

HOME RANGES AND MOVEMENTS OF BROWN BEARS IN PLITVICE LAKES NATIONAL PARK, YUGOSLAVIA

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Abstract: Two European brown bears (*Ursus arctos*) were captured in Plitvice Lakes National Park, fitted with radiocollars and tracked for 426 and 198 days. The home ranges used by these bears were 85 km² and 50 km². Daily movements ($N = 66$) averaged 2.0 km (median = 1.6 km) and ranged from 0.4 to 6.2 km. These bears spent 37% of their time outside the Park boundaries, in areas where they may be hunted.

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Much of the forested mountain regions of Yugoslavia are inhabited by the European brown bear. The bear population increased after World War II (Isaković 1970) and has since stabilized in Yugoslavia. Hunters estimate the current population at 2,000 animals. Approximately 120 bears are legally harvested annually, all being shot at night over bait.

About 350 bears inhabit the 3,900 km² of bear habitat in the Socialist Republic of Croatia, Yugoslavia (Anon. 1981). Between 20 and 35 bears are annually harvested from this population, a portion of which comes from the Plitvice Lakes National Park area.

Before this study, knowledge of the general biology and ecology of the Plitvice Lakes National Park bear population was based on random experience of the local residents. No information was available on their vulnerability to harvest outside the Park. Our objectives were to document home range sizes, and daily and seasonal movements of individual bears in and around Plitvice Lakes National Park. The preliminary home range and movements data are presented here; detailed activity patterns are presented in Roth and Huber (this volume).

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STUDY AREA

Plitvice Lakes and the surrounding area were established as a 19,172-ha national park in 1949. The Park is located in south-central Croatia, approximately 60 km northeast of the Adriatic Sea and 110 km south of Zagreb (Fig. 1). Elevations range from 417 to 1,280 m. Yearly precipitation averages 1,360

mm, and average monthly temperatures range from -2.6 C in January to 17.0 C in July. Snow lasts 60-108 days each year.

Forests cover about 75% of the area. Areas below 800 m are dominated by beech (*Fagus sylvatica*); a mixture of fir (*Abies alba*), spruce (*Picea abies*), and beech dominate at higher elevations. Openings in the forest occur throughout the Park. The study area is characterized by shallow soils on limestone with typical karst topography. There are also irregularly shaped large depressions and valleys, 1-5 km in diameter, without surface drainage.

The major attraction of the Park is a series of 17 lakes connected by waterfalls that cover about 1% of the area. These lakes are visited by up to 700,000 tourists yearly. Few people use other parts of the Park.

Besides brown bears, the large mammal fauna of the area includes gray wolf (*Canis lupus*), red fox (*Vulpes vulpes*), European wild cat (*Felis silvestris*), European badger (*Meles meles*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), and wild boar (*Sus scrofa*). No hunting is allowed within the Park, but all species listed, including the bear, may be hunted outside the Park.

The initial study area was confined to the Park but, because of bear movements, was extended up to 12.5 km beyond the Park boundaries.

METHODS

Bears were captured with Aldrich foot snares baited with 5-10 kg of slaughterhouse refuse. Captured bears were immobilized with ketamine hydrochloride and xylazine hydrochloride and fitted with radiocollars. Marked animals were located daily, when possible, by triangulation from forest roads. Home range size was calculated from the polygon defined by connecting the outermost radiolocations (Mohr 1947). The relative use of portions of the home range was measured by the number of locations per

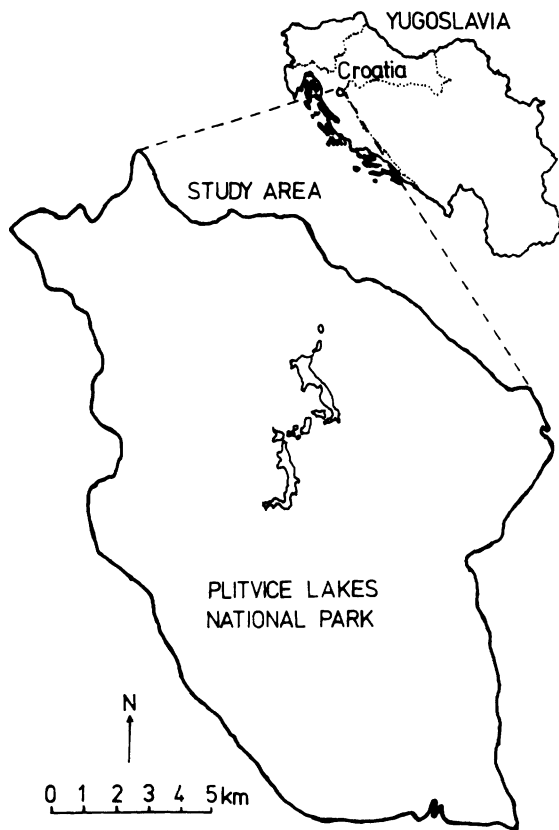


Fig. 1. Location of the study area in Croatia, Yugoslavia.

unit area. Analysis of movements was based on measurements of straight line distances between consecutive day locations.

