Radiotracking of Grizzly Bears in Yellowstone National Park, Wyoming, 1964

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Grant Nos. 427, 448: For continuation of project begun in 1959 to study the ecology of the Yellowstone grizzly bear *(Ursus arctos horribilis)* by means of telemetry.

This cooperative project continued successfully during 1964. (See also Nat. Geogr. Soc. Res. Repts., 1963 Projects, pp. 59-67.) Cooperating and supporting agencies included the National Geographic Society, National Science Foundation, Philco Corporation, National Park Service, U. S. Fish and Wildlife Service, Boone and Crockett Club, New York Zoological Society, Wildlife Management Institute, Environmental Research Institute, and the Yellowstone Park Company (which contributed buildings and utilities in the Park). Research team collaborators included Frank C. Craighead, Jr.; John J. Craighead; Joel Varney, Philco Corporation; Hoke Franciscus (W3ELV), Carlisle, Pennsylvania; and Bob Ruff and Dick Ellis, Montana Cooperative Wildlife Research Unit.

The main objective of this season's radiotracking was to gather specific ecological data relative to the grizzly by instrumenting and tracking selected animals, such as dominant bears, orphans, yearlings, sows with families, and problem bears. Another objective was to develop and experiment with transmitters and external sensors for telemetering physiological information from free-roaming animals. Emphasis was placed on developing and testing methods for telemetering body temperature and EKG.

A long-range aim of the biotelemetry research is to correlate physiological information obtained via radiotelemetry with activity patterns of free-roaming animals determined simultaneously through radiotracking. In the case of the grizzlies, this telemetric information is being correlated with ecological data on environment and with population phenomena and other data gathered by more conventional methods. The telemetric information, by supplementing other data, is filling gaps in our knowledge of the ecology of the grizzly and is providing insight into cause-and-effect relationships hitherto not understood.

Since 1959, 198 different grizzlies have been captured, individually marked, and numbered. A total of 342 grizzlies have been handled during the six years of the ecological study. Sixty grizzlies were captured from June through September 1964. Of these, 33 were new individuals. Observations and studies of these marked animals have been productive, resulting in an accumulation of related data. Complementing this is information obtained this season from 8 grizzly bears that were instrumented with radio transmitters and tracked for a total of 208 animal-tracking days while their behavior and activities were studied. They were nos. 6, 14, 34, 40, 150, 158, 170, and 194. Two of these, nos. 40 and 150, were instrumented in previous years. Although only 8 were instrumented, 23 were actually tracked and studied as the radio-tagged animals were members of family groups that were cohesive units. These 8 made in all 21 grizzly bears tagged with radios since our biotelemetric research was initiated in 1961. Thirteen of these were different bears. Four were instrumented for two or more years.

In 1964 five additional ranges were plotted, making a total of 10 grizzly-bear ranges determined via radiotracking (fig. 1). As in the past, ranges were delineated from fixes and bearings and from sightings while tracking. Ranges were constructed by drawing connecting lines through the peripheral fixes plotted on topographic maps. All other fixes and sightings lie within the circumscribed area. Two of the five ranges were home ranges, two were summer ranges, and one was a fall range. For the first time we definitely worked out a home range which embraced the animal's annual movements and included its hibernation den. We also delineated a fall range that was separate and distinct from the grizzly's summer range. We have found that this pattern of summer and fall ranges separated by considerable distance is typical of some grizzlies. Sufficient information has accumulated to reveal great variation in the size of individual ranges, but in all cases there have been small localized areas of activity where individual bears spend a great deal of their time. (See table 1.)

The range of no. 40 was plotted for the fourth consecutive year, and with the location of her "hibernation" den a 4-year home range was actually determined. As far as we know, this 6-year-old grizzly has spent her entire life within a home range of approximately 15 square miles. The size of the range increased slightly, when she had a cub, over the size determined for her in previous years. Her pattern of activity remained much the same.

