Lynx, *Felis lynx*, predation on Red Foxes, *Vulpes vulpes*, Caribou, *Rangifer tarandus*, and Dall Sheep, *Ovis dalli*, in Alaska

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Observations of Canada Lynx (*Felis lynx*) predation on Red Foxes (*Vulpes vulpes*) and medium-sized ungulates during winter are reviewed. Characteristics of 13 successful attacks on Red Foxes and 16 cases of predation on Caribou (*Rangifer tarandus*) and Dall Sheep (*Ovis dalli*) suggest that Lynx are capable of killing even adults of these species, with foxes being killed most easily. The occurrence of Lynx predation on these relatively large prey appears to be greatest when Snowshoe Hares (*Lepus americanus*) are scarce.

Key Words: Canada Lynx, *Felis lynx*, Red Fox, *Vulpes vulpes*, Caribou, *Rangifer tarandus*, Dall Sheep, *Ovis dalli*, predation, Alaska.

Although the European Lynx (*Felis lynx lynx*) regularly kills large prey (Haglund 1966; Pullianen 1981), the Canada Lynx (*Felis lynx canadensis*) relies largely on small game, primarily Snowshoe Hares (*Lepus americanus*), for food (Saunders 1963; van Zyll de Jong 1963; Nellis and Keith 1968; Nellis et al. 1972; Brand et al. 1976; Parker et al. 1983). When hares are scarce, the Canada Lynx shows an increased reliance on alternate prey (Brand et al. 1976). Records of Canada Lynx preying on animals other than small game are limited.

There are only two documented accounts of lynx predation on Red Foxes (*Vulpes vulpes*) (Seton 1911), although Dufresne (1946) stated that the remains of foxes consumed by Lynx were commonly found when hares were scarce. Lynx predation on Caribou (*Rangifer tarandus*) neonates has been well documented (Bergerud 1971, 1973), but reports of predation on older, larger Caribou are scarce (Seton 1911; Saunders 1963; Gubser 1965) as are reports of predation on Dall Sheep (*Ovis dalli*) (Sheldon 1930; Bailey 1936). In addition, various authors have alluded to cases of Lynx predation on Caribou or Sheep, but provided no details (Murie 1935; Dixon 1938; Murie 1944). This paper describes additional cases of Lynx predation on Red Foxes, Caribou, and Dall Sheep in Alaska.

The cases of Lynx predation reported here occurred in a variety of forested and semiforested terrain in interior Alaska. This area is covered by taiga, an extension of the boreal forest (Viereck and Schandelmeier 1980). Temperatures frequently reach 25° C in summer and -10 to -40° C in winter. Snow depths are generally below 80 cm, and snow usually remains loosely packed except at high elevations.

Methods

Incidental to field studies during winters 1982-1983, 1984-1985, and 1986-1987 we encountered two instances of successful Lynx predation on foxes, three successful and one unsuccessful cases of attempted predation on Caribou, and one successful attack on a Dall Sheep. These observations led R.O.S. to ask approximately 40 exprienced trappers if they knew of similar occurrences. Ten trappers reported evidence of one or more cases of predation on foxes, and eight reported evidence of predation on Caribou. One trapper reported a case of predation on a Dall Sheep. Informants' reports originated primarily from 1960 to 1985, with one report in the 1930s. Informants names are included in Tables 1 and 2.

In each of these cases, tracks in snow allowed accurate identification of the predator involved and often provided details of the encounter. In addition, Lynx were observed by us or by informants during or after attacks on eight Caribou, two foxes, and one Dall Sheep. The informants contributing information in most cases provided detailed and plausible accounts of their observations and we are confident in their veracity.

We were able to obtain long bones from only two Lynx-killed Caribou and one sheep. The fat level in femur marrow was determined using the dry-weight method (Neiland 1970).

TABLE 1. Cases of Lynx predation on Red Foxes in Interior Alaska, 1930–1983. Both successful and unsuccessful attempts are listed.