RESULTS AND DISCUSSION

Home Ranges

We captured 2 bears during this study. Bear 1, captured 1 November 1981, was a yearling female weighing 39 kg. She and her sibling accompanied their mother until May 1982 when the mother was most probably killed by a hunter outside the Park. Bear 2, captured 17 June 1982, was a 4.5-year-old male weighing 135 kg. Radio-collared bears were successfully radio-contacted on 157 of 171 different day attempts. Bear 1 was radio-contacted more frequently (on 134 days, 94% success) than bear 2 (on 23 days, 79% success), because its home range was more accessible.

Although the capture sites of the 2 bears were only 1.7 km apart, their home range overlap was only 4% (5.5 km²) because the home ranges extended in opposite directions (Fig. 2). The size of the home range

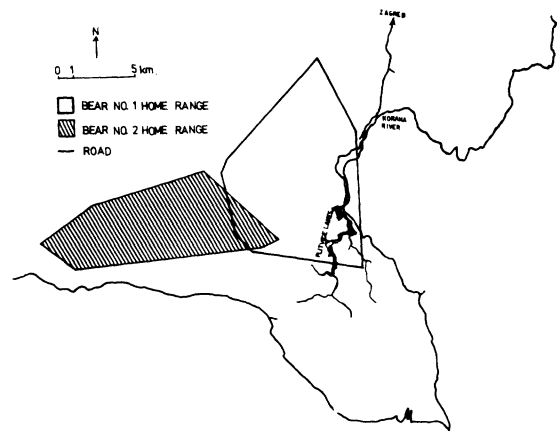


Fig. 2. Brown bear home ranges in relation to Plitvice Lakes National Park, Yugoslavia.

used by bear 1 during the 14-month monitoring period (1 Nov 1981–31 Dec 1982) was 85 km² (Fig. 3). Monthly home ranges (Fig. 4) indicated that this bear used a very small area during the summer, when food was abundant. In October 1982 she made several long unexplained excursions, thus markedly expanding her home range.

While accompanying her mother (Nov 1981–May 1982), bear 1 used a 53-km² range. For 7.5 months, while living alone, she used a 49-km² range. A 36-km² area was used during both periods. Two core areas were identified. The 1st area was established by the entire family and was 0.6 km². This area, used in fall 1981, was a high-elevation (1,000–1,200 m) mature beech and fir forest with an abundance of beechnuts and was rarely visited by humans.

After the mother disappeared in spring 1982, bear 1 concentrated her activity in a 2nd core, a 1.1-km² area she used 15 times more intensively than the rest of her home range. This area, used May–December 1982, was heavily cut-over, brushy, deciduous forest at 500–700 m elevation located near 3 villages; no point was more than 1.5 km from human settlement. This area provided the 1st spring foods, especially arum (*Arum maculatum*). Bear 1 used this area through December 1982 without returning to the higher elevation used the previous fall.

Since summer 1982, the steep slopes of the Korana River canyon, which is bordered on both sides by relatively busy, paved roads (remotest points only 150 m from road), were part of the core area. Bear 1 swam the 15- to 25-m wide Korana River many times during all seasons of the year and, despite living

