

PANEL 1: THE ECOLOGY, POPULATION CHARACTERISTICS, MOVEMENTS AND NATURAL HISTORY OF BEARS

Radio Tracking Brown Bears on Kodiak Island

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SUMMARY

As part of a continuing study on brown bears (*Ursus arctos*), the movement patterns and activities are described on the basis of 247 fixes obtained from 14 radio-equipped bears during the summer and fall seasons of 1967-69 at the Kodiak National Wildlife Refuge, Alaska. The size of individual activity areas established by eight bears averaged 5.5 square miles and four bears used two activity areas each that averaged 5.7 square miles in size. Activities were associated with food gathering and winter denning. Fix frequency and location indicated that the 14 bears studied spent most or 50 percent of their time in lowland habitat.

INTRODUCTION

One objective of our long-term investigations was to determine the movement patterns and habitat requirements of brown bears (*Ursus arctos middendorffi*) on the Kodiak National Wildlife Refuge in Alaska. A total of 202 bears were live-trapped during periodic field studies conducted from 1959 to 1966, using techniques described by Troyer & Hensel (1961). Each bear was marked so recoveries and field observations could be the means of obtaining this information. Effectiveness, however, was reduced by a high incidence of marker loss and an excessive time lapse between observation or recovery dates.

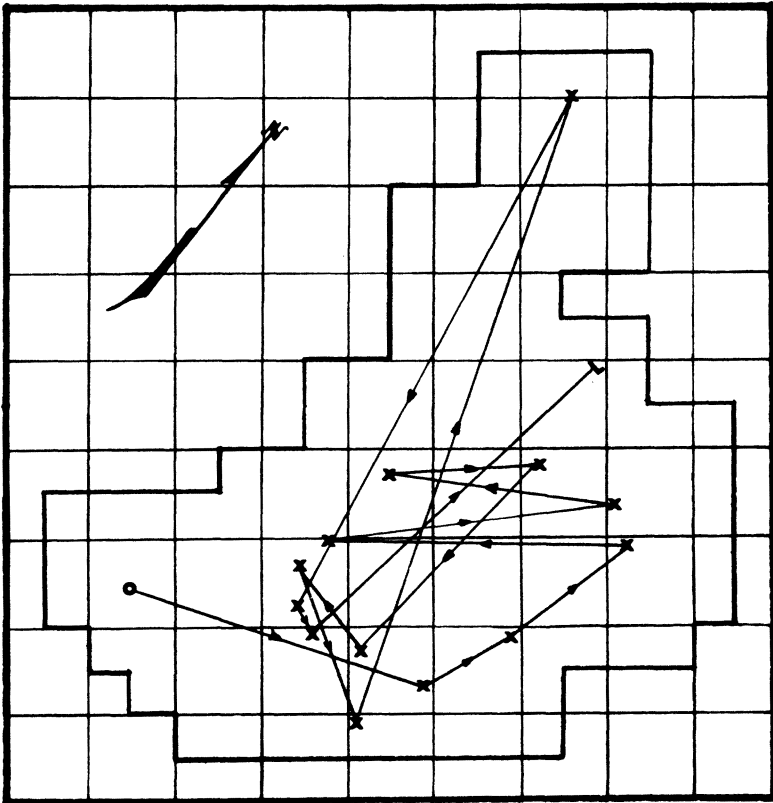
A radio tracking study has been in progress since 1967 in an attempt to obtain more refined data (Berns 1968). This paper reports the findings made of movement and habitat use patterns noted during summer and fall seasons of 1967-69. Special credit is given to P. Martin and W. Dodge for their guidance in the use of electronic equipment.

MATERIALS AND METHODS

The 14 bears used in this study included 8 females with young, 4 solitary females and 2 mature males which were captured with the aid of steel traps and drug delivery equipment. A radio transmitter was attached as a collar around the neck of each animal (Tester *et al.* 1964). Movements and behavior of radio-equipped bears were monitored from a receiver mounted in a Piper Supercub aircraft and to a lesser extent by hand-held portable receivers

operated by ground crews. As a result of the maritime climate characterizing this region, movements were only monitored from aircraft during favorable flying conditions. A detailed description of equipment specifications and monitoring procedures was given by Berns (1968). A total of 247 fixes obtained from 14 bears was considered adequate to evaluate movements and habitat use during summer and fall periods of study.

The concentration of fix locations indicated that bears made intensive use of certain areas for food gathering and denning purposes. These areas are referred to as *activity areas*. An overlay, divided into quarter section grids (160 acres), was superimposed on a map used to plot the fix locations of each bear. Fix locations were connected with straight lines as shown in Figure 1.



Scale: 1" = 1.124 mi.

Fig. 1 Method for estimating the size of activity areas included summing the 160-acre squares containing fix locations and straight line connections that occurred inside a boundary. As diagrammed, No. 83, a female with two yearlings, ranged in an area approximately 11.7 square miles in size.

