been reported on a number of occasions (Oehme 1975, Koivusaari 1980, Helander 1983).

The versatile hunting capacity of the White-tailed Eagle is also evident from the new prey material collected from different areas in Finland. The generalist nature of the species is reflected in the fact that it is capable of hunting a wide variety of prey species (see Appendix). According to Koivusaari (1980), the White-tailed Eagle seems to prey on species which occur most abundantly in its hunting range and are easiest to catch, i.e. its hunting behaviour is primarily opportunistic and optimal from the point of view of energy economy.

The diet of the White-tailed Eagle is, of course, also affected by the hunting habitat, which is mainly wetland habitats. Therefore, prey species in these habitats are caught relatively more often than land birds and land mammals in the same area. The latter are the main prey species of the Golden Eagle (e.g. Sulkava 1967). For example, the White-tailed Eagle rarely preys on hares (1.4%, Appendix) as compared with the Golden Eagle (hares in diet 21–33%, Sulkava 1967 and unpubl.). With this in mind, it is, however, interesting to note that the proportion of mountain hares in the diet of White-tailed Eagles taken from Norway to Scotland is almost 10 times greater (20.3%) than in Finland, which indicates that White-tailed Eagles are, when necessary, well capable of hunting on land and catching hares, although these often seem to be avoided.

*Acknowledgements.* The authors express their gratitude to the WWF White-tailed Eagle working group in Finland, of which many of the members have recorded the diet material presented in the present paper, and to Oskar Öflund's Stiftelse Foundation for their financial support for the identification of the material by Risto Tornberg and Kauko Huhtala. The paper was translated into English by Antti Rönkkö and Malcolm Hicks. We are most grateful also to Hannu Pietiäinen, Henrik Wallgren and two anonymous referees for the many valuable comments on the drafts of this paper.

## Selostus: Merikotkan ravinto Suomessa

Vuosittaista ravintoaineistoa on merikotkan pesintä talletettu vuodesta 1964 alkaen (J. Koivusaari),

ja vuosina 1978–94 useat WWF:n merikotkatyöryhmän jäsenet keräsivät saalisjätteitä Suomen kaikilta merikotkan pesimisalueilta. Merikotkan saalisjäteaineiston suurin virhelähde lienee kalojen aliedustus (haukea pehmeäpääisemmistä ja varsinkin pienistä kaloista jää niukasti jätteitä). Aliedustettuja ovat ilmeisesti myös pienehköt linnut ja nisäkkäät, joiden jätteitä löytyy useimmiten vain oksennuspalloista.

Ravinnossa on (aineiston mukaan) lounaisilla merialueilla ja Merenkurkussa 59–65% lintuja, Lapissa sen sijaan vain vajaa kolmannes. Tärkeimmät saalislinnut ovat merialueilla haahka (ei kuitenkaan Merenkurkussa), koskelot, sinisorsa, telkkä, pilkkasiipi ja sotkat, Lapissa koskelot, sinisorsa ja riekko. Lokkilajien runsaslukuisuudesta huolimatta niiden osuudet ravinnossa ovat useimmiten vähäisiä (Merenkurkussa kuitenkin naurulokki on tärkeä saalis). Nisäkkäitä merikotka syö Suomessa vain vähän (yhteensä 4–10%), useimmin piisameja. Hauki on kaikilla Suomen merikotka-alueilla tärkein yksittäinen saalislaji, Ahvenanmaalla 19%, Merenkurkussa 25% ja Lapissa 53% todetuista saalisryhmistä. Säyneitä aineistossa on 3–4%, muita kaloja yhteensä 3–10%. Kalojen kokonaisuus on Lapissa kaksi kolmannesta, Merenkurkussa 32% ja Ahvenanmaalla vain 27%.

