# Diet of the Golden Eagle *Aquila chrysaetos* (L.) in Gotland, Sweden during the breeding season

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## Introduction

Within certain limits a characteristic feature of the Golden Eagle is the flexibility of prey choice (see e.g. Glutz von Blotzheim et al 1971). The bird mainly requires rather large prey animals to satisfy its need for energy. Black Grouse *Tetrao tetrix,* Capercaillie *Tetrao urogallus* and hares *Lepus* spp. are the commonest prey in the Palearctic (Lunde 1985, Randla 1976, Semenow-Tjan-Šanskij 1960, Sulkava et al. 1984, Tjernberg 1983). The Golden Eagle also eats carrion.

During 1978–1983 we studied how the prey choice of the Golden Eagle was influenced by the composition of the specific fauna in Gotland. Only about 23% of the indigenous species of mammals of Sweden exists on this island in the middle of the Baltic Sea (Noréhn 1959) and tetraonids are nearly absent (Gustafsson & Högström 1981).

## Material and methods

### Study area

Gotland is situated in the Baltic 90 km from Sweden's east coast and 150 km from Estonia. The island has an area of 3172 km$^2$, of which 1381 km$^2$ are forests, chiefly pine dominated (SCB 1979). The hunting areas of the eagles consist of pine forests with many small fens and clearings and even wide open seashores and treeless pastures. The winters are often mild, generally with snow covered ground for 2–3 months.

### Collection of prey remains

The nests were visited mainly from July to October. We made on average four visits to each nest where eagles were breeding. At the beginning of this time young eagles had left or were just leaving the nests. They often stayed in the vicinity of the nest if they were not disturbed and continuously left fresh prey remains. Collecting was carried out below the nest trees and in the immediate vicinity and only exceptionally in the nest. The prey remains consisted of fells, carcasses, skeletal parts, feathers and pellets.

### Classification of prey remains

The bird sternum was classified in accordance with Selstam & Selstam (1973) and other skel-

etal parts of birds according to our own reference collection, containing about 700 bones (cranium, sternum, pelvis, humerus, ulna, coracoideum, scapula, furcula, femur and tibiotarsus/fibula) from 229 individuals of 45 species. For the determination of feathers we used the collection in the Nature Museum of Gotland. Mammals were determined according to e.g. Gyldenstolpe & Bergström (1953), Brinck (1958) and Siivonen (1976), and skeletal parts of the three lagomorph species were borrowed from the Zoological Museum, University of Uppsala. The variation in the skeletal parts of the hares was large and the characters given in the literature and shown in the reference material were not always compatible with our findings. Nearly half of the hare samples, mostly young animals, could therefore not be classified.

## Estimation of number and weight of prey animals

For estimating the number of a prey species we counted the most plentiful items (skeletal parts, fells, feathers) at a nest during one season. Pellets played only a minor role in indicating additional prey species. A small number of feathers in pellets could be classified, as well as squirrel claws and hedgehog spines. The weights of

Table 1. Prey species of the Golden Eagle during the breeding season in Gotland 1978–1983.

