EARLY EXPERIENCES WITH THE FIRST RADIO-MARKED BROWN BEARS IN SWEDEN

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Abstract: In 1984–85, 4 brown bears (*Ursus arctos*) were radio-tracked in the alpine and northern boreal zones in northern Sweden, and 3 bears were radio-tracked in the northern and middle boreal zones in central Sweden to obtain information on movements, home ranges, food habits, and activity patterns. With 1 exception, ear-attached transmitters were used. They functioned well on 1 bear for 2 seasons but not as well on 6 other bears. In 4 cases, the signal gradually weakened until bears could not be relocated. Preliminary results indicate home range sizes varied from about 50 km^2 (yearling bear) to 500 km^2 (adult male). In the northern area, activity seemed closely related to daylight. Activity patterns were diurnal in summer, with 24 hours of daylight, and in autumn.

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In 1975 the brown bear population in Sweden was estimated to be 400–600 (Bjarvall 1980). Since then no census or research has been conducted. Increased demand in recent years for bear hunting in previously closed areas and for greater harvests in other areas have created a need to update census figures and learn more about brown bears in Sweden.

This project, which began in March 1984, was intended to obtain information on movements, activity patterns, and population dynamics of brown bears in Sweden. It was the 1st study incorporating radiotelemetry in Fennoscandia.

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STUDY AREA

The northern study area (67° N 18° E) is northwest of the village of Jokkmokk in the county of Norrbotten. It includes coniferous forest of the northern boreal zone (Sjors 1967) and mountains in the alpine zone. Elevations range from less than 300 m in the east to more than 2,000 m in Sarek National Park in the west. U-shaped valleys are common. Treeline of birch (*Betula tortuosa*) forests occurs at about 700 m. A few small settlements and roads exist on the periphery of the study area.

The central Sweden study area lies in the southern and middle boreal zones (61° N 14° E). It is a coniferous, hilly woodland. Elevations range from 200 to 500 m. Lakes and bogs cover large areas. Although roads and small villages are common, the area is sparsely populated.

METHODS

Bears were immobilized with a Rompun-Immobilon mixture. Revivon was used as an antidote. A yearling bear (bear 1, Table 1), recently out of the den with its mother, was immobilized in the northern area in 1984 using a jabstick (Bjarvall and Ahlqvist 1985). In 1985, 3 more bears (bears 2, 3, and 4) were immobilized in the northern and 3 (bears 5, 6, and 7) in the southern area (Sandegren and Bjarvall 1985). Bear 5 was immobilized in the den using a jabstick, and 2 yearling males (bears 3 and 4) were immobilized while feeding on a moose (*Alces alces*) carcass. Bears 2, 6, and 7 were captured from a helicopter using the technique described by Pearson (1975).

Captured bears were fitted with radiotransmitters. To eliminate the risk of skin damage and death from constriction by a neck collar as an animal grows, we initially used ear-mounted transmitters (Servheen et al. 1981). In 1984–85, the ear-mounted transmitters functioned well on 1 bear, but the signal gradually faded on the others, and 4 of the remaining 6 bears could not be located 1–3 months after capture. Signals from the other 2 bears also weakened, but new transmitters were later applied and they were monitored until mid-October, when they probably denned.

On recapture in early October 1984, bear 1 was equipped with 2 ear-transmitters, 1 standard and 1 with a photosensitive switch. On the 2nd recapture in September 1985, it was outfitted with an ear-transmitter and a neck collar transmitter because ear-mounted transmitters created problems.

Table 1. Age, sex, and related information for 7 brown bears captured in Sweden, 1984–85.

