

MOVEMENTS OF RADIO-INSTRUMENTED GRIZZLY BEARS WITHIN THE YELLOWSTONE AREA

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Abstract: Grizzly bear (*Ursus arctos horribilis*) movement patterns were studied with the aid of 18 radio-instrumented grizzly bears in 1975 and 1976. Five bears gave minimal information because of death, transmitter failure, or loss of transmitters. Seasonal home range information is presented for 13 bears. Two bears, trapped inside Yellowstone National Park, included areas outside of the park in their home ranges. Twelve bears trapped outside included parts of the park in their home ranges. Three females with young gave no indication of having smaller home ranges than other individuals. Movement patterns prior to denning and dates of denning varied among individual bears.

Grizzly bears in and around Yellowstone National Park are under the jurisdiction of several state and federal agencies. The states of Idaho, Montana, and Wyoming, and the National Park Service all have direct responsibilities for bear management. The U.S. Forest Service has direct responsibility for most bear habitat outside of Yellowstone National Park, and the U.S. Fish and Wildlife Service has jurisdiction over the entire population under the Endangered Species Act. The philosophies and management objectives of most of these agencies differ with respect to grizzly bears.

Knowledge of movement patterns across political boundaries is desirable for the formulation of management plans by each agency involved. Information on use of habitat types, especially those where physical modification or other human encroachment has occurred or may occur, is essential in light of the Endangered Species Act. Previous research was carried out by Craighead and Craighead (1970), but no radiotracking has been conducted since major garbage dumps within Yellowstone National Park were closed in 1971. Bear movement patterns since that time are largely unknown.

In 1975, the Interagency Grizzly Bear Study Team began to radio-instrument grizzly bears in and around Yellowstone National Park with the following objectives: (1) to obtain data on bear use of various habitat types; (2) to determine movement patterns of bears with respect to various political boundaries; and (3) to document reactions of grizzly bears to other activities within their habitat, especially logging, livestock grazing, and recreational development. This paper reports on movement patterns observed during the 1975 and 1976 field seasons.

STUDY AREA

The study area lies in the junction of the states of Montana, Idaho, and Wyoming. Yellowstone National Park forms the center and covers approximately half of the more than 20,720-km² area. The remaining half

falls mainly on National Forest lands surrounding the park (Fig. 1). The area is essentially a very large high-elevation basin encircled by mountain ranges. Elevational extremes range from 4,196 m on Grand Teton Peak to 1,610 m around Gardiner, Montana, with most of the area lying between 2,134 and 2,438 m.

The basic geology of the area was extensively studied and described by Hague (1899). Considerable uplifting and faulting of sedimentary strata and volcanic activity within the more recent geologic past have elevated the surrounding mountains. Present geothermal activity is a persisting indicator of recent geologic instability. Former glacial activity is much in evidence in many of the surrounding high-relief areas, especially on the north and east sides. Much of the area is forest interspersed with marshes, meadows, steppes, and shrub steppes. This variation in cover type is due in part to the diverse topography with its inherent microclimates that foster a range of vegetative communities from cold-desert to alpine.

The forest habitat types have been extensively described by Pfister et al. (1974) and Cooper (1975). Periodic wildfires have played a key role in many plant communities in the Yellowstone system. Though fire suppression by man over the past 80 years is now allowing many areas to reach or approach climatic climax (Houston 1973), many of the forest habitat types are presently in seral stands of lodgepole pine (*Pinus contorta*) because of these fires.

The nonforest habitat types have not been as intensively classified. Many, however, will fall into the tentative habitat types that have been delineated in grasslands and shrublands below the alpine zone in western Montana by Mueggler and Handl (1974).

The mean annual temperature at Mammoth, Wyoming, is 4.3°C. January is generally the coldest month, averaging -7.7°C, and July is the warmest, averaging 16.9°C. Annual precipitation ranges from about 34.8 cm in the northeast to 97.2 cm in the southwest. A