| Species | Number | Species | Number |
|---|---|---|---|
| Hedgehog *Erinaceus europeus* | 274 | Lapwing *Vanellus vanellus* | 1 |
| Rabbit *Oryctolagus cuniculus* | 109 | Snipe *Gallinago gallinago* | 1 |
| Brown Hare *Lepus europeus* | 3 | Woodcock *Scolopax rusticola* | 4 |
| Mountain Hare *Lepus timidus* | 27 | Snipe / Woodcock *Gallinago gallinago / Scolopax rusticola* | 1 |
| *Lepus spp.* | 25 | Curlew *Numenius arquata* | 5 |
| *Lepus /Oryctolagus* | 1 | *Charadriidae / Scolopacidae* | 1 |
| Red Squirrel *Sciurus vulgaris* | 9 | Black-headed Gull *Larus ridibundus* | 3 |
| Brown Rat *Rattus norvegicus* | 1 | Common Gull *Larus canus* | 2 |
| Red Fox *Vulpes vulpes* | 1 | Herring Gull *Larus argentatus* | 2 |
| Domestic Cat *Felis domesticus* | 3 | *Larus spp.* | 4 |
| Domestic Sheep *Ovis spp.* | 7 | Guillemot *Uria aalge* | 2 |
| Bittern *Botaurus stellaris* | 1 | Stock Dove *Columba oenas* | 6 |
| Brent Goose *Branta bernicla* | 1 | Wood pigeon *Columba palumbus* | 6 |
| *Branta / Anser* | 5 | *Columba spp.* | 5 |
| Shelduck *Tadorna tadorna* | 3 | Long-eared Owl *Asio otus* | 1 |
| Mallard *Anas platyrhynchos* | 56 | Black Woodpecker *Dryocopus martius* | 1 |
| Eider *Somateria mollissima* | 10 | Fieldfare *Turdus pilaris* | 1 |
| Long-tailed Duck *Clangula hyemalis* | 5 | Raven *Corvus corax* | 1 |
| Velvet Scoter *Melanitta fusca* | 5 | Hooded Crow *Corvus corone* | 22 |
| *Aythinae* | 1 | *Corvus spp.* | 2 |
| *Anatinae / Aythinae* | 8 | *Aves indet* | 7 |
| Red-breasted Merganser *Mergus serrator* | 4 | | |
| Goosander *Mergus merganser* | 1 | Grass snake *Natrix natrix* | 1 |
| Buzzard *Buteo buteo* | 3 | | |
| Black Grouse *Lyrurus tetrix* | 1 | | |
| Domestic Fowl *Gallus gallus* | 1 | Mammals *Mammalia* | 460 |
| Domestic Fowl / Pheasant *Gallus gallus / Phasianus colchicus* | 6 | Birds *Aves* | 191 |
| | | Reptiles *Reptilia* | 1 |
| Crane *Grus grus* | 1 | | |
| Oystercatcher *Haemotopus ostralegus* | 1 | Number of prey items | 652 |

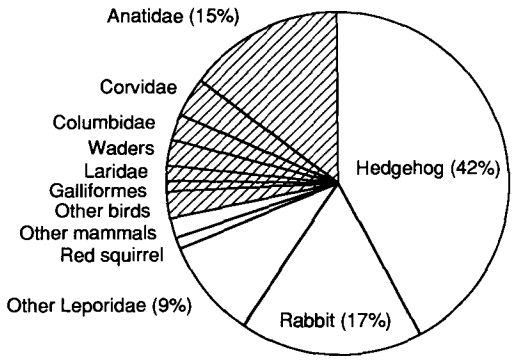


Fig. 1. Distribution of prey categories of the Golden Eagle in Gotland during the breeding season, in terms of number of prey items.

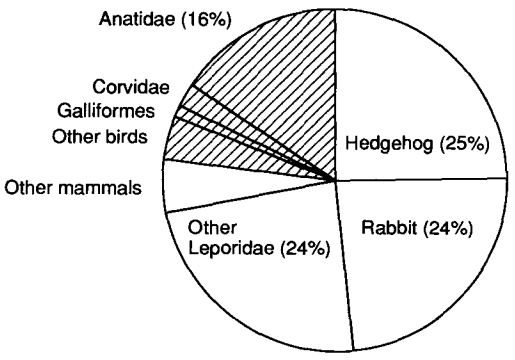


Fig. 2. Distribution of prey categories of the Golden Eagle in Gotland during the breeding season, in terms of prey weight.

mammals were mainly taken from Brinck (1958) and Siivonen (1976) and of birds from Černý (1981) and Haftorn (1971). For hares we used the following values: brown hare 4.6 kg, mountain hare 4.0 kg and undefined, mostly young, hare 3.5 kg.

Known sources of error are e. g. that larger prey animals are overestimated, that female eagles take away prey remains from the nests, that loose feathers and hairs blow away from the nest or are taken away by other animals, and that adult eagles feed upon the same prey as their young (see e. g. Lunde 1985). In addition to these known sources of error we had to consider the removal of prey remains by human beings to protect the nest from discovery. A check of our dates shows that the removal affects all prey categories rather equally.