Useiden vesilintujen osuudet merikotkan ravinnossa ovat pienentyneet 1964–90, mutta haahkan osuus on selvästi kasvanut johtuen haahkan voimakkaasta runsastumisesta. Merikotka näyttää Suomessa suosivan saaliinaan 1–2 kg:n painoisia vesilintuja. Joutsenet ovat merikotkallekin liian suuria saaliita. Vaikka saalistus useimmiten painottuu vesien eläimistöön, merikotka on monipuolinen petolintu, joka kykenee saalistamaan myös sisämaassa, missä myös metsäkanalinnut ja jänis voivat olla tärkeitä saaliita. Sisämaassa ravinnonsaanti voi kuitenkin olla merikotkalle yleisesti niukempaa kuin rannikoilla.

## References

- Berman, G. 1982: Population dynamics, colony formation and competition in *Larus argentatus*, *fuscus* and *marinus* in the archipelago of Finland. — *Ann. Zool. Fennici* 19: 143–164.
- Colwell, R. & Futuyma, D. 1971: On the measurement of niche breadth and overlap. — *Ecology* 52: 567–576.
- Fischer, W. 1982: Die Seeadler. — *Die Neue Brehm-Bücherei*. A. Ziemsen Verlag, Wittenberg-Lutherstadt.

- Häkkinen, I. & Jokinen, M. 1974: Jäniksen talviekologiasta ulkosaaristossa (On the winter ecology of the snow hare, *Lepus timidus*, in the outer archipelago). — Suomen Riista 25: 5–14.
- Hario, M. & Selin, K. 1988: Thirty-year trends in an eider population: timing of breeding, clutch size, and nest site preferences. — Finnish Game Res. 45: 3–10.
- Helander, B. 1981: Nestling measurements and weights from two White-tailed Eagle populations in Sweden. — Bird Study 28: 235–241.
- Helander, B. 1983: Reproduction of the White-tailed Sea Eagle *Haliaeetus albicilla* (L.) in Sweden, in relation to food and residue levels of organochlorine and mercury compounds in the eggs. — Ph.D.-thesis, Univ. of Stockholm, Dept. of Zoology.
- Hildén, O. & Hario, M. 1993: Muuttuva saaristolinnusto. — Forssa.
- Hildén, O., Ulfvens, J., Pahtamaa, T. & Hästbacka, H. 1995: Changes in the archipelago bird populations of the Finnish Quark, Gulf of Bothnia, from 1957–60 to 1990–91. — Ornis Fennica 72: 115–126.
- Hyytiä, K., Kellomäki, E. & Koistinen, J. (toim.) 1983: Suomen lintuatlas. — SLY:n Lintutieto Oy, Helsinki.
- Koivusaari, J. 1980: Merikotkan (*Haliaeetus albicilla* L.) ravintobiologiasta (“On the nutritional biology of the Sea Eagle”). — Unpubl. Ph.lic.-thesis, Univ. of Kuopio. (In Finnish.)
- Koivusaari, J. 1988: Merenkurkun merikotkain perikato II. — Suomen Luonto 47 (3): 13–17.
- Koivusaari, J., Nuuja, I. & Palokangas, R. 1980: Uhattu Merikotka. — Gummerus, Jyväskylä.
- Korpimäki, E. & Sulkava, S. 1990: Does the year-to-year variation in the diet of eagle and Ural owls support the alternative prey hypothesis? — Oikos 58: 47–54.
- Kulves, H. 1973: Havsörnens (*Haliaeetus albicilla albicilla* L.) ekologi på Åland. — Skrifter utgivna av Ålands kulturstiftelse IX: 1–126. Mariehamn.
- März, R. 1987: Gewöll- und Ruffungskunde. — Akademie-Verlag Berlin.
- Oehme, G. 1975: Zur Ernährung des Seeadlers, *Haliaeetus albicilla* (L.), unter besonderer Berücksichtigung der Population in den drei Nordbezirken der DDR. — Inaugural-Dissertation, Ernst-Moritz-Armdt-Universität Greifswald.
- Siivonen, L. & Sulkava, S. 1994: Pohjolan Nisäkkäät. — Otava, Keuruu.
- Stjernberg, T. 1983: Havsörnarnas häckningsresultat i Finland 1970–82 (The reproductive success of the White-tailed Eagle in Finland during 1970–82). — Lintumies 18: 35–43.
- Sulkava, S. 1966: Zur Nahrung des Steinadlers, *Aquila chrysaetos* (L.), in Finnland südlich vom Rentierzuchtgebiet. — Aquilo, Ser. Zool. 5: 1–13.
- Ulfvens, J. 1988: Comparative breeding ecology of the Horned Grebe *Podiceps auritus* and the Great Crested Grebe *Podiceps cristatus*: arcipelago versus lake habitats. — Acta Zool. Fennica 1983: 1–75.
- von Haartman, L., Hildén, O., Linkola, P., Suomalainen, P. & Tenovuo, R. 1963–72: Pohjolan Linnut Värikuvoin. — Otava, Helsinki.
- Watson, J., Leitch, A. & Broad, R. 1992: The diet of the Sea Eagle *Haliaeetus albicilla* and Golden Eagle *Aquila chrysaetos* in western Scotland. — Ibis 134: 27–31.
- Wille, F. & Kampp, K. 1983: Food of the White-tailed Eagle *Haliaeetus albicilla* in Greenland. — Holarctic Ecol. 6: 81–88.
- Willgohs, J. F. 1961: The White-tailed Eagle *Haliaeetus albicilla albicilla* (Linné) in Norway. — Acta Univ. Bergensis, Ser. Math. Rer.-Nat. 12: 1–212.
- Willgohs, J. F. 1984: Havörn i Norge, naering, forplantningsökologi, konkurrenter og fiender. — Viltrapport 27: 1–81.
- Zimin, V., Koivusaari, J., Nuuja, I. & Palokangas, R. 1981: Pohjois-Euroopan merikotkat: Karjalan ASNT:n ja Muurmanin alueen merikotkatilanteen kehitys vuoteen 1980. — Ornis Karelica 2: 35–54.