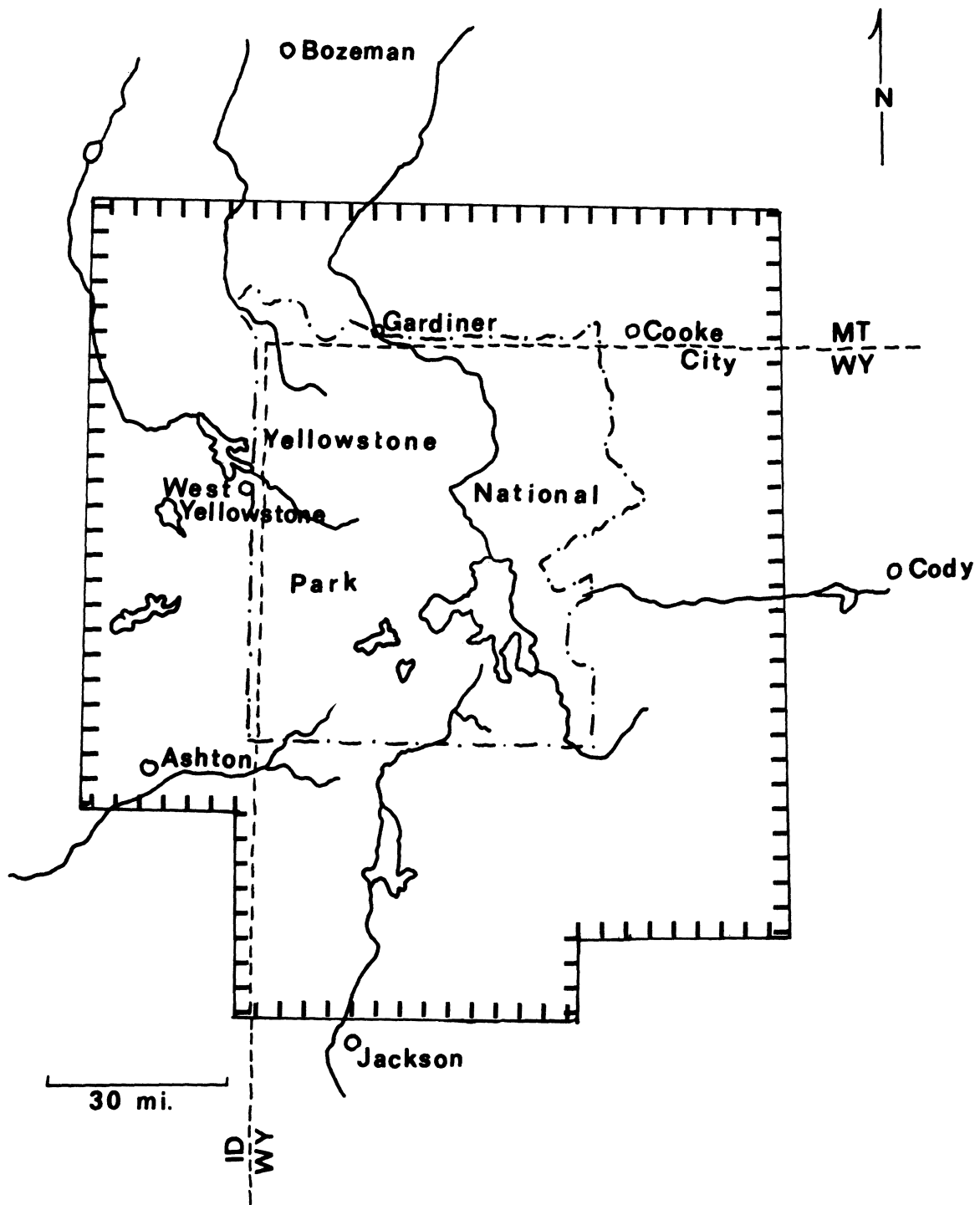


Fig. 1. Interagency Study Area.

rain shadow effect causes xeric conditions in the central and eastern portions of the study area. Most precipitation occurs as snow, with areas above 2,134 m receiving an average in excess of 3.8 m.

Populations of large ungulates share the area with grizzly bears. These animals at times become a food

source for the bears, especially as carrion during the spring months. Populations of black bears (*Ursus americanus*) and other large carnivores also inhabit the study area. Pocket gophers (*Thomomys nuttalli*) are abundant in many meadow areas and are at times sought by grizzly bears for food.

Until recent years, this area remained a virtual wilderness. Although forested, access was too difficult for logging, and the timber was of the type and quality that was not in great demand. Climate and terrain prevented extensive agriculture. Hunters and stockmen were the main users of the area, and neither made many apparent major changes in the grizzly bear habitat.

Since 1960, changes in logging needs and practices have opened up many formerly inaccessible areas. Increased recreational demands and developments have opened still more. How these changes will ultimately affect the grizzly bears and their habitat remains to be seen.

METHODS

Radiotelemetry was used to determine bear movements and habitat use. Transmitters used were in the 164-MHz range. Transmitter failure due largely to improper packaging caused some difficulty early in the summer of 1975.

Most radiotracking was done from the air. A Piper Supercub equipped with a rotatable 3-element yagi antenna was used for most of the work. Stacked yagi antennas mounted on wing struts were available when additional range was required. Weather permitting, flights were made 3 times a week.