Case No.	Date	Location	Sex	Age	Approx. amount consumed	Informant	Informant comments
1	About 1930	Hog Landing, Koyukuk River	Unk	Unk	Unk	J. Huntington	After a Snowshoe Hare population crash, an abundant population of Lynx decimated the local fox population. He found several places where Lynx had killed and eaten foxes, which rapidly became scarce.
2	1970s	North of Galena	Unk	Unk	Unk	S. Cleaver	Found where a Lynx had killed a fox and cached the remains, after which a Wolverine had eaten the rest of the fox.
3	1960s	Northway	Unk	Unk	N/A	D. James	On two occasions Lynx were observed following about 50 m behind a fox. The Lynx appeared to be hunting the fox in each case.
4	1960s and 1970s	Tanana Flats	Unk	Unk	Unk	R. Long	Reports finding, at various times, about 12 foxes that had been killed and eaten by Lynx after short chases. Notes an inverse correlation between Lynx and fox abundance in local areas.
5	1971–1972	Suslota Creek	Unk	Unk	60%	D. Cramer	Found remains of fox recently killed by a Lynx. Tracks showed the fox had emerged from willows 10 m ahead of Lynx traveling on overflow ice. Fox was caught after 20 m chase.
6	March 1976	Ladue River	Unk	Unk	95%	T. Brigner	Found a fox which a Lynx had killed and consumed on the river. Snowshoe Hares and Lynx were abundant at the time.
7	1 November 1982	East of Tanana River near Tower Bluffs	F	Ad	0%	T. Carda	Found carcass of a freshly killed fox on trail. Tracks showed that a Lynx had killed the fox after a struggle. The carcass showed numerous bite wounds on the head and neck and numerous claw marks on the shoulders and back.
8	November 1982	Near Chicken, Taylor Highway	Unk	Unk	50%	D. Carlson	Found a fox recently killed by a Lynx. The trail of the chase was plain in the snow. The front half of fox had been eaten.
9	20 November 1982	Kalutna River, Northway Flats	Unk	Unk	50%	This study (D. Grangaard)	Examination of fresh tracks showed that a large Lynx had encountered a fox while traveling along a lake. The fox ran across the lake but was caught and killed after a 200 m chase. After a brief struggle, the Lynx carried the fox off the lake before consuming it.
10	15 February 1983	Upper Ladue River	Unk	Unk	50%	W. Gramont	Found the half-eaten carcass of a fox that had been killed by a Lynx.

Continued

TABLE 1. *Concluded.*

Case No.	Date	Location	Sex	Age	Approx. amount consumed	Informant	Informant comments
11	6 December 1982	Tok River	Unk	Ad	90%	This study (R. Stephenson)	Adult male radio-collared Lynx was seen feeding on a fox it had killed. An examination of the site showed the fox had been killed on the previous day after a chase lasting more than 30 m. Part of the fox had been cached in the snow and then dug out. Remains included a front and hind leg, tail, pelvis, and skull, which was buried.
12	November 1982	Northway Flats	Unk	Unk	Unk	D. James	No details available. Informant was told that residents of Northway had found a fox killed by a Lynx.
13	February 1983	Nikolai Slough, Koyukuk River	Unk	Unk	99%	K. Dayton	While traveling on the river, the informant came upon a Lynx feeding on a freshly killed fox. Upon returning later in the day, the informant found only 16 cm of the fox's tail remaining.
14	February 1983	Lake south of Galena	Unk	Unk	90%	J. Demoski	Informant found the scattered remains of fox where it had encountered a Lynx at a point on a lake. Lynx caught fox in two bounds.

Results and Discussion

The observations of ourselves and our informants include 13 cases of Lynx predation on Red Foxes and two observations of Lynx stalking foxes. Two of these reports included several cases of predation observed by an individual over a period of time. We also recorded 12 successful and one unsuccessful attacks on Caribou and two successful attacks on Dall Sheep. Pertinent details for attacks on foxes and ungulates are provided in Tables 1 and 2, respectively.

Eight cases of successful predation on foxes, four cases of predation on Caribou, and one case involving a Dall Sheep occurred during winter 1982-1983. The other case of predation on Dall Sheep occurred during winter 1985-1986. During the period 1982 through 1986, Snowshoe Hare populations were low or declining in interior Alaska as evidenced by observations of both trappers and biologists and by a decline in the production and survival of Lynx kittens (Stephenson and Karczmarczyk 1989; Alaska Department of Fish and Game, unpublished data). This suggests that, as noted by previous authors, the incidence of Lynx predation on relatively large animals such as foxes and Caribou increases when Snowshoe Hares are scarce.