Bear no.	Capture date	Age at capture	Sex	Capture location	Period monitored	Number of locations	Transmitter type
1	22 Mar 1984	1	F	Norrbotten	Continuing	> 100	Ear, neck
2	23 Apr 1985	1	M	Norrbotten	23 Apr–05 Jun	> 10	Ear
3	16 Jun 1985	1?	M	Norrbotten	16 Jun–20 Oct	55	Ear
4	18 Jun 1985	1?	M	Norrbotten	18 Jun–20 Oct	55	Ear
5	17 Mar 1985	1?	?	Dalarna	17 Mar–16 Aug	65	Ear
6	30 Mar 1985	4	M	Dalarna	30 Mar–09 Jun	33	Ear
7	04 May 1985	7	M	Dalarna	04 May–30 Jun	15	Ear

Animals were located from the air to get information about major movements and were periodically ground tracked to monitor shorter movements, activity patterns, and behavior. Ground work was limited by equipment problems, but bear 1 was followed for extensive periods during 1984 and 1985.

Daily activity patterns were recorded using Roth's (1983) methods. The activity level was determined by the rate of change in signal strength based on at least 40 consecutive signals during the 1st 5 minutes of every quarter hour. We tried to monitor activity patterns for at least 1 24-hour period each week.

RESULTS AND DISCUSSION

The 1st ear-mounted transmitter was still functioning when it was replaced after 6 months, and neither the transmitter nor the ear of the bear showed damage. Three other ear-mounted transmitters recovered after 1.5 ($N = 1$) and 11 ($N = 2$) months were badly damaged. Antennas were completely or partly destroyed, and transmitter ranges were only a few hundred meters. Holes in the ear were slightly enlarged, and 1 ear was infected.

Servheen et al. (1981) did not report such problems, but they did not mention the ages of the bears they studied. Bears 3 and 4, yearlings that accompanied each other, may have destroyed transmitters by biting each other's ears. Bear 1 damaged her transmitters in 1985 but not in 1984; possibly because her ears were infected in 1985 and she scratched at them.

Wide areas around the 4 bears that "disappeared" were carefully searched from the air without success. Three of these bears were males. It seems most likely that the disappearance was due to transmitter failure rather than long-distance movements.

Home Ranges

Telemetry and direct observations were used to determine spring and summer home ranges for bears 5, 6, and 7 in the southern study area for 1985 (Fig. 1). Areas were calculated by connecting the outermost locations forming a convex polygon (Mohr 1947), a technique used by Pearson (1975), Miller et al. (1982), and Servheen (1983).

The home range of bear 5 during 153 days, March–August, (65 locations) was about 50 km^2. For bears 6 and 7, home ranges were about 70 km^2 (49 days, Mar–June, 33 locations) and about 500 km^2 (58 days, May–Jun, 15 locations), respectively. The home ranges for bears 3 and 4, the siblings in the northern area, were about 115 km^2. These seasonal home

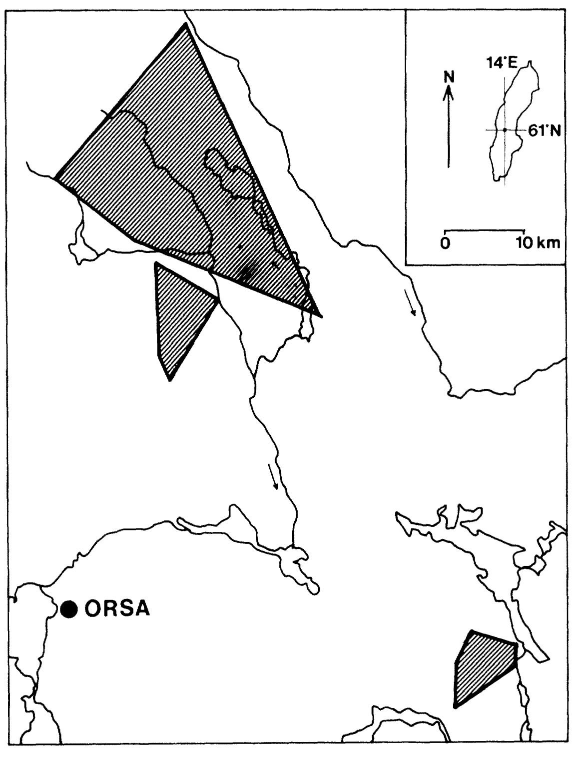

Fig. 1. Spring-summer home ranges for 3 bears in the central Sweden study area. 1984–85.

ranges are similar to those reported by Pearson (1975) and Miller et al. (1982) in North America. These authors emphasized that ranges of individual bears vary in size from year to year.