The extent of movements of radio-instrumented bears was found by using a center of activity (Harrison 1958, White 1964). Relocation of each animal was plotted on a map, and a geometric center (center of activity) was calculated by superimposing the relocations on a grid system described by Haynes (1949). Standard diameters (SD) for each animal were then calculated by using Harrison's (1958:198) formula:

$$SD = \sqrt{\sum d^2 / N}$$

where d is twice the distance from the center of activity to each relocation and N is the total number of relocations. The standard diameter describes the diameter of a circle that has the center of activity as its center; this circle contains 68.26 percent of all the relocations and thus 68.26 percent of the animal's activity during the period considered. We use the standard diameters as an index for comparison of movements among bears in different areas and different years. We do not ascribe any biological significance to them.

Minimum home range of each bear was calculated by using the minimum polygon that enclosed the bear's known movements (Stickel 1954). We feel that this method presently gives the best biological interpretation of radiotracking data.

RESULTS

Eighteen grizzly bears were captured and instrumented. Twelve of these furnished sufficient data to make some interpretations of seasonal movements. Five bears furnished data for 2 consecutive years. Two bears were trapped inside Yellowstone National Park near Yellowstone Lake, and the rest were trapped in areas surrounding the park.

Both 1975 and 1976 were years of exceptionally high precipitation resulting in lush growth of herbaceous vegetation throughout the study area. We are not sure what effect this had on bear movements but do believe it contributed to relatively poor trapping success. Most bears were trapped in July and August, when they began to concentrate in areas of high food availability.

Grizzly bears in our study area exhibited a variety of habitat use and movement patterns as well as home range sizes. We use Calhoun's (1963) definition of home range. On 27 August 1976, 11 single bears and 3 family groups were located. Elevational differences among bears ranged from a low of 1,920 m to a high of 2,999 m on this day. Habitat types being used included wet meadows, dense lodgepole pine stands, subalpine fir (*Abies lasiocarpa*), and spruce (*Picea engelmannii*).

The movements of any individual bear were apparently influenced by the habitat types available to it, the amount of forage available, and prior experience. Data on 2 bears immediately after emergence from the den illustrate the difference between available habitats. A 5-year-old male (No. 7) that denned in northern Yellowstone Park moved from his denning area to an elk winter concentration area where he partially consumed a winter-killed elk and then killed and consumed an adult elk. Six days later, he killed an elk calf and consumed it. A 4-year-old female (No. 4) that denned west of Yellowstone Park was 26 airline km and over one mountain range from the nearest ungulate winter range when she emerged from her den. Her early spring movements were between her den site and areas where she could find squirrel caches, insect larvae, and grass, which were essentially the only forages available at the time.

A female (No. 16) with 2 cubs of the year appeared to be highly motivated by previous experience in her movements. Trapped near Hebgen Lake in August, she moved to Yellowstone Park for 10 days where she apparently spent most of her time digging for roots on the periphery of small ponds and swamps. She then returned to the vicinity of Hebgen Lake where she fed on the carcass of a dead horse and spent some time in close proximity to the West Yellowstone dump, which had

been bearproofed for 4 years. The bear then returned to Yellowstone Park where she resumed digging around ponds and swamps until she denned. This bear's movements from Yellowstone Park to Hebgen Lake were probably influenced by prior experience of finding carrion in that vicinity and feeding at the West Yellowstone dump before it was bearproofed.

Minimum home range sizes for 4 bears trapped at Cooke City dump in 1975 are shown in Fig. 2. Minimum home range sizes in km² are given in Table 1. Somewhat comparable information for 3 of these bears appears in Table 2 and Fig. 3, as well as information on 3 additional bears.

Movement patterns of these bears were diverse although their ranges overlapped. Two, a 15-year-old male (No. 9) and a 5-year-old female (No. 10), concentrated their activities around and near the Cooke City dump.

An 8-year-old male (No. 5) divided his time almost equally between the Cooke City dump and some natural

Table 1. Minimum home ranges of 5 radio-instrumented grizzly bears. Inter-agency Study Area, 1975. Bears were in dens by last date of respective tracking periods. Home range sizes approximated areas used during tracking periods and do not necessarily represent total home range size.

Bear no.	Sex	Age (years)	Tracking period	Minimum home range (km ²)	Number of locations
4	F	3	Jul 75 to 22 Dec 75	324	41
5	M	7	Jul 75 to 14 Nov 75	158	34
7	M	4	Aug 75 to 22 Dec 75	262	34
8	F	9	Aug 75 to 14 Nov 75	62	25
10	F	4	Sep 75 to 14 Nov 75	18	9

range centered 23 airline km to the west. He used the same basic movement patterns and general range area and even denned in the same natural cave for 2 successive years.