Two families of grizzlies, or 6 bears, were tracked to hibernation dens. Hibernation is used here to mean lethargy, winter dormancy, or sleep—not the torpid state of true hibernation. All dens were located at elevations of

8,200 to 8,400 feet. All were on slopes, all in timber, all far removed from man and his influences, and all had a northern aspect. With one exception dens were located with the entranceway beneath the base of a large tree (table 2). Den excavation was found to begin as early as September 8 when an instrumented grizzly, no. 40, and her cub were approached while digging between the roots at the base of a tree. All the dens have been dug entirely by the animals and have been variously lined with boughs.

Nos. 40 and 158 were tracked to their dens over a 4-day period by means of portable receivers. Approximate fixes were first obtained, a set of

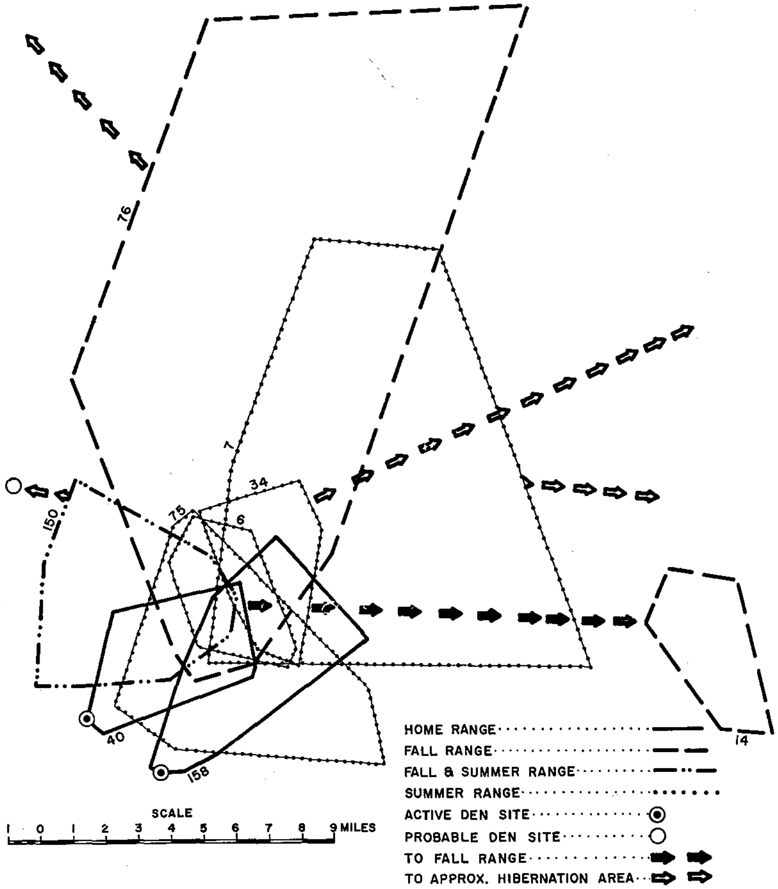

FIG. 1. Grizzly-bear ranges as determined by radio-positioning and radiotracking.

TABLE 1.—GRIZZLY-BEAR RANGES DETERMINED BY RADIOTRACKING, 1963-1964

Year	Bear designation	Number of bearings used in determining range	Number of plotted fixes	Area of ranges in square miles	Remarks
1963	No. 40	140	32	8	Lone 5-year-old female
	150	227	35	27	Sow with cubs
	75	145	21	36	Sow with yearlings
	7	256	32	106	Sow with yearlings
	76	129	21	168	Lone 5-year-old male
1964	6	49	11	12	Lone 5-year-old female
	14	58	5	12	Large adult male
	34	151	26	13	Sow with yearlings
	40	106	27	15	Sow with cubs
	158	98	14	22	Yearling (family of sow and 3 yearlings)

