

The diet of the lynx *Lynx lynx* in Norway

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Stomach content analyses show that roe deer *Capreolus capreolus* and reindeer *Rangifer tarandus* constitute the most important food for the lynx *Lynx lynx* in Norway, particularly during winter. Other important prey items are hares and tetraonids. A change in the diet of females occurs around December towards a higher proportion of cervids. It appears that the lynx has a good food supply in mid-winter in areas with rich populations of cervids.

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INTRODUCTION

In Europe the lynx *Lynx lynx* is one of the larger predatory mammals, and currently occurs in much of Norway (Myrberget 1970). According to Haglund (1966), most studies have demonstrated that hares (Leporidae) and deer (Cervidae) make up the main food of the lynx. The living conditions of the lynx in Norway are similar to those in Sweden where Haglund (1966) showed that before mid-winter a change occurred from a diet dominated by small game to one dominated by cervids.

This is a study of the diet of the lynx in Norway based on examination of stomach contents of animals which had been either trapped or shot. The data are analysed according to region, season, sex and age classes. Most of the data were collected during winter.

MATERIAL AND METHODS

A condition for payment of the State bounty for lynx in Norway is that the corpse is sent to the Norwegian State Game Research Institute. All animals received during the period 1.7.1960–1.7.1967 were available for this study. Most lynx were killed during January–April (Figure 1).

Data were collected from a sample of 170 stomachs (102 male and 68 female). The total number of lynx harvested in Norway during the study period was 218, but in some cases the bodies were lacking or the stomachs had to be discarded. Most animals came from mid-Norway (68 from Nord-Trøndelag county) and from the southern part of northern Norway (58 from Nordland county).

All animals were categorized as «young» (up to 1 year) or «adult» depending on tooth development (Lindemann 1955). In both males and females, 20% were «young».

The volume of food was measured directly in a cylinder. The larger prey animals were identified by hair analyses, while also other remains were used to identify smaller mammals. The hairs were sorted into types, and prints were made in shellac of five hairs of each type. Comparative material from potential prey was used for identification of species, together with descriptions in literature, mainly from Mayer (1952), Day (1966) and Birkeland et al. (1972). In the case of birds, usually only the shafts of feathers, or just a few feathers, were present; in most cases these could not be identified to species.

To study geographical differences in lynx habits, the country was divided into three areas. The county of Nord-Trøndelag (approximately 63°15'N–65°05'N) was treated as the «central» area; to the north of this was the «northern» and to the south the «southern» area.

RESULTS

Seventeen stomachs (10%) were completely empty. Of the remainder, 26 stomachs had no measurable content, i.e. they had only traces of food such as individual hairs.

The mean value of the content in 127 stomachs with measurable amounts of animal or plant material was 206 cm³. The largest volume was 2200 cm³, a stomach containing a cat. The males showed a significantly lower average volume in February (75 cm³) than in other months ($t = 4.87$, $0.01 > p > 0.001$).

Tab. 1. Frequency of occurrence of different animal species in 146 stomachs of lynx.

	Number	Per cent
Reindeer	57	31
Roe deer	32	17
Moose	1	0.5
Unidentified cervids	8	4
Hares	35	19
Small rodents	14	8
Wild carnivores	7	4
Sheep	7	4
Other domestic mammals	2	1
Unidentified mammals	1	0.5
Birds	19	10
Fish	2	1

Of 146 stomachs with animal remains, 114 contained one species, 25 held two species, and 7 had three species, i.e. an average of 1.3 species per stomach.

Table 1 gives the frequency of different animal species found in the stomachs. Of the 185 identified animals, 164 were mammals (89%), mainly cervids (53%). The most common cervids were reindeer *Rangifer tarandus* and roe deer *Capreolus capreolus*, but the material also included one moose calf *Alces alces*. Blue hares *Lepus timidus* constituted 19%. There were also one cat and one pig (from bait for a trap). Two red foxes *Vulpes vulpes* and three mustelids (Mustelidae) were identified among the wild carnivores.

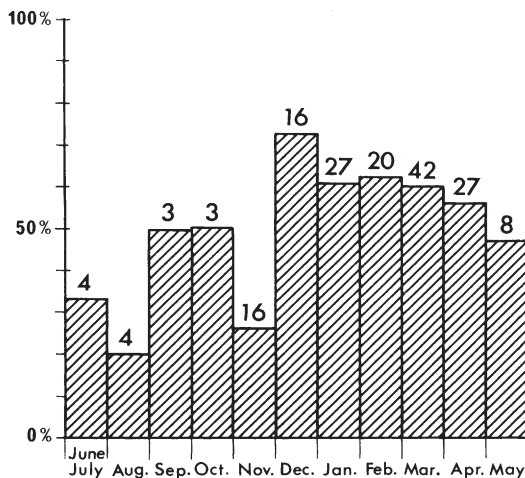


Fig. 1. Number of cervids as a percentage of the total number of prey in different months. The numbers over the columns show the number of stomachs examined.