A 10-year-old female (No. 8) used the same general area for 2 years. In 1975, she spent some time at the Cooke City dump, but more of her time was spent on

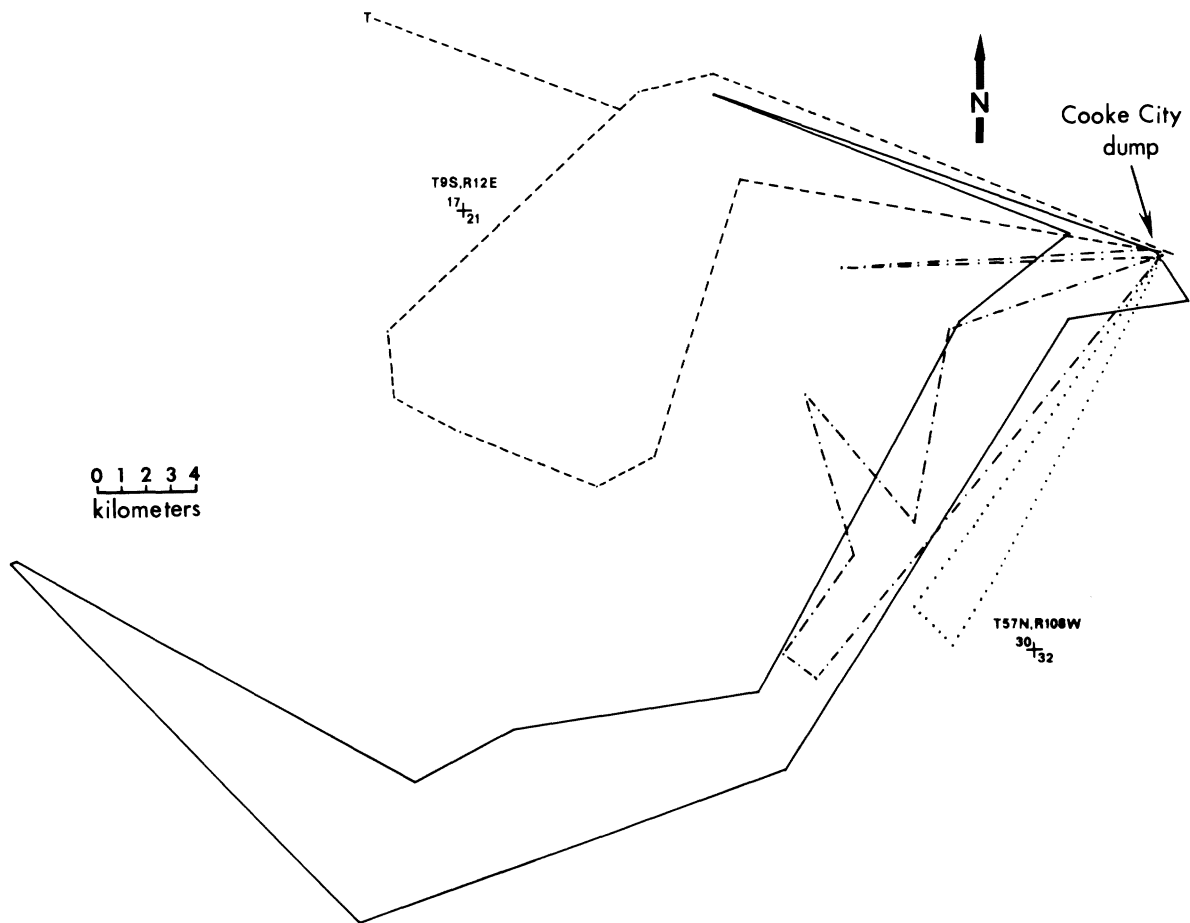


Fig. 2. Minimum home range areas of 4 instrumented grizzly bears: summer to denning, 1975.

Table 2. Minimum home ranges of 12 radio-instrumented grizzly bears. Inter-agency Study Area, 1976. Bears were at dens by last date of respective tracking periods except for bears No. 8 and No. 14. Home range size approximate areas used during tracking periods and do not necessarily represent total home range size.