TABLE 2.—GRIZZLY-BEAR DEN DATA

Bear no.	Den location	Vegetation type	Soil structure	Den elevation *(feet)*	Aspect of entrance	Species den tree	Measurements *(inches)* Den L	Den W	Den Ht	Entrance Ht	Entrance W	Entrance L	Years used	Den lining	Hibernation date
164	Upper Alum Creek	Lodgepole pine	Soft earth (loess)	8,200	North slope	Lodgepole pine	59	53	48	40	17	60	1963	Conifer boughs	Nov. 5
158	Upper Trout Creek	Lodgepole pine	Packed soil, gravel layer	8,400	North slope	None	64	60	60	42	30	32	1964	Conifer boughs	Nov. 10
40	Upper Alum Creek	Lodgepole pine, spruce-fir	Packed (loess)	8,200	North slope	Spruce	48	42	48	30	30	36	1963 1964	Conifer boughs	Nov. 10
Unknown[1]	Upper Trout Creek		Compacted	8,200	N. W. slope	Spruce	43	63	43	26	26	64	Prior or 1963	Conifer boughs	
Unknown[1]	Absaroka Range, Mist Creek	Whitebark pine	Rocky	9,000	S. W. slope	Whitebark pine	54	60	36	—	—	—		Conifer boughs	

[1]Inactive den.

bearings being made from the base station 15 miles from the instrumented bears and another set from the field station. One field-station bearing, as later verified, went directly through the den site of no. 40 and the other slightly to the east of no. 158's den.

We tracked the two families in 1-2 feet of snow, closing in on them during daylight and monitoring the signal from their radio-collars at night from our sleeping bags. These animals as well as all other grizzlies in the area moved to their den sites during falling snow. In the four days and nights of radiotracking, we did not cross a single grizzly trail or see any tracks until we were right at the entrance to the dens. The grizzlies did not immediately enter the dens and remain inside as others had done the previous years. The triggering snowstorm of October 30 that moved them to their den sites was followed by clear weather and rising temperatures. Ambient temperature in the shade close to no. 40's den at 1:45 p.m., November 4, was 40° F. Snow was wet, melting, and dropping from trees. There was a 10-day wait from the time the grizzlies arrived at their dens until the final storm on November 10 put them into hibernation or winter sleep, presumably for the rest of the winter. Sow no. 40 and her cub hibernated together, as did sow no. 39 and her three yearlings, including the instrumented one. This sow weighed approximately 550 pounds and her yearlings about 250 pounds each. All four hibernated in the same den and no doubt were closely packed, as the den measured 5 feet high, 5 feet wide, and 8 feet long.

As in past years, movement of grizzlies to hibernation areas and entering of dens were associated with a falling barometer and snowstorms. On October 14 and 15 the minimum temperatures were 28° and 24° F., respectively. It was snowing, and grizzly no. 40 moved to her den site but did not remain there. On October 30 and 31 minimum temperatures were 38° and 35° F. At this time a falling barometer and snowstorm started most grizzlies moving toward their dens. On November 9 and 10 minimum and maximum ambient temperatures were 20° and 24°, respectively, and it was snowing. The grizzlies entered their dens on November 10. Low temperatures alone did not initiate hibernation though gradually dropping fall temperatures in conjunction with fall snowstorms were conditioning factors. Much lower October temperatures in previous years had not caused bears to hibernate. A combination of accumulated snow from previous storms, falling snow (storm), and below-freezing temperatures appear to be needed to put the grizzlies into their dens for the winter. This set of conditions is recognized by the entire bear community and acted upon simultaneously.

Examples of information gathered by means of radiotracking included:

1. A large boar, no. 14, was tracked for 41 days, and his fall range in up-

per Pelican Valley was found to be distinct from his summer range in Hayden Valley.

2. In summer, with food readily available, elk fed and bedded down in timbered areas within 100 feet of grizzlies in their day beds. The elk showed no signs of alarm or uneasiness and the grizzlies no inclination to attack.

3. Sow no. 34 and her family made 11 known crossings of the Yellowstone River between August 3 and August 25. They were observed on one occasion swimming the river at night. Grizzlies entered water and swam rivers more frequently than we had anticipated. This posed the problem of securing better waterproofing for transmitter battery packs.