The home range size for bear 1, based on several hundred observations during 2 seasons (May 1984–Oct 1985) was about 185 km^2 (Fig. 2). However, this value does not reflect the area used by the animal. The bear only appeared to use a main river valley and 2 of its tributary valleys. A convex polygon drawn from the outermost locations, includes large areas that the bear never visited. One could argue that this bear visited these areas when not monitored; however, she had shown a very regular movement pattern throughout the season. She remained in the valley bottom or on the gentle slopes and climbed steeper slopes only to avoid helicopters and other disturbances. It seems unlikely she would have used even higher elevations when undisturbed.

Pearson (1975) found the minimum home range polygon technique particularly useful in working with the mass of data recovered from a biotelemetry study. It seems, however, that some caution is needed in areas with extreme habitat variation. When relocations are clustered in certain areas and along certain lines, other methods should be used. Judd and Knight (1980) used a concave polygon in an attempt to exclude areas not used by the bear and believe their method gives the best biological interpretation of radio-tracking data. If we base the home range size on "true" movements, the home range of bear 1 was around 120 km^2 (Fig. 2).

Daily Activity

In his study of the daily activity of bears in Italy, Roth (1983) classified the animals as active when the signal strength fluctuated. We used the same classi-

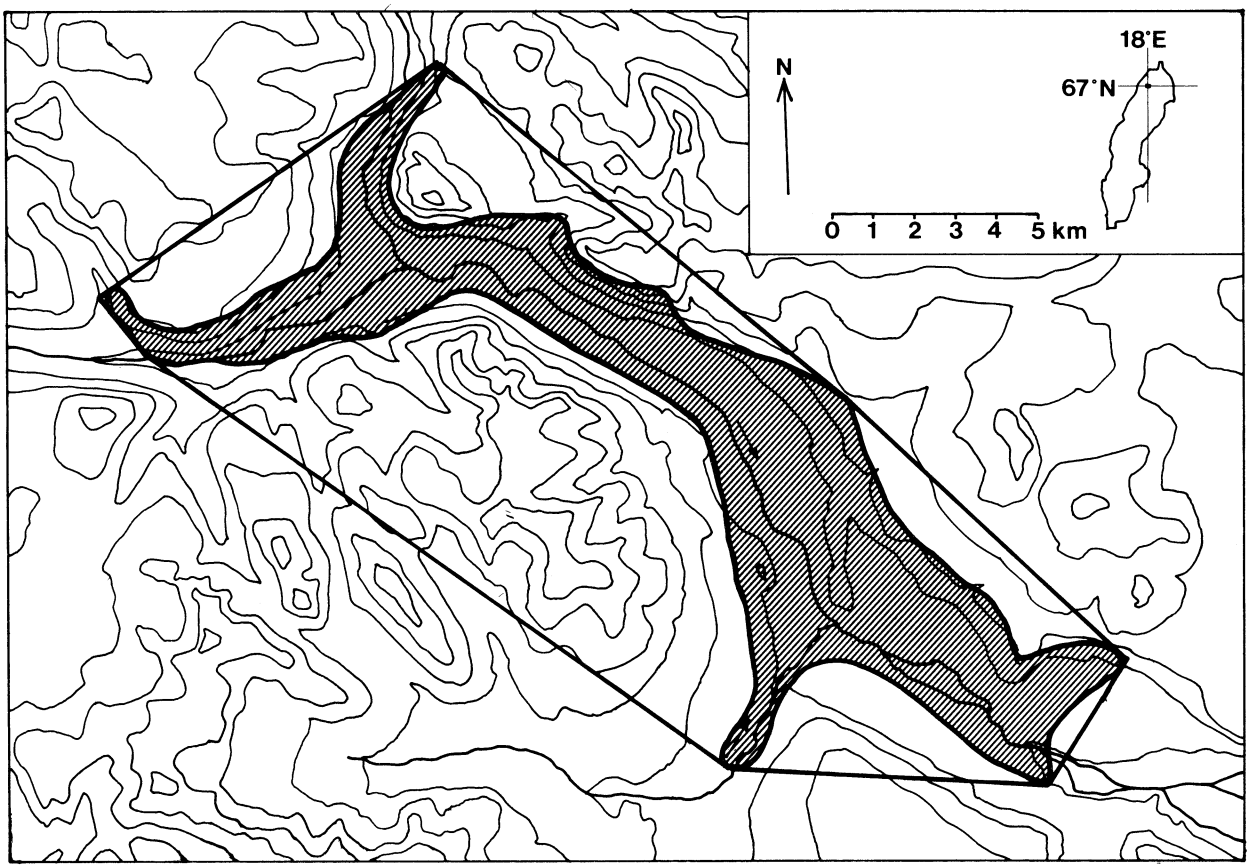

Fig. 2. Home range of a young female bear during 2 summer seasons. The solid line represents a convex polygon; the shaded area represents habitat actually used by the bear.

fication for bear 1. The results indicated a bimodal pattern in summer, with peaks in early morning and evening. Later in the autumn, however, the pattern was more diurnal.

Toward the end of the 1984 season, bear 1 was observed for long periods while its activity was recorded. Signals could be clearly fluctuating even though the bear was lying down and obviously inactive, apparently because even an "inactive" bear moves its head and ears.