Bear no.	Sex	Age (years)	Tracking period	Minimum home range (km ²)	Number of locations
4	F	4	3 Apr 76 to 29 Oct 76	194	51
5	M	8	28 Jul 76 to 3 Nov 76	212	24
6	F	7	14 Jul 76 to 22 Nov 76	523	39
8	F	10	10 Apr 76 to 19 Oct 76	150	27
9	M	15	9 Aug 76 to 5 Nov 76	117	28
10	F	5	4 Aug 76 to 5 Oct 76	26	18
11	M	6	18 Jun 76 to 20 Oct 76	255	35
12	F	Adult	9 Jul 76 to 3 Nov 76	174	38
13	F	7	11 Aug 76 to 5 Nov 76	741	28
14	M	9	13 Aug 76 to 15 Sep 76	98	13
15	M	5	16 Aug 76 to 8 Nov 76	93	23
16	F	10	18 Aug 76 to 11 Nov 76	350	29

natural range. In 1976, she was accompanied by a cub-of-the-year and again spent most of her time on natural range. She may have made 1 or 2 trips to the Cooke City dump.

A 4-year-old male (No. 7) used the Cooke City dump from summer into early fall in 1975. He moved west from the dump to a fall range, then on to a denning area about 40 airline km from Cooke City. His transmitter failed in early April and he was not relocated.

An adult female (No. 13) accompanied by a cub-of-the-year was trapped on 11 August 1976 at the Cooke City dump. She was not relocated at the dump after this date. Her movements were characterized by long-distance traveling. During the tracking period, she and her offspring used the largest minimum home range, about 741 km², that we documented. This home range is about 63 km long east to west, with the park boundary at the center of its east-west axis.

An adult male (No. 11) trapped east of the park area did not use or even approach the Cooke City dump. His home range was fairly well defined and randomly used (Fig. 3).

Two grizzly bear home ranges (Fig. 4) were apparently associated with spawning runs of cutthroat trout (*Salmo clarki*) from Yellowstone Lake. One adult female (No. 12) trapped in July 1976 had a distinct summer range separated by a migration corridor from her spring-fall range. These areas lie about 14.5 airline km apart. The other (No. 6), a 5-year-old female, apparently used the same spawning area, but there the resemblance ended. This bear was trapped in July 1975 while working spawning trout, but her radio failed before much information could be collected. We determined that she ranged several kilometers west-northwest of the trap site on Yellowstone Lake to the Old Faithful area. She was retrapped in July 1976 at the

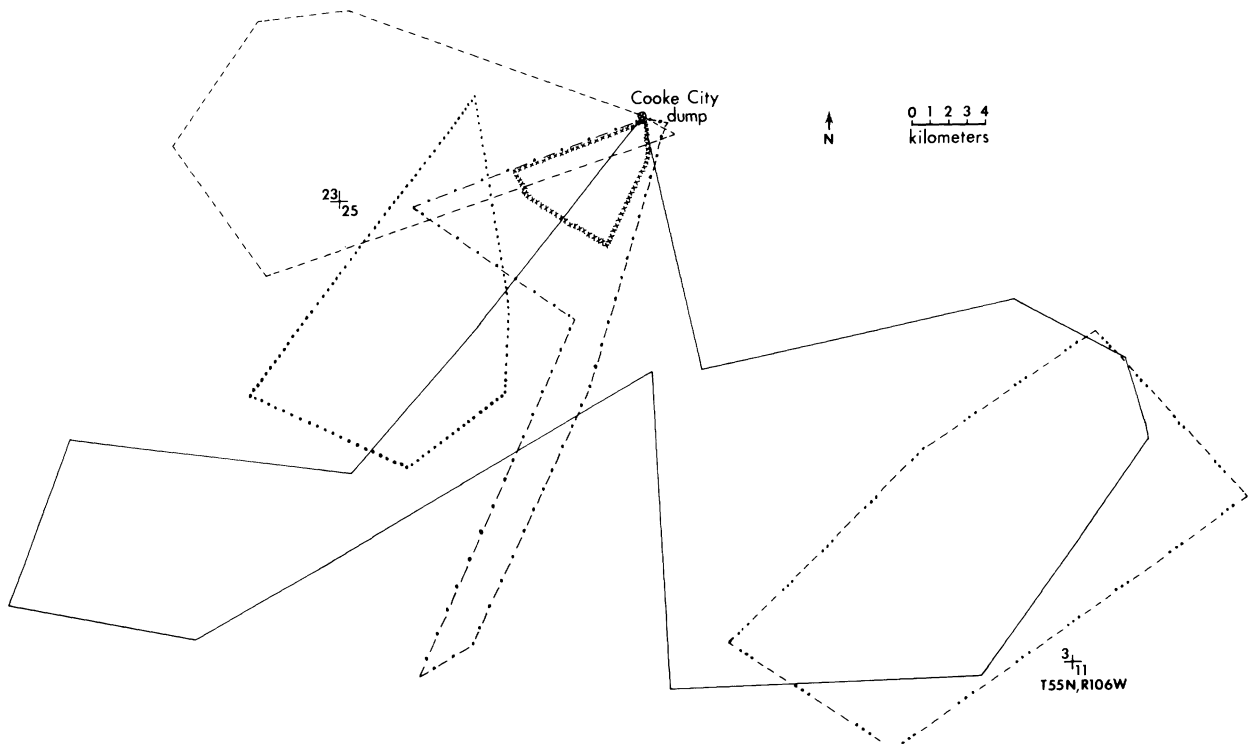


Fig. 3. Minimum home range areas of 6 instrumented grizzly bears, 1976.