Appendix. Prey species and their numbers and percentages in the diet of the White-tailed Eagle in Finland by number of prey items, as indicated by prey remnants collected from the Åland Islands, the Quark region and Lapland in 1978–90.

	Åland		Quark		Lapland	
	n	%	n	%	n	%
Pike, <i>Esox lucius</i>	254	19.1	271	25.4	397	53.0
Ide, <i>Leuciscus idus</i>	57	4.3	41	3.8	23	3.1
Bream, <i>Abramis brama</i>	9	0.7	3	0.3	—	—
Roach, <i>Leuciscus leuciscus</i>	8	0.6	8	0.7	5	0.7
Crucian carp, <i>Cyprinus carassius</i>	4	0.3	—	—	—	—
Cyprinidae sp.	5	0.4	3	0.3	—	—
Perch, <i>Perca fluviatilis</i>	11	0.8	8	0.7	22	2.9
Burbot, <i>Lota lota</i>	2	0.2	1	0.1	34	4.5
Cod, <i>Gadus callarias</i>	2	0.2	4	0.4	—	—
Flounder, <i>Pleuronectes flesus</i>	6	0.5	—	—	—	—
White fish, <i>Coregonus lavaretus</i>	—	—	—	—	13	1.7

Continues ...

Appendix. Continued.