Our observations, and those of informants, suggest that Lynx predation on foxes is motivated by hunger. We examined three sites where foxes were killed by Lynx after chases lasting from 20 to 200 meters. In two instances the fox had been almost entirely consumed by the Lynx and in one case parts of the fox had been cached. Informants described 10 additional cases of predation on foxes. Details on the length of all but one chase are lacking, but in each case the Lynx had consumed a large portion of the fox. We were able to examine the intact carcass of only one fox, which showed numerous claw and bite marks on the head, neck, shoulders, and back. Lynx are probably aided in their pursuit by soft snow which places foxes at a disadvantage due to their greater weight load on track. We did not observe or record any instances of Lynx predation on foxes that occurred near sources of food, such as ungulate carcasses or carrion.

Our observations, and those of informants, indicate Lynx usually ambush Caribou at close range but that a protracted encounter may occur before a Caribou is actually killed. During 1982-1983, we examined three sites at which Lynx had killed Caribou after chases ranging from 25 to 400 m. Informants described nine additional cases of predation on Caribou; in one case the chase was observed to cover 135 m. Our observations at the site of the longest chase of 400 m indicated the Lynx initially wounded the Caribou only 46 m

TABLE 2. Lynx predation on Caribou and Dall Sheep, Interior Alaska, 1960–1985.

No.	Date	Location	Species	Sex	Age	Approx. amount consumed	Informant	Informant comments
1	March 1965 or 1966	Nabesna Road	Caribou	Unk	Calf	Unk	D. Fredericks	Came upon a large male Lynx that had just killed a Caribou calf after chasing the Caribou across a road.
2	16 November 1967	Headquarters Area, Denali National Park	Caribou	F	Calf	—	D. and S. Kogl	Informants saw Lynx feeding on a Caribou killed no more than 12 hours before. Tracks showed the Lynx killed the Caribou after a stalk of about 100 m and an attack covering about 135 m. The Caribou showed numerous wounds around the eyes and ears and along the back.
3	1960s	Headquarters Area, Denali National Park	Caribou	F	Unk	Unk	D and S. Kogl	Informants saw a Lynx on the back of the Caribou. Caribou remained in the area for 3 days and then died.
4	January 1972	Suslositna Creek	Caribou	Unk	Calf	2%	J. Ainesworth	Informant found a Caribou calf recently killed by a Lynx, which leapt from a leaning spruce as the Caribou crossed a frozen pond. The Caribou had been bitten around the head. The Lynx left the Caribou after killing it and never returned. The carcass was later visited by a fox and a Wolverine.
5	1970s	Suslota Lake	Caribou	F	Ad	10%	D. Cramer	Found two adult cow Caribou that had been killed at the same place, but on separate occasions, by an adult male Lynx. The Lynx had jumped off a bank and in one bound reached the Caribou. It appeared the second kill was made after the first was frozen. The Lynx apparently abandoned both carcasses after they became frozen.
6	1975–1976	Koyukuk River near Hughes	Caribou	F	Ad	0%	J. Davis	During aerial Caribou survey a large Lynx was observed sitting next to the intact carcass of an adult cow. Despite a heavy snowfall, the snow adjacent to the carcass showed fresh blood stains and signs of a struggle, indicating the kill was only minutes old.
7	7 November 1982	1.6 km south of Mentasta Lodge	Caribou	Unk	Calf	Unk	G. Maule	Observed a Lynx on the Caribou's back, after which the mortally wounded calf tumbled down a steep slope along a highway. Calf had been clawed and bitten on the head. Lynx proved to be a large male (est. wt. 12.7 kg).