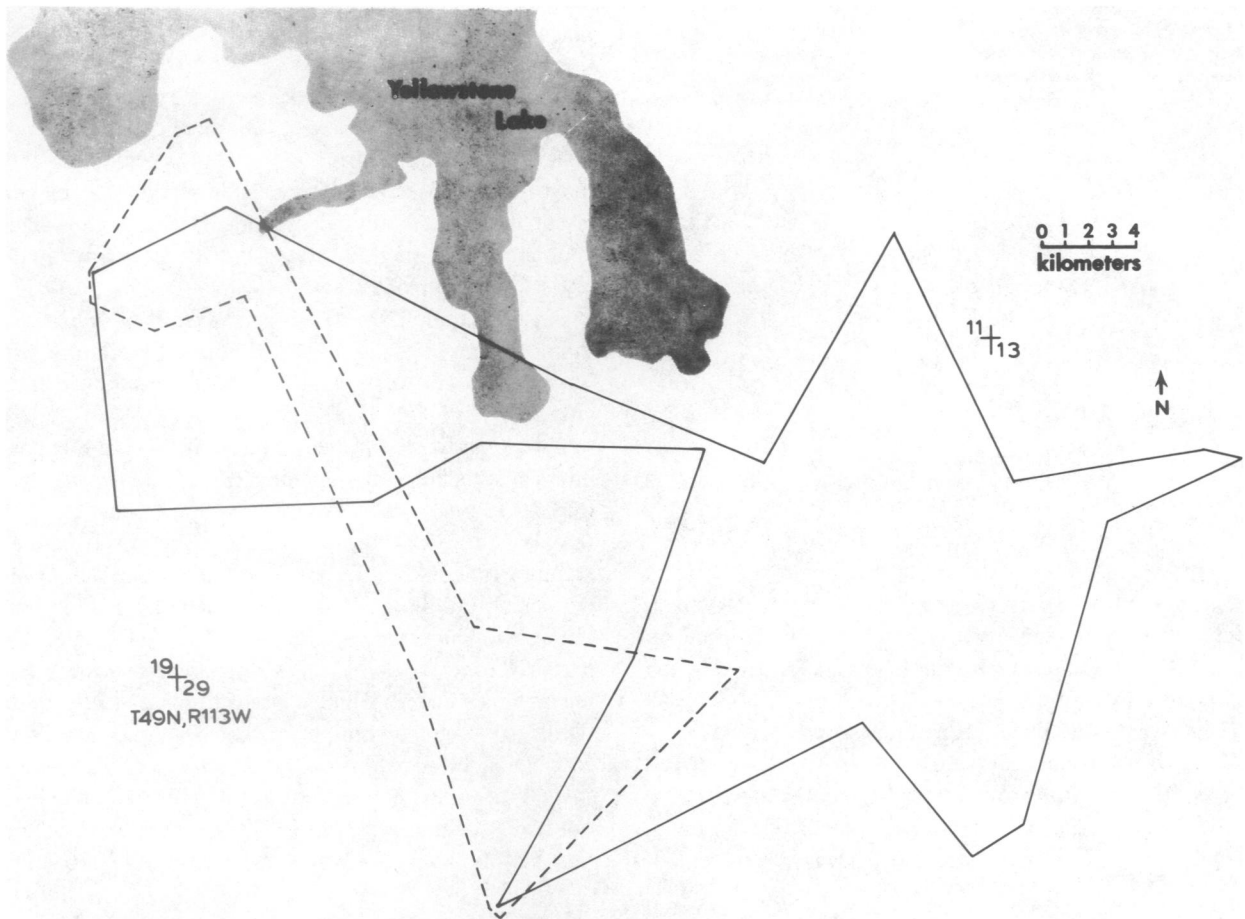


Fig. 4. Minimum home range areas of 2 instrumented grizzly bears, 1976.

same trap site and moved opposite to her previous year's range. She traveled east and south-southeast from Yellowstone Lake and eventually out of the park. The only known area of home range overlap between the 2 years was on the trout spawning area. She returned to an area near Heart Lake to den, and it is possible that she denned in this vicinity in 1975-76. In all, she used a minimum home range of 523 km² in 1976.