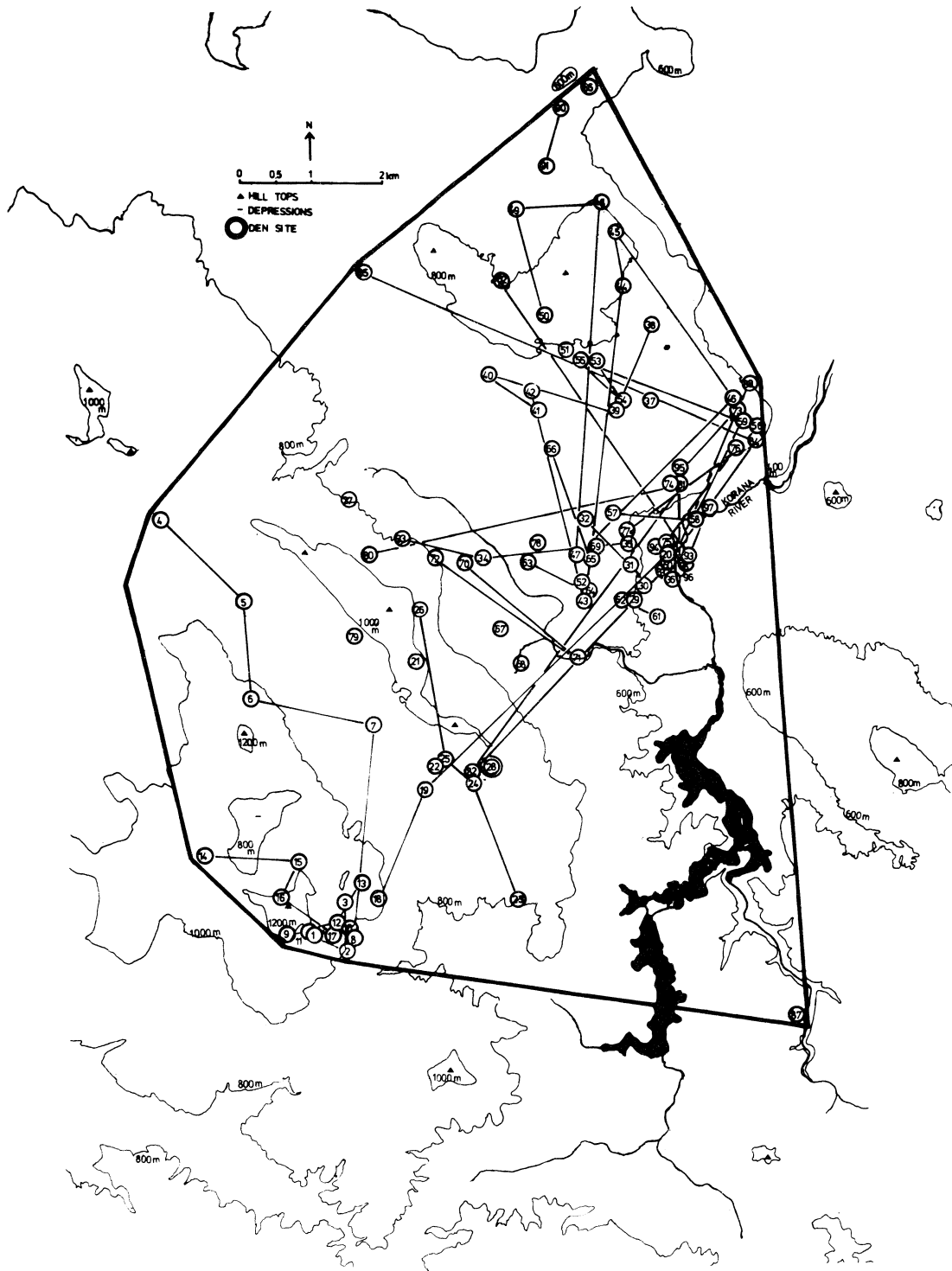


Fig. 3. Home range of bear 1, a yearling female, in Plitvice Lakes National Park, Yugoslavia. Consecutive-day locations are connected.

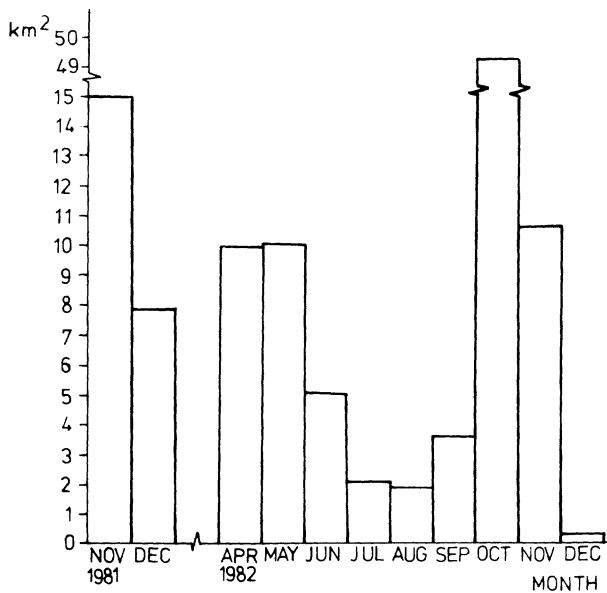


Fig. 4. Monthly home ranges of bear 1, a yearling female, in Plitvice Lakes National Park, Yugoslavia.

near human habitation, she remained very shy and avoided observation by people.