## Results

The material (see Table 1) consists of the remains of 652 animals, representing 39 species, 9 of which are mammals, 29 birds and 1 reptile. The hedgehog numerically dominates among the prey, followed by the rabbit, ducks and hares. These four groups make up 85% of the number (Fig. 1). With regard to weight, these groups make up 88% of the estimated prey biomass, which is 880 kg (Fig. 2). The mean weight per animal then becomes 1.3 kg.

### Comments on the choice of prey

*Rabbit.* During the first breeding period of the eagles in Gotland in the 1950s, the rabbits prob-

Table 2. Distribution of some prey categories (%) from three different territories of the Golden Eagle in Gotland 1978–1983. In territories 2 and 3 alternative nests were used in different years.

| Territory | 1 | 2 | 3 |
|---|---|---|---|
| Distance from the coast | 8 km | 1 resp. 2 km | 0.5 resp. 2 km |
| Number of prey items | 109 | 250 | 100 |
| Mammals | 68 | 77 | 71 |
| Anatidae | 4 | 17 | 25 |
| Other birds | 28 | 6 | 4 |

ably made up a larger part of the prey animals. Nowadays the rabbit population is only about 3% of its size in 1962–63, when it peaked, according to hunting statistics (Svenska Jägarförbundet 1980–1984).

*Other animals*. No bones of small rodents were observed in pellets. This indicates that small rodents do not form a part of the food of Golden Eagles in Gotland. Other investigations have shown that small rodents may be present in the diet of Golden Eagles (Lockie1964, Delibes et al. 1975, Sulkava et al. 1984).

The percentage of lambs is extremely low considering that, during the actual study period, a quarter of a million lambs were born in Gotland (SCB 1978–1983). A great deal of them were born outdoors. About 20 000 lambs died before the lamb census in June (Gotlands Läns Hushållsningssällskap 1984).

## Choice of prey animals in relation to distance from the coast

A survey of various prey items from three territories with high concentrations of prey animals is given in Table 2. The percentage of mammals was similar for eagles with territories including a coastline and those without a coastline. With respect to bird prey, there was a distinct difference. A large proportion (17–25%) of the prey items of the eagles hunting on the seashore were ducks. The pair breeding in the interior compensated for this supply by taking a larger quantity

Table 3. Proportions (%) of animal categories as prey for nesting Golden Eagles in different European regions. Sources: 1) Glutz von Blotzheim et al. 1971, 2) This study, 3) Delibes et al. 1975, 4) Randla 1976, 5) Semenov-Tjan-Sanskij 1960, 6) Glutz von Blotzheim et al. 1971, 7) Sulkava et al. 1984, 8) Tjernberg 1983 and 9) Lunde 1983.

| Region | 1 The Alps | 2 Gotland | 3 Spain | 4 Estonia | 5 Northern Soviet | 6 Scotland | 7 Finland | 8 Northern Sweden | 9 Norway |
|---|---|---|---|---|---|---|---|---|---|
| Birds | 19.0 | 29.3 | 33.8 | 41 | 47.0 | 53.6 | 63.0 | 66.0 | 71.5 |
| Mammals | 80.8 | 70.6 | 51.7 | 59 | 52.5 | 46.4 | 36.9 | 34.0 | 26.5 |
| Other animals | 0.2 | 0.1 | 14.5 | – | 0.5 | – | 0.2 | – | 2.0 |
| *Galliformes* | 13.8 | 1.2 | 24.7 | 34 | 40.0 | 52.6 | 50.3 | 54.0 | 52.0 |
| *Anatidae* | 0.2 | 15.2 | – | 3 | – | – | 5.9 | 3.8 | 4.5 |
| *Grus grus* | – | 0.2 | – | 2 | – | – | 2.9 | 0.6 | 0.8 |
| *Corvidae* | 2.6 | 3.8 | 4.2 | } 2 | – | 0.5 | 1.7 | 4.2 | 2.7 |
| Other birds | 2.4 | 8.9 | 4.9 | | 7.0 | 0.5 | 2.3 | 3.3 | 11.5 |
| *Leporidae* | 10.2 | 25.3 | 48.1 | 27 | 34.5 | 42.2 | 25.1 | 20.6 | 10.7 |
| *Perissodactyla* and *Artiodactyla* | 14.5 | 1.1 | 0.4 | 5 | 6.5 | 1.9 | 6.3 | 8.2 | 5.8 |
| *Rodentia* | 50.8 | 1.5 | 1.5 | 4.0 | 4.0 | 1.9 | } 5.5 | 1.7 | 1.4 |
| Other mammals | 5.2 | 42.6 | 1.6 | 23 | 7.5 | 0.5 | | 3.5 | 8.6 |
| Numbers of prey | 421 | 652 | 669 | 279 | 127 | 211 | 5562 | 2803 | 513 |