Minimum home ranges of a young female, an adult female with 2 cubs-of-the-year, and an adult male are presented in Fig. 5. The young female (No. 4), 4 years old in 1976, was tracked for portions of 2 years. She used a minimum home range of 324 km² in 1975. During 1976, she used only the northern 194 km² of her previous range. A partial explanation of this decreased range use may lie in the fact that she was traveling with a large bear throughout 1975. She either denned with or in close proximity to the other bear in 1975. However, they were not observed together again after a few days following emergence from the den, between 3 and 6

April 1976. She remained at or in the vicinity of the den site at least until 6 July.

The adult female (No. 16) with 2 cubs-of-the-year used 2 summer-fall range areas lying about 29 airline km apart. One was a natural forage area; the other appeared linked to garbage and livestock carrion. This family group was highly mobile at times; they once moved about 23 airline km in about 23 hours.

The 5-year-old male (No. 15) was trapped in West Yellowstone, Montana, in August 1976. He used a deceptively small, 93-km² summer-fall range. This male was originally trapped in August 1974 at West Yellowstone and by agreement between Montana and Wyoming Game Departments was transplanted into Wyoming. He denned just west of Cody, Wyoming, in 1974 and remained in the transplant area at least through mid-June of 1975. It is not known by what route he returned to West Yellowstone, but the minimum distance between his 1974 den site and the recapture site is 153 airline km.