	Åland		Quark		Lapland	
	n	%	n	%	n	%
Trout, <i>Salmo trutta</i>	1	0.1	–	–	–	–
Pisces sp.	4	0.3	–	–	–	–
Pisces, total	363	27.3	339	31.7	504	67.2
Black-throated Diver, <i>Gavia arctica</i>	–	–	2	0.2	2	0.3
Great Crested Grebe, <i>Podiceps cristatus</i>	37	2.8	22	2.1	–	–
Red-necked Grebe, <i>Podiceps grisegena</i>	9	0.7	4	0.3	–	–
Horned Grebe, <i>Podiceps auritus</i>	–	–	2	0.2	–	–
Cormorant, <i>Phalacrocorax carbo</i>	1	0.1	1	0.1	–	–
Mallard, <i>Anas platyrhynchos</i>	69	5.2	44	4.1	28	3.7
Teal, <i>Anas crecca</i>	3	0.2	5	0.5	29	3.9
Wigeon, <i>Anas penelope</i>	–	–	1	0.1	4	0.5
Shoveler, <i>Anas clypeata</i>	–	–	2	0.2	–	–
Pintail, <i>Anas acuta</i>	–	–	–	–	4	0.5
<i>Anas</i> sp.	4	0.3	–	–	22	2.9
Tufted Duck, <i>Aythya fulvicula</i>	47	3.5	49	4.6	7	0.9
Scaup, <i>Aythya marila</i>	4	0.3	25	2.3	–	–
Pochard, <i>Aythya ferina</i>	3	0.2	6	0.6	–	–
Diving ducks, <i>Aythya</i> sp.	15	1.1	30	2.8	–	–
Goldeneye, <i>Bucephala clangula</i>	68	5.1	20	1.9	3	0.4
Long-tailed Duck, <i>Clangula hyemalis</i>	5	0.4	–	–	–	–
Velvet Scoter, <i>Melanitta fusca</i>	65	4.9	18	1.7	–	–
Common Scoter, <i>Melanitta nigra</i>	13	1.0	2	0.2	–	–
Eider, <i>Somateria mollissima</i>	197	14.8	38	3.6	–	–
Red-breasted Merganser, <i>Mergus serrator</i>	39	2.9	41	3.8	6	0.8
Goosander, <i>Mergus merganser</i>	71	5.3	31	2.9	10	1.3
<i>Mergus</i> sp.	27	2.0	23	2.2	2	0.3
Anatidae sp.	33	2.5	25	2.3	1	0.1
Shelduck, <i>Tadorna tadorna</i>	2	0.1	–	–	–	–
<i>Anser</i> sp.	8	0.6	2	0.2	11	1.5
<i>Cygnus</i> sp.	1	0.1	–	–	–	–
Goshawk, <i>Accipiter gentilis</i>	2	0.2	–	–	–	–
Sparrow Hawk, <i>Accipiter nisus</i>	1	0.1	–	–	–	–
Osprey, <i>Pandion haliaetus</i>	–	–	2	0.2	–	–
Honey buzzard, <i>Pernis apivorus</i>	1	0.1	–	–	–	–
Peregrine Falcon, <i>Falco peregrinus</i>	–	–	–	–	1	0.1
(White-tailed Eagle pull.)	(1)	(0.1)	–	–	–	–
Black Grouse, <i>Tetrao tetrix</i>	17	1.3	24	2.2	4	0.5
Capercaillie, <i>Tetrao urogallus</i>	–	–	4	0.4	9	1.2
Willow Grouse, <i>Lagopus lagopus</i>	–	–	–	–	15	2.0
Domestic Hen, <i>Gallus domesticus</i>	1	0.1	–	–	–	–
Oystercatcher, <i>Haematopus ostralegus</i>	3	0.2	–	–	–	–
Woodcock, <i>Scolopax rusticola</i>	1	0.1	–	–	–	–
Lapwing, <i>Vanellus vanellus</i>	1	0.1	–	–	1	0.1
Ruff, <i>Philomachus pugnax</i>	–	–	–	–	13	1.7
Whimbrel, <i>Numenius phaeopus</i>	–	–	–	–	2	0.3
Wood Sandpiper, <i>Tringa glareola</i>	–	–	–	–	1	0.1
Snipe, <i>Capella gallinago</i>	–	–	–	–	1	0.1
Ringed Plover, <i>Charadrius hiaticula</i>	–	–	–	–	1	0.1
Charadriidae–Scolopacidae sp.	–	–	2	0.2	–	–
Coot, <i>Fulica atra</i>	7	0.5	2	0.2	–	–

Continues ...