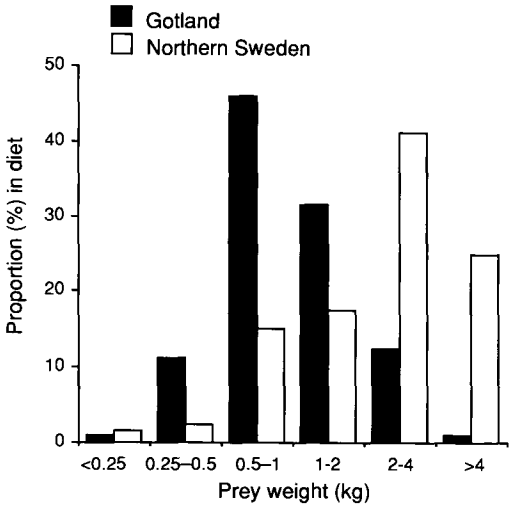


Fig. 3. Weight classes of prey animals taken by Golden Eagle during the breeding season. Gotland (n = 652; black columns) and the coniferous region in northern Sweden (n = 2137, after Tjernberg 1983; white columns).

of other birds. This difference is significant ($\chi^2 = 55.91$, $P < 0.001$, $df = 4$).

## Discussion

The mean weight per prey animal from Gotland, 1.3 kg, can be compared with the figures of Tjernberg (1983), who gives a mean weight of 2.8. kg. It is the great number of small prey items in Gotland that reduces the mean weight (Fig. 3). The difference if significant ($\chi^2 = 617.79$, $P < 0.001$, $df = 5$). As a consequence the Gotland eagles have to catch almost double the number of prey items as those in North Sweden to obtain an equivalent quantity of food. In Table 3 we have put together the prey categories from nine regions of Europe. Gotland differs from the other eight regions with regard to three prey animals:

1) Fowl, which often make up a great deal of the number of prey animals in other regions, were almost completely missing in Gotland.
2) Ducks were found to a larger extent in Gotland than in any other region.
3) The group "Remaining mammals" shows a large divergence in Gotland. In other parts of Europe (apart from Estonia) this proportion is much lower. In Gotland the hedgehog dominates within this group.

In most European countries Leporidae are the second most important prey group by number (after the fowl). In Gotland Leporidae are also an important group, being the most important after the hedgehog. With regard to weight Leporidae form the foremost prey group in Gotland.

When one of the normal prey groups, tetraonids, are lacking, Golden Eagles compensate for this with a higher proportion of ducks and hedgehogs (Table 3).

## Sammanfattning: **Näringsval hos gotländska kungsörnar *Aquila chrysaetos* (L.) under häckningstid**

Kungsörnens bytesval under häckningstid på Gotland har studerats under åren 1978–1983. Insamlade bytesrester härrör från 652 individer av 39 arter. De dominerande bytesdjuren var igelkott, vildkanin, änder och harar. En signifikant skillnad i näringsvalet föreligger mellan örnar som häckar vid kusten och i inlandet. De förra fångade fler änder medan de senare tog fler andra fåglar. Medelvikten hos bytesdjuren på Gotland (1.3 kg) är knappt hälften mot i norra Sverige. Kungsörnars näringsval på Gotland skiljer sig från olika delar av Europa genom en högre andel änder och igelkottar och en låg andel hönsfåglar, vilket är en anpassning till den gotländska faunans sammansättning.

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