TABLE 2. *Concluded.*

No.	Date	Location	Species	Sex	Age	Approx. amount consumed	Informant	Informant comments
8	29 November 1982	1 km south of Mentasta Lodge	Caribou	M	Calf	2%	This study (R. Stephenson)	Tracks showed that a Lynx had killed the calf after a protracted encounter covering about 400 m, as described in the text. Caribou femur marrow fat = 56%.
9	15 February 1983	Upper Ladue River	Caribou	M	Calf	5%	W. Gramont	Informant found largely intact carcass of a Caribou that had been killed by a Lynx. The Lynx had fed on the neck and part of a shoulder.
10	12 March 1983	West Fork Dennison River	Caribou	M	Calf	60%	This study (D. Garngaard)	A large male Lynx was observed at a Caribou carcass on five occasions between 3/10 and 4/20/83. An inspection on 3/21 showed the Lynx had killed the Caribou 25 m after first making contact with it. The Lynx remained at the kill for at least 42 days, until 4/21 when the river ice thawed and the carcass washed away. Caribou femur marrow = 77%.
11	28 January 1985	Mosquito Park, Fortymile River	Caribou	Unk	Cow and Calf		This study (D. Grangaard)	Tracks showed that a Lynx had followed the Caribou for at least 1 km. At one point the Lynx had run about 30 m, chasing the Caribou, before again following the Caribou at a walk.
12	28 March 1987	Tangleblue Creek, John River	Caribou	Unk	Calf	9%	This study (R. Stephenson)	A large Lynx was observed resting at the carcass of a freshly killed Caribou. Tracks in the snow showed clearly that the Lynx had just killed the Caribou after an attack covering at least 200 m. The Lynx fed on the carcass for several days and had covered the carcass with snow by the second day following the kill. Lynx tracks were also observed at an older Caribou carcass 1 km away.
13	December 1983	Charley River	Dall Sheep	M	Ad	Unk	W. Rimer	Informant was told that a trapper (A. Carol) found a large Dall Sheep ram that had been killed by a Lynx on the upper Charley River. The Lynx, a large male, was trapped at the sheep carcass.
14	17 December 1985	Riley Creek, Denali National Park	Dall Sheep	M	9	1%	This study (J. Burch)	As described in the text, a sheep was found soon after it was killed by a Lynx. Tracks indicated the Lynx had ridden the sheep for at least 30 m before the sheep died. Major wounds were on the dorsal part of the neck behind the head. Sheep femur marrow fat = 70%, age = 9.5 years.

after the attack began. In one case examined by us and in three cases described by informants, major wounds were located on the head, neck, or shoulders of Caribou.

Eight (73%) of 11 known-age Caribou killed by Lynx during 1965-1987 were calves, and three were adult females. The proportion of calves in interior Alaska Caribou herds during winter rarely exceeds 25% (Davis and Valkenburg 1978), suggesting that Lynx may select relatively small Caribou during winter, as well as in summer (Bergerud 1971).

Marrow fat levels in two Caribou calves killed in November 1982 and March 1983 were 56% and 77%, respectively. These are well above levels found in Caribou dying from malnutrition ($\bar{x}$ = 6.5%, range = 5.0-7.8%), and similar to levels measured in Wolf-killed Caribou (which were apparently in good nutritional condition ($\bar{x}$ = 6.4.6%, range = 27.2-96.9%) (Davis and Valkenburg 1978).

We closely examined the scene of successful attacks on a Caribou calf and a Dall Sheep ram within a few hours after the predation occurred, and include here a detailed account of each incident.

On 29 November 1982 we investigated the site at which a Lynx had recently killed a Caribou. Tracks provided a clear record of the attack, which extended over a distance of 400 m. It appeared the Caribou initially became frightened and ran approximately 46 m without being pursued by the Lynx, which continued to stalk along the opposite side of a low ridge parallel to the Caribou. The Caribou stopped, defecated, and then ran directly away from the Lynx. The Lynx pursued it around a lake edge and succeeded in wounding it as it "rode" the Caribou for a distance of about 50 m. The Caribou then bedded down, bleeding, at the lake edge after traveling an additional 90 m, with the Lynx also bedded 9 m away. The Caribou then moved 50 m to a low knoll before again lying down. The Lynx walked around the Caribou at least twice before again attacking, driving the Caribou onto the lake where it was mortally wounded on the neck and began bleeding profusely. After this struggle the Caribou walked 183 m across the lake, with the Lynx following, to a narrow channel between islands, where it died. The Lynx had consumed about 0.5 kg of flesh from the neck.

The scene of a successful attack on a Dall Sheep was inspected on 17 December 1985 within 24 hours after the kill. When discovered, the sheep was lying on creek ice on its sternum with its head down and legs splayed out on either side. The Lynx had eaten less than 1 kg of flesh from an area 20 cm wide along the back of the neck, down to and around the spine. Except for this area, a few abrasions on its forelegs, and areas along the back where Ravens (*Corvus corax*) had begun to feed, the carcass was intact. The tracks of a single Lynx showed it had recently left the carcass.

The total length of the chase is unknown, but a close examination of the last 100 m of the chase showed the Lynx pursued the ram down a steep gully and onto the creek ice, with the Lynx running along the right side of the ram's trail. After traveling 20 m on the creek, the ram had broken through some overflow ice over a 0.5 m deep airpocket. This may have slowed the ram slightly; about 10 m beyond this point tracks showed the Lynx had leaped onto the ram where it remained as the ram attempted to climb a nearly vertical rocky bank. The ram climbed two-thirds of the way up the 20 m bank before turning and angling back down onto the ice where it fell and slid 1-2 m to the point where it died. No blood or hair was found along the path of the chase, and it appeared the Lynx had killed the ram by biting the back of its neck, perhaps injuring its spine.