Most lynx stomachs examined from the winter contained lynx hairs and two contained much lynx hair and some claws. The presence of worn teeth in the jaws of these lynx suggested that they had gnawed on hard material and had probably been trapped. Therefore it seems likely that the lynx remains were derived from the animals themselves during the struggle to escape.

The bird included one egg, three ptarmigan *Lagopus* spp., and two black grouse *Lyrurus tetrix*. In one case only the intestines of a bird were found. One fish was identified as catfish *Anarhichas lupus*.

In late autumn there was a change in food composition towards an increasing percentage of cervids (Fig. 1). From May-November, 18 of 35 food animals (51%) were cervids, while from December-April the number was 80 of 111 (73%). When dividing the material on the basis of sex and age, however, there was no difference in the occurrence of cervids in the two seasons for adult males (65% and 67% respectively), while the difference was marked for adult females (39% and 67%).

For «young» lynx, 17 out of 35 food animals (50%) were cervids. In winter, two young animals were shot close to farmhouses; one had earlier eaten from the head of a reindeer inside a barn and the next day stolen a catfish.

Seven of the stomachs contained only plant remains. In total, 59 stomachs (35%) contained various amounts of vegetable matter. Often stomachs contained small twigs, about 3–4 cm long and 1–5 mm thick, the largest 124 x 12 mm. One stomach yielded a bandage and a human hair, and another metal wire which may have come from a bird snare. Some of the stomachs contained paper, rope or plastic.

DISCUSSION

A study such as this has limitations which may lead to systematic errors. Hairs from certain food species may remain in the stomach for a longer time than hair from other species. Sometimes the stomachs were filled with food, but in other cases they contained only a few hairs. The frequency of occurrence has the same value whether there was one, or many individuals of a given species in a stomach — and when the food item was either large or small.

Our results are also influenced by the method of hunting and trapping the lynx. When lynx are followed for a long time during the hunt, they seldom eat (Haglund 1966). Of the lynx ex-

amined, 24 were reported as killed by poison or as taken in traps; an additional 17 animals may have been taken illegally by these methods. In such cases remains of the bait may have been described as a prey item. Many of the animals were shot or trapped when revisiting carcasses of larger quarry.

This study therefore gives only an approximate picture of the value of the different species as food for the lynx in Norway.

Composition of the diet

The diet has been studied in different areas of Europe: Sweden (Haglund 1966), southern Finland (Pulliainen & Hyypää 1975), Soviet Union (Iurgenson 1955, Novikov 1956), Poland (Lindemann 1956, Suminski 1973), Karpates (Lindemann 1956, Vasilu & Decei 1964, Hell 1971, 1978), Switzerland (Reitz acc. to Scherzinger 1978), and Spain (Valverde 1957, Delibes et al. 1975). These studies indicate that mammals make up about 70–90% of the diet, which agrees well with our results (89%).

In Sweden cervids made up the main part of the diet. Conversions from Haglund's data show that the diet included 25% hares and 54% cervids. These figures are similar to our results of 19% hares and 53% cervids. Scandinavia, the Karpates and Altai mountains (Egorov 1965) seem to be the only studied areas where cervids are the most important prey species for lynx, particularly during winter. These areas are distinguished by long snowbound winters — a factor which may influence the lynx's diet.

Small rodents are frequently recorded as a component of the food, but they are rarely exploited as a major food source.

Lynx prey upon carnivorous mammals such as red fox and mustelids; and dogs find it difficult to withstand attacks by the lynx (Lingonblad 1952, Lindemann 1956). Cannibalism occurs amongst lynx and Canadian lynx *Lynx canadensis*, but the only certain records refer to feeding on carrion of lynx, or lynx caught in traps (Lindemann 1956, Saunders 1963, Vasilu & Decei 1964). Our material did not reveal cannibalism.

All birds identified in our material were tetraonids (Tetraonidae). This corresponds to other studies on the lynx and the Canadian lynx, but birds such as waterfowl may also be of significance (Lindemann 1956).

The daily food requirement of the lynx is at least 1 kg (Eisfeld 1978). Hunting small rodents

such as voles would thus be uneconomic for the lynx, except in periods with very high rodent populations. On the other hand, a single individual of a small game species such as hare, grouse or waterfowl, would provide one fairly good meal for a lynx and a cervid may provide several meals over a period of time. The composition of the diet of the Scandinavian lynx agrees well with the hypothesis that adult vertebrates optimize their food intake by maximizing the energy gained per feeding effort (Griffiths 1975, Stenseth et al. 1977).