During the 6.5-month period bear 2 was monitored (17 Jun–31 Dec 1982), he used a 50-km² home range (Fig. 5). This home range appears smaller than that used by bear 1, but comparing only the June–December ranges shows both bears used similar areas during this period (bear 1, 53 km²; bear 2, 50 km²). Although bear 2 was captured in a relatively secluded area at an elevation of 850 m, he spent much of his time in the western portion of his range at elevations of 600–800 m near several villages. This part of his home range was dominated by shrubby deciduous forest and some mature pine (*Pinus silvestris*) forest. Throughout the study, bear 2 was located in the eastern part of his home range only from July through August and in December 1982.

The home range sizes obtained in this study were generally smaller than those reported for North American brown bears (Pearson 1975, 1976; Craighead 1976; Glenn and Miller 1980; Judd and Knight 1980) excepting the small ranges of brown bears on Kodiak Island (Berns et al. 1980).

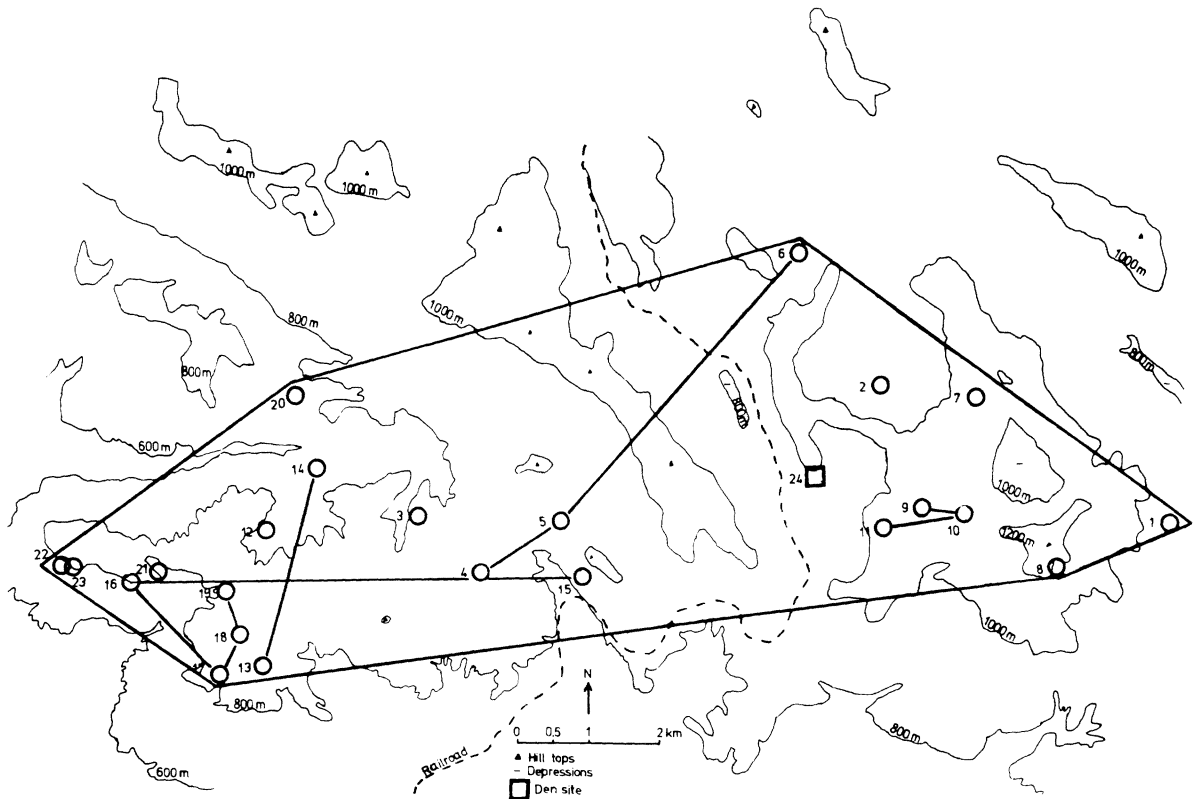


Fig. 5. Home range of bear 2, a 4.5-year-old male, in Plitvice Lakes National Park, Yugoslavia. Consecutive-day locations are connected.

Movements

Daily movements were combined for both bears because differences were not significant (Wilcoxon test, $P > 0.3$: bear 1; $N = 57$, median = 1.6 km; bear 2; $N = 9$, median = 1.4 km). Movements ranged from 0.4 to 6.2 km (median = 1.6 km).