The kill had occurred within the 24 hours since the area had been visited the day before, and probably occurred less than an hour before it was found, judging by the small amount of snow in the tracks (light snow had fallen all day). A visit to the site on the following day showed the Lynx had returned to feed on the carcass and that foxes and Ravens had also fed extensively. Both front legs had been removed and carried off, and the neck, back, and ribs had been fed upon. The viscera and hindquarters were intact. The head and one femur were collected at this time. By 1030 on 19 December 1985 the carcass was gone, with only hair and rumen contents remaining at the site. Tracks showed that the Lynx, as well as foxes and Ravens, had dismembered the carcass and consumed or carried it away.

Examination of horn annuli showed that the ram was 9.5 years old. Although the femur marrow contained 70% fat, the mandibles showed signs of severe lump jaw (W. E. Heimer, Alaska Department of Fish and Game, personal communication.) Hoof or leg abnormalities were not found.

The cases reviewed here indicate that adult Lynx are quite capable of killing foxes, Caribou, and Dall Sheep. Although no precise measure of observer field effort is available, high fur prices during the past two decades caused a rapid increase in trapping effort that has been, to a large degree, sustained during this period (Alaska Department of Fish and Game, unpublished data). Our records of Lynx predation on alternate prey do, however, suggest that this behavior is most common when Snowshoe Hares are scarce, as has been suggested elsewhere for Lynx (Brand et al. 1976) as well as for Coyotes (*Canis latrans*) (Todd and Keith 1983).

Reported Lynx population densities in North America range from 1 Lynx/5 km² (Parker et al. 1983) to 1 Lynx/50 km² (Brand et al. 1976) or more depending on the phase of the Snowshoe Hare cycle. When hare populations crash, dense populations of Lynx are left to rely more on other food sources, and it is during this period that Lynx predation would have the greatest effect on populations of animals such as foxes, Caribou, or Dall Sheep. Because of the relatively high densities that Lynx populations can attain, they constitute a potentially significant source of mortality on these, and possibly other, species. The availability of alternate prey during cyclic lows in small game populations may be an important factor allowing some Lynx to survive periods of hare scarcity.

The general observations reported here suggest that Lynx could, at times, contribute to declines in Red Fox populations in Alaska. When Lynx are abundant, their population density can approach that of foxes, which approximates 1 fox/10 km² in northern boreal forests (Voigt 1987). Even a small number of foxes killed by individual Lynx could, in aggregate, reduce fox numbers. The observations of numerous trappers in the upper Tanana Valley indicate that fox abundance declined drastically during winter 1982-1983. One trapper reported that a similar phenomenon occurred in the Koyukuk River drainage in western Alaska in the 1930s.

Five of the most experienced trappers we interviewed reported that foxes are usually scarce when Lynx are abundant in local areas. However, it is difficult to know the extent to which this is caused by different habitat preferences of the two species (foxes preferring more open habitat than Lynx), by foxes actively avoiding areas having high Lynx numbers, or by high mortality of foxes from Lynx predation.

The effects of Lynx predation on Caribou and Dall Sheep populations are unknown. The Newfoundland Caribou studied by Bergerud (1971) generally calve in small areas of open muskeg intermixed with forest. In Alaska several major Caribou herds calve on alpine or arctic tundra (Skoog 1968; Hemming 1971). However, Caribou herds in interior Alaska commonly frequent forested and partly forested habitat during and after calving when calves are small and vulnerable (Davis et al. 1978). Lynx predation could, at times, be an important source of mortality for these Caribou. The occurrence of Lynx predation on relatively large prey may be relatively easy to overlook because the predator is small, forest dwelling, unobtrusive, often solitary, and does not dismember and scatter to kill to the same extent as some other predators, such as Wolves. The likelihood that other large carnivores such as Wolves, Wolverines (*Gulo gulo*), or bears (*Ursus* spp.) may usurp Lynx kills, and partly obliterate signs of Lynx presence, would also lessen the chances of identifying Lynx predation as a cause of death. Knowledge of predation on Caribou calves during their first six weeks of life has resulted largely from observations in open areas, where Lynx rarely occur. To date, few Caribou calf mortality studies have employed telemetry or other techniques that would eliminate the bias against locating kills in brushy or forested habitat.

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