A modification of the Boundary Exclusive Method (Stickel 1954) was used to establish a boundary around an activity area. The summation of squares with fixes and straight line connections provided an estimate as to the size of each activity area. In using this method, movements of each bear were assumed to have extended halfway to the next grid. Grids separated along either axis by more than three vacant grids were considered as outside the active boun-

dary. This procedure has the advantage over that of connecting external locations and measuring the enclosed area, in that it gives use intensity and a submeasurement of home range. It may, however, give an exaggerated activity value and also eliminate a grid in which a bear spent considerable time because it was separated by more than three vacant grids. This could happen when no fixes were obtained while an animal was moving between widely separated areas; we considered such movements as migrations and wanderings.

For the purpose of interpreting habitat usage, the approximate location of fixes was subjectively categorized as made in lowland, midland and upland habitat types. Lowlands may be described as valley bottoms containing lakes and streams bordered by grass and brush communities. Midlands consist of brush-covered foothills and uplands are characterized by open slopes or plateaus favoring alpine vegetative types.

RESULTS AND DISCUSSION

Reproductive, feeding and denning activity are important factors that influence the movements of brown bears on Kodiak Island. We recognized that 12 of the 14 bears studied had established at least one activity area during the summer and fall.

Movements between activity areas best fit the definition of migration since bears traditionally traveled over routes that connect adjacent drainages. Variations in salmon spawning chronology, as accorded by different species (*Oncorhynchus spp.*), appeared to have a marked influence on the migratory habits of brown bears. Movements related to winter denning areas may be termed as migrations while others extending outside areas of intense use may best be described as wanderings. Although brown bears may wander for no apparent purpose, we believed berry crops motivated bears to travel erratically in search of this highly preferred food item.

Seasonal Activity and Movements

The fix data indicated that each of eight bears had a definitive area of activity (Table 1). These areas averaged 5.5 square miles in size (range: 2.5 to 11.7 sq. mi.) and provided a source of salmon, a major food item during July, August and late fall. The largest area, approximately 11.7 square miles (Figure 1), was occupied by No. 83, a female with two yearlings. Her activities also differed in that she consistently ranged in the alpine habitat, distant from salmon streams, and presumably denned in the same area.

Seven bears ranged in proximity to salmon streams but four of these apparently wandered to distant foothills to feed on berry fruits. The information presented in Table 2 revealed that four other female bears—3 singletons, 1 female with a yearling—used two activity areas. These areas averaged 5.7 square miles and ranged 1.0 to 13.9 square miles in size. The short term observations of bear No. 50 suggested she had established a salmon feeding area prior to migrating 5.7 linear miles in search of a den site. If more extensive observations were made, we would expect salmon feeding would have been the focal point of her activities. The solitary female, No. 516, provided more complete information in that fix locations were recorded from July 20 through the time she denned on about November 17 (Figure 2). The activity areas she occupied were located in

TABLE 1. ACTIVITY AREA DATA FROM EIGHT FEMALE BEARS INSTRUMENTED WITH RADIO TRANSMITTERS

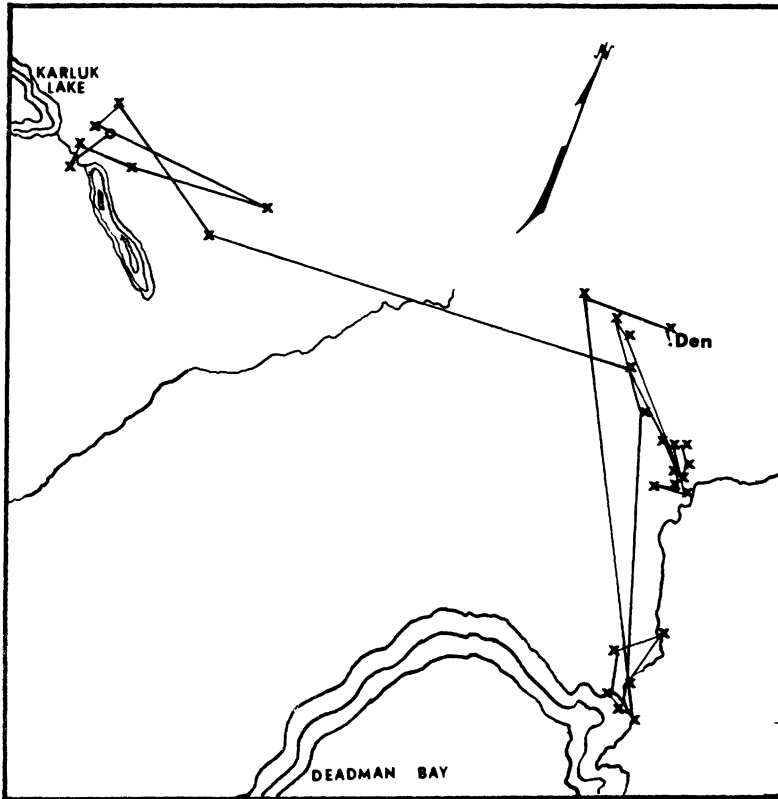
Bear No.	Activity Area Data			Other Data			Remarks
	No. Fixes	Period	Size (sq. mi.)	No. Fixes	Period	Linear Miles Moved	
655	20	7/19-9/5	2.5	—	—	—	Close fix array. Activity—salmon feeding
09	12	8/4-11/9	6.2	—	—	—	Activity—salmon feeding
83	14	8/4-11/9	11.7	—	—	—	Close fix array in alpine habitat. Activity—feeding herbaceous vegetation. Den located near last fix.
33A	20	7/16-8/5	3.8	—	—	—	Close fix array. Activity—salmon feeding
33B	34	8/12-11/7	4.7	2	8/15-9/4	24.0	Moved to adjacent drainage on 2 occasions. Activity—salmon feeding.
38 ¹	26	7/15-7/28	7.0	5	8/1-8/7	6.3	Activity—salmon feeding; probable second activity area.
58	15	7/20-10/31	4.1	1	8/12-8/12	15.9	Approx. 10 days outside activity area. Activity—fishing, berry feeding.
87	7	8/3-9/4	4.6	3	9/11-9/24	10.3	Remained in same drainage. Activity—salmon feeding.