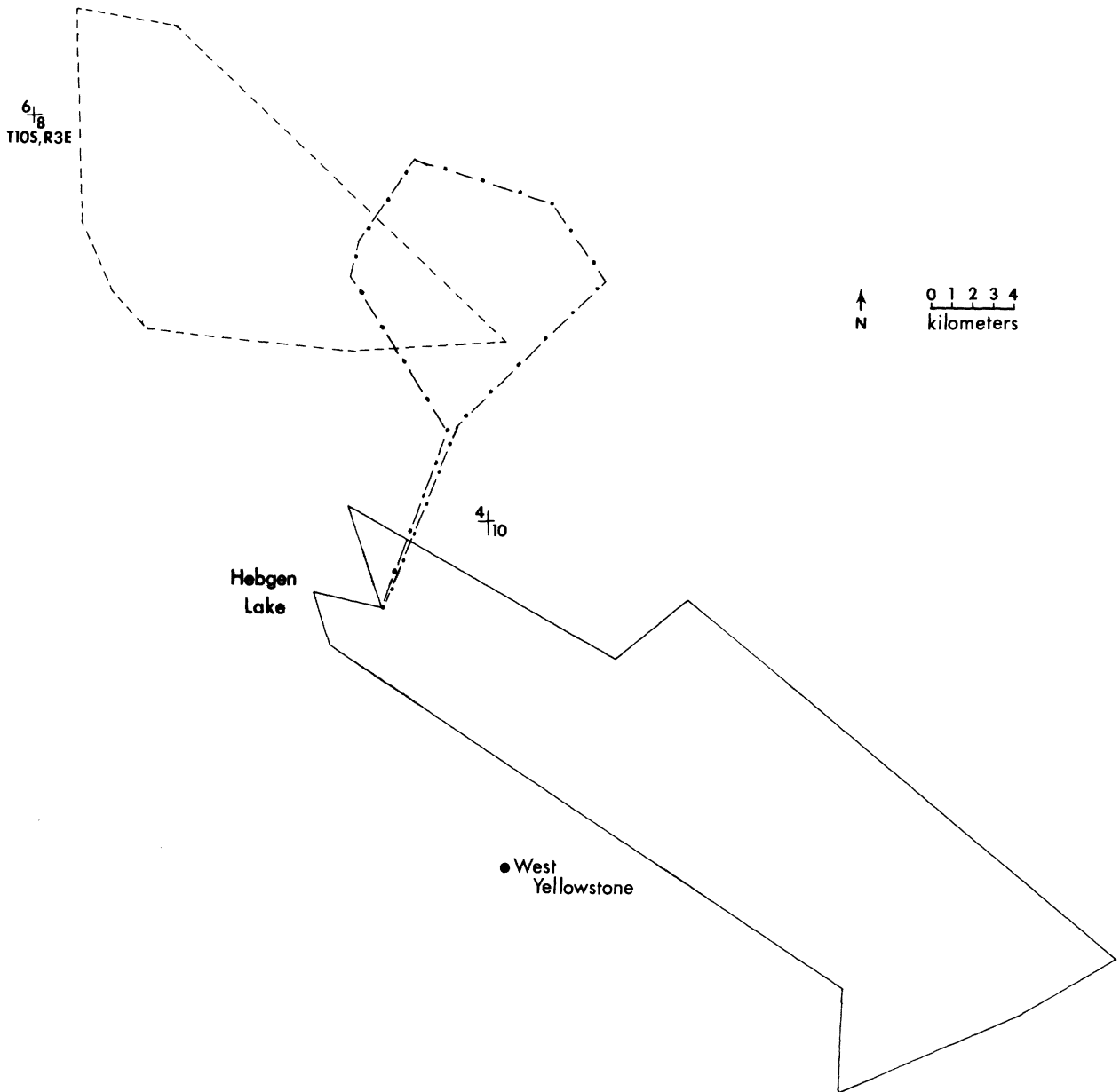


Fig. 5. Minimum home range areas of 3 instrumented grizzly bears, 1976.

DISCUSSION

Use of standard diameters was a poor method of measuring year-long movements and home ranges of grizzly bears. Only 3 bears used their entire home ranges in a uniform enough manner to permit the establishment of year-long activity centers (Table 3). Most of the bears made relatively long movements between

seasonal foraging areas or to den areas. For those bears, we calculated geometric centers and standard diameters on areas of more concentrated use rather than include all of the movements in one figure, which, in most instances, would have given an unrealistically expanded movement index.

Similar data gathered by Joslin (personal communication) for grizzly bears west of the Continental Divide

Table 3. Ranges of activity of radio-instrumented grizzly bears, Interagency Study Area, 1975-76, as indicated by standard diameters of areas of activity. Numbers of observations do not include location checks when bears were in dens. Numbers of days indicate minimum time spent in areas and include time in dens where applicable.

Bear no.	1976				1975			
	Standard diameter (km)	No. of observations	Season(s) of use	No. of days	Standard diameter (km)	No. of observations	Season(s) of use	No. of days
4	13.15	52	All	315	17.65	41	Summer-fall	156
5	20.18	23	Summer	79	14.34	28	Summer-fall	84
	0	1	Predenning	58+	1.88	6	Predenning	26
6	20.44	27	Summer-fall	89	-	-0-	-	-
8	-	-	-	-	11.00	5	Summer	15
	11.18	26	All	196+	5.30	20	Fall to denning	67
9	9.66	18	Summer-fall	67	-	-0-	-	-
	3.09	3	Predenning	74	-	-	-	-
11	15.90	35	Summer-fall	125+	-	-	-	-
12	11.43	16	Summer	46	-	-	-	-
	6.97	22	Spring-fall	125	-	-	-	-
13	28.94	20	Summer-fall	63	-	-	-	-
	0.89	3	Predenning	66	-	-	-	-
16	12.70	18	Summer-fall	60	-	-	-	-
	8.26	11	Summer-fall	66	-	-	-	-

indicate that standard diameters for entire home ranges in that area may be comparable in size to diameters of seasonal use areas in the Yellowstone vicinity. In only 4 instances associated with predenning were movements concentrated in small areas.

Grizzly bears within the study area do not observe political or management agency boundaries, and movements across these were not restricted to any given area. Two of the 18 grizzly bears radio-instrumented in 1975-76 died before much information could be collected on them. Fourteen of the bears freely crossed into and out of Yellowstone National Park. Only 2 instrumented bears are not known to have ranged into the park.

CONCLUSIONS

Information gathered to date indicates that grizzly bear movements in the Yellowstone area are not typical of those found in other areas. Our movement data, especially of females with young, show much larger home ranges than those reported by Pearson (1975) for the Yukon Territory or by Berns and Hensel (1972) for Kodiak Island. Craighead and Craighead (1969) show ranges smaller than ours for most of their animals, but the movements of their radiocollared bears may have

been influenced by abundant food sources at the Trout Creek dump, which was still in operation at that time.

Much of the difference between the movement patterns of bears in our study and those reported for bears in Alaska and Canada can probably be explained by wide differences in habitats and available foods. Differences from bears west of the Continental Divide in northern Montana may also be explained this way. Mealey (personal communication) has found approximately twice as many forested habitat types of apparent importance to grizzly bears in northwestern Montana than occur in the Yellowstone area.

The topography of Yellowstone Park may promote long movements. Although most of the area lies above 2,134 m, it is relatively flat. A grizzly bear on Yellowstone's Central Plateau may have to travel over 32 km to gain 305 m in elevation.

Prior experience appears to play an important part in the use of seasonal ranges by some bears. Bears that formerly fed at garbage dumps in Yellowstone National Park were probably forced into relatively long movements at times of the year when dumps were not in operation. Some of the movements of our radio-instrumented bears indicate that they periodically check the West Yellowstone dump even though it has been bearproofed for about 4 years.

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