Sixty-seven percent of the daily movements were less than 2 km and only 3% were greater than 6 km. The frequency distribution of daily movements was strongly positively skewed (Fig. 6) (Roth 1983). Therefore, the t -test was not used to compare these distances and the median provided a measure of central tendency. Certainly the straight-line distances we measured were much shorter than the real distances bears traveled in a day. These distances are similar to those reported for European brown bears in Italy (Roth and Osti 1979, Roth 1983). Both average and maximum movements were shorter than those reported for North American brown bears (Craighead 1976).

Although European brown bear home ranges were smaller and daily movements shorter than those of North American brown bears, the mobility of the European bears was greater than originally believed. We found bear 1 within the Park 77% of the time (74 of 96 daily locations). She ranged up to 5 km north of the Park boundary. Only 8% (2 of 23) of the locations for bear 2 were within the Park. He spent most of the time more than 5 km (and up to 12.5 km) west of the Park. These results suggest that bears of Plitvice Lakes National Park often cross the Park boundaries and thus become more susceptible to hunting than previously believed. A revision of bear management in and around Plitvice Lakes National Park may be necessary.

LITERATURE CITED

- ANON. 1981. Stanje i mogućnosti razvoja lovstva u SR Hrvatskoj za razdoblje od 1981. do 1985. godine. Socijalistička Republika Hrvatska. Izvršno vijeće Sabora. 61pp. (In Croatian.)
- BERNS, V. D., G. C. ATWELL, AND D. L. BOONE. 1980. Brown bear movements and habitat use at Karluk Lake, Kodiak Island. *Int. Conf. Bear Res. and Manage.* 4:293-296.
- CRAIGHEAD, F. C. 1976. Grizzly bear ranges and movements as determined by radiotracking. *Int. Conf. Bear Res. and Manage.* 3:97-109.

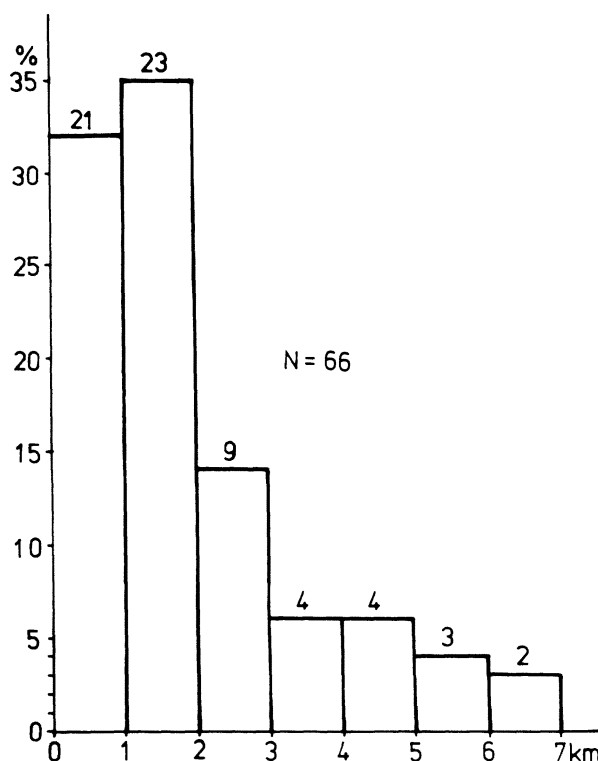


Fig. 6. Frequency distribution of straight-line distances between consecutive day locations for 2 brown bears, Plitvice Lakes National Park, Yugoslavia. Numbers represent absolute frequencies.

- GLENN, L. P., AND L. H. MILLER. 1980. Seasonal movements of an Alaska Peninsula brown bear population. *Int. Conf. Bear Res. and Manage.* 4:307-312.
- ISAKOVIĆ, I. 1970. Game management in Yugoslavia. *J. Wildl. Manage.* 34:800-812.
- JUDD, S. L., AND R. R. KNIGHT. 1980. Movements of radio-instrumented grizzly bears within the Yellowstone area. *Int. Conf. Bear Res. and Manage.* 4:359-367.
- MOHR, C. O. 1947. Table of equivalent populations of North American small mammals. *Am. Midl. Nat.* 37:223-249.
- PEARSON, A. M. 1975. The northern interior grizzly bear (*Ursus arctos* L.). *Can. Wildl. Serv. Rep. Ser.* 34. 86pp.
- . 1976. Population characteristics of the arctic mountain grizzly bear. *Int. Conf. Bear Res. and Manage.* 3:247-260.
- ROTH, H. U. 1983. Home ranges and movement patterns of European brown bears as revealed by radio-tracking. *Acta Zool. Fennica* 174:143-144.
- , AND F. OSTI. 1979. Prime esperienze di radiolocalizzazione di due orsi bruni del Trentino. *Natura Alpina (Trento)* 30:27-38. (In Italian.)