Therefore, we changed the method slightly in 1985. We listened to 40 consecutive signals, then classified them according to the degree of variation from 0/40 (no variation) to 40/40 (continuous variation). Between these extremes, we had 3 classes of estimated variability: 10/40, 20/40, and 30/40. We considered 0/40 and 10/40 to be nonactive and others to be active. The 1985 results include data from 4 1-week or longer monitoring periods in May, June, September, and October (Fig. 3).

Bear 1 had a diurnal activity pattern (Fig. 3). Between 0700 and 2100 hours, activity exceeded 30% but it was below 30% during the night. This differs from Roth's (1983) findings of 1 activity peak in early morning (0500–0800 hours) and another in the evening (1800–2300 hours). It also differs from that reported from Italy, where about 45% of the telemetry locations ($N = 2{,}329$) were classified as active (Roth 1983). The corresponding value from this study ($N = 1{,}433$) is 29%.

This raises the question of whether our procedure

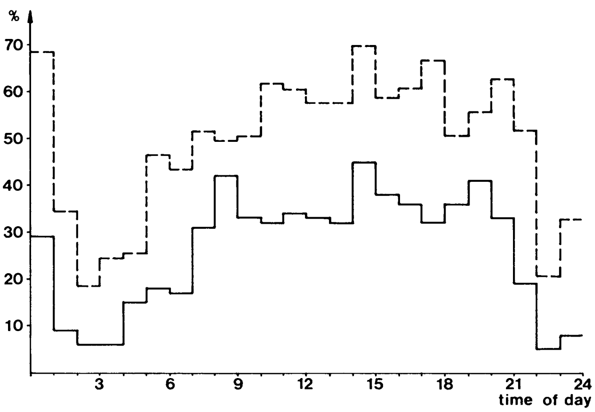

Fig. 3. Daily activity pattern of a young female bear as monitored in May, June, September, and October 1985. Activity level 10/40 was considered inactive for the solid line; it was considered active for the broken line.

of classifying activity values of 10/40 as nonactive biased the data. To test this, all 10/40 values (N = 338) were reclassified as active. The overall pattern remained unchanged (Fig. 3), but this procedure increased the level of activity to 53%, comparable to Roth's (1983) results, where bears were active 45%–60% of the time during summer and fall.

Brown bear activity varies among areas. In the Yukon, an area where bears are hunted, Pearson (1975) found low activity levels during the day, increased activity in the late afternoon, and continued high activity for at least part of the night. In an unhunted area in Alaska, Egbert and Stokes (1976) found high activity in the evening, a sharp decrease after 2200 hours, and continued low activity through the night and early morning. Our activity studies were done within a national park without bear hunting and human settlement. Thus the diurnal activity pattern of this bear agrees with the general idea that bears seem to be less nocturnal in areas where they are less disturbed by people (Roth 1983).

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