Many of the lynx stomachs contained vegetable matter, sometimes of a kind that must have been consumed deliberately. The reasons for this are not known.

Variations according to locality, season, sex and age

The number of lynx stomachs containing animal remains were in the southern area 36, central area 43 and northern area 67. There was no marked difference in the frequency of stomachs with cervids between the areas (75, 72 and 61% from south to north).

In the northern area the cervids totalled 37 reindeer and 1 moose, in the central area 14 reindeer and 12 roe deer, and in the southern area 6 reindeer and 19 roe deer. Therefore, in the more northerly regions there was an increasing proportion of reindeer compared with roe deer in the lynx's diet. This geographical variation in the diet is partly explained by the distribution of roe deer in Norway; they are scarce in the northern area and most common in the southern area (Raiby 1968).

Semi-domestic reindeer occur in all three areas, whilst wild reindeer are only found in southern Norway, usually living on higher ground or in mountain forests. Reindeer do not appear to constitute an important part of the lynx's diet in the southern area, which may indicate that the feeding habitats vary in different parts of the country. This is supported by the fact that in the northern parts of Norway the lynx often wanders into the mountains, whilst in southern Norway it remains predominantly in forested areas (Myrberget 1970) which hold rich populations of roe deer.

During the summer, cervids seemed to be less important food items for females than for males. This may be because the female lynx is slightly smaller than the male, but also to some extent because the two sexes show different patterns of

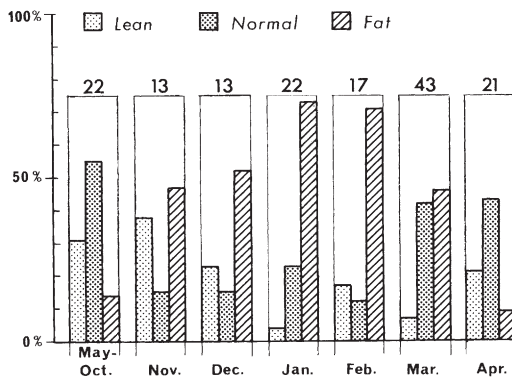


Fig. 2. Percentage distribution in different months of the number of fat, medium and lean lynx carcasses. Sample size is given above the columns.

behaviour; the adult female wandering with the young. Also female bobcats *Lynx rufus* select smaller prey than males (Fritts & Sealander 1978).

Werner (1953) and Haglund (1966) both reported that the lynx's diet contained more cervids in winter than in summer. Our data support their findings but the dietary shift appears to be more marked for the females. Werner (1953) suggested that this change in feeding habits was due to the presence of larger numbers of weak and sick cervids during the winter months, and several other workers (Borg 1962, Haglund 1966, Cop 1977, Wotschikowsky 1978) have reported that young and weak cervids often fall victim to the lynx.

Haglund (1966) maintains that the lynx is forced to hunt cervids to a greater extent when populations of small game decrease in autumn and winter, and small rodents become inaccessible under deep snow. Under certain snow conditions cervids have difficulty in making rapid progress; this may make attacks by the lynx more successful as the paws of the lynx are better adapted to travelling in deep snow (Formozov 1946). However, when hunting in deep loose snow the attacks of the lynx may be hampered and small game animals frequently escape (Haglund 1966, Nellis & Keith 1968).

The change in diet in late autumn is therefore due in part to the lynx and the potential prey species taking advantage of, or being at a disadvantage in, differing snow conditions. The dietary shift may also be due to variations in the species composition of potential prey.

Werner (1953) states that the lynx has a good supply of winter food in areas with rich popula-

tions of cervids. To evaluate this we subjectively placed our lynx corpses into three categories: fat, medium and lean (Fig. 2). There were markedly more fat and fewer lean animals in December-March than in other months. This may support Werner's hypothesis. On the other hand, in Scandinavian areas with few cervids, the lynx may live on the border of famine during winter (Haglund 1966).

Male lynx had a relatively small volume of food in February, which may be related to rutting.

At 10 months, about the age when they leave their mothers, young lynx are poor hunters (Haglund 1966). The food habits indicate that solitary young lynx find it difficult to obtain food and therefore approach dwellings where they eat garbage. Many young in this category may starve to death (Haglund 1966).

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SAMMENDRAG

Ernæringen til gaupe *Lynx lynx* i Norge

På basis av mageinnhold i felte gauper fra alle aktuelle norske landsdeler er det vist at særlig vinterstid utgjør rådyr og rein de viktigste næringsemner for gaupa. Andre viktige byttedyr er hare og skogshøns (Fam. Tetraonidae). Omkring desember foregår et skifte i dietten hos hungauper slik at andelen av hjortedyr øker. I områder med gode bestander av hjortedyr synes gaupa å ha et rikelig næringstilbud vinterstid.

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