## Appendix. Continued.

	Åland		Quark		Lapland	
	n	%	n	%	n	%
Crane, <i>Grus grus</i>	–	–	–	–	4	0.5
<i>Stercorarius</i> sp.	–	–	1	0.1	–	–
Great Black-backed Gull, <i>Larus marinus</i>	–	–	1	0.1	–	–
Lesser Black-backed Gull, <i>Larus fuscus</i>	1	0.1	4	0.4	1	0.1
Herring Gull, <i>Larus argentatus</i>	23	1.7	23	2.2	6	0.8
Common Gull, <i>Larus canus</i>	4	0.3	17	1.6	3	0.4
Black-headed Gull, <i>Larus ridibundus</i>	30	2.3	107	10.0	7	0.9
<i>Sterna</i> sp.	7	0.5	–	–	2	0.3
Laridae sp.	2	0.2	8	0.8	3	0.4
Razorbill, <i>Alca torda</i>	4	0.3	2	0.2	–	–
<i>Uria</i> sp.	–	–	1	0.1	–	–
Black Guillemot, <i>Cepphus grylle</i>	6	0.5	12	1.1	–	–
Wood Pigeon, <i>Columba palumbus</i>	4	0.3	6	0.6	–	–
Hawk Owl, <i>Surnia ulula</i>	–	–	–	–	2	0.3
Short-eared Owl, <i>Asio flammeus</i>	–	–	1	0.1	–	–
Tengmalm's Owl, <i>Aegolius funereus</i>	–	–	–	–	1	0.1
Hooded Crow, <i>Corvus cornix</i>	24	1.8	14	1.3	12	1.6
Raven, <i>Corvus corax</i>	–	–	2	0.2	2	0.3
Fieldfare, <i>Turdus pilaris</i>	2	0.2	–	–	–	–
Starling, <i>Sturnus vulgaris</i>	–	–	1	0.1	–	–
Waxwing, <i>Bombycilla garrulus</i>	–	–	1	0.1	–	–
Tree Pipit, <i>Anthus trivialis</i>	–	–	–	–	1	0.1
Great Spotted Woodpecker, <i>Dendrocopos major</i>	–	–	1	0.1	–	–
Aves sp.	4	0.3	1	0.1	–	–
Birds, total	869	65.3	630	58.8	219	29.2
Muskrat, <i>Ondatra zibethica</i>	60	4.5	60	5.5	2	0.3
Mountain hare, <i>Lepus timidus</i>	22	1.7	15	1.6	6	0.8
Mink, <i>Mustela vison</i>	–	–	11	1.0	1	0.1
Red fox, <i>Vulpes vulpes</i>	1	0.1	4	0.4	–	–
Cat, <i>Felis domestica</i>	1	0.1	1	0.1	–	–
Norwegian lemming, <i>Lemmus lemmus</i>	–	–	–	–	4	0.5
Cricetidae sp.	–	–	3	0.3	1	0.1
Red squirrel, <i>Sciurus vulgaris</i>	3	0.2	–	–	1	0.1
Roe deer, <i>Capreolus capreolus</i>	7	0.5	–	–	–	–
Pig, <i>Sus scrofa</i> (carcass)	–	–	6	0.6	–	–
Elk, <i>Alces alces</i> (carcass)	–	–	3	0.3	–	–
Reindeer, <i>Rangifer tarandus</i> (carcass)	–	–	–	–	7	0.9
Reindeer fawn, <i>Rangifer tarandus</i> juv.	–	–	–	–	3	0.5
Hedgehog, <i>Erinaceus europaeus</i>	1	0.1	–	–	–	–
Mammalia sp.	1	0.1	–	–	–	–
Mammals, total	98	7.4	103	9.6	27	3.6