¹ Bears listed had yearling cubs except solitary female No. 38.

TABLE 2. ACTIVITY AREA DATA FROM FOUR FEMALE BEARS INSTRUMENTED WITH RADIO TRANSMITTERS

Bear No.	Activity Area No. 1			Activity Area No. 2			Other Data			Linear Miles Moved	Remarks
	No. Fixes	Period	Size (sq. mi.)	No. Fixes	Period	Size (sq. mi.)	No. Fixes	Period			
50 ¹	4	10/22-10/24	1.0	3	11/11-12/15	1.5	0	—	5.7	Moved from feeding to denning area; den located 12/15.	
42	10	7/21-8/2	7.7	8	8/19-9/17	3.0	5	8/3-8/25	29.4	May have fed on berries while wandering between activity areas.	
516	7	7/20-7/28	7.1	22	8/1-11/17	13.9	0	—	4.6	Moved from feeding area to denning area; den located 11/17.	
57	7	7/16-9/5	4.0	7	10/8-10/18	7.4	3	8/1-8/2	4.0	Moved from feeding area, wandered 4 miles; moved to denning area.	

¹ Bears listed were solitary females except No. 50, a female with one yearling.



Scale: $\frac{1}{2}$ " = 1.37 mi.

Fig. 2 Movement pattern of No. 516, a solitary female, from July 7 through November 17, 1968, revealed the use of two activity areas. The Karluk Lake area, 7.1 square miles in size, offered an abundant supply of salmon while the 13.9 square mile area near Deadman Bay provided berries, salmon and a place to den for the winter.

the Karluk Lake and Deadman drainage and covered approximately 7.1 and 13.9 square miles respectively. Activities at Karluk Lake apparently concerned salmon feeding while those at Deadman involved berry-salmon feeding and selecting a place to den for the winter.

Habitat Use

The frequency and percentage of the time 14 bears were located in three habitat categories is given in Table 3. The fact that bears were located 50 percent of the time in lowlands reflects the effort bears expend in preying on salmon. The foothills characterizing midland habitat are evidently used as resting places between forays to salmon streams and, more importantly, to feed on berries. The phenology of Kodiak Island reveals berries mature concurrently with the seasonal decline of major salmon runs. Bears respond by foraging along midlands and traversing the uplands to descend upon the berry thickets

found along adjacent foothills. Lowlands are occasionally visited as the means of supplementing berry diets with salmon which spawn in diminishing numbers up to the time bears begin to den for the winter.

Obviously, movements of bears differ according to changes in environmental conditions. Major shifts in habitat use can be expected during times of food scarcity or abundance and the processes of winter denning.

TABLE 3. FREQUENCY AND PERCENT () OF THE TIME BROWN BEARS USED THREE HABITAT CATEGORIES DURING SUMMER AND FALL PERIODS

Bear No.	Sex	Habitat Category			Total No. of Fixes
		Lowland	Midland	Upland	
655	F	20(100)	—	—	20
50	F	3(75)	—	1(25)	4
09	F	1(8)	5(42)	6(50)	12
83	F	4(29)	2(14)	8(57)	14
33A	F	6(30)	12(60)	2(10)	20
33B	F	6(18)	27(80)	1(2)	34
42	F	19(79)	4(17)	1(4)	24
38	F	12(63)	3(16)	4(21)	19
516	F	23(74)	3(10)	5(16)	31
57	F	17(57)	11(37)	1(3)	29
58	F	5(30)	11(64)	1(6)	17
87	F	5(56)	2(22)	2(22)	9
19	M	1(11)	5(56)	3(33)	9
86	M	3(60)	1(20)	1(20)	5
Total No. of fixes		125	86	36	247
Time in habitat category (%)		50	35	15	

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