4. Radiotracking was utilized to follow the movements of transported problem grizzlies. Sow no. 170 was moved twice and each time returned to her home range near Gardiner, Montana. On one occasion she covered 34 air miles of timbered mountainous country in 62 hours before arriving back at Gardiner. This averaged about 0.5 airline mile per hour.

5. A radio-tagged sow and two yearlings were jumped while being tracked. They ran a measured mile in 3 minutes, an average speed of 20 miles an hour across rolling sagebrush country.

6. Both problem bears and aggressive grizzlies were instrumented and information gathered on bear-man relationships. Such information will prove valuable in minimizing bear-man encounters and in anticipating and remedying conditions that might result in attacks by grizzlies.

7. Grizzly movement was measured by radio. Much bear activity can be summed up as considerable traveling without moving very far. As an example, the greatest airline distance between fixes for no. 34 measured for 12- and 24-hour periods was 3 miles, and the average distance between these fixes was 2.6 miles.

Most of the work in physiological telemetry was developmental and experimental in character. Steps were taken to develop an information telemetry capability (EKG, body temperature) that would be compatible with the tracking system. The equipment was constructed by Philco engineer Joel Varney and associates at their Western Development Laboratories. Field tests and experiments were carried out in Yellowstone National Park. Three methods of transmitting information were investigated. Of these, pulse duration modulation and pulse frequency modulation were found to be well suited for the particular requirements of the radiotracking system. Battery life is longer than that possible with an AM or FM system and modification of the present system for telemetering EKG would require only the addition of a detector at the receiver audio output.

Changes were made in a temperature sensitive transmitter with considerable improvement in linearity and repeatability. No grizzlies were instrumented with this, but two elk were instrumented with the temperature-sensitive transmitter in February and interesting data were obtained. As an example, we found that temperature changes in the collar-transmitter could be correlated with certain environmental conditions and with changes in animal activity. We found also that the battery temperature averaged 15° F. above the general air temperatures owing to the warming influence of the animal's body. This warming increases battery efficiency at low temperatures. Such experimental work has paved the way for further development and future testing of a modified transmitter that will telemeter body temperatures from free-roaming animals.

A number of changes and improvements were made in the transmitters. Our tracking results in 1963 indicated that we obtained about as good a range with 100-milliwatt transmitters as with 200. One transmitter was equipped with a Bulova Accutron mechanical timer. The timer turned the transmitter on for 3 minutes at 30-minute intervals, thus reducing the transmitting time by a factor of 10. The useful life of the transmitter is theoretically 600 days or nearly two years, but is limited to about one year by the battery life of the timer. An elk was instrumented with this transmitter in February 1965. Results were quite satisfactory, but tests indicated that 3 minutes on and 15 minutes off would prove more efficient for tracking purposes. A portable "cubicle quad" antenna was built and tested. Range and directional properties compared with a 3-element yagi, and it had the advantage of being portable for backpacking into remote areas.

An inescapable conclusion from the work to date is that biotelemetry, which includes radio location and tracking as well as the transmitting of information from free-roaming animals and from their immediate environment, is emerging as a valuable and needed tool for the study and understanding of ecosystems—that is, the total and complete environment (including man and his influence) with its interactions and interplay of forces constantly altering and adapting in a dynamic system. Man's future is closely allied to his understanding of ecosystems, to his relation to them, and to his intelligent application of this knowledge. Improved biotelemetry equipment and techniques will provide a wide range of information, often distantly, simultaneously, and continuously gathered. Analysis, correlation, and interpretation of such data will open new horizons of knowledge and will widen our perspectives relative to the world we live in. In our times, characterized by change proceeding at fantastically accelerated rates, it is imperative that we take an ecological look and develop a holistic approach to man and his environment. Biotelemetry is one of many research tools that can help provide the factual foundation for doing this. We have reached a point in our civilization where knowledge and its proper application are synonymous with survival. Decisions once made may be irreversible.

Scientists in many disciplines are working diligently to improve and perfect biotelemetry techniques and to apply these to gathering information, much of which has not previously been attainable. Our biotelemetry work with grizzly bears is but one example. The methodology we are helping to perfect and the information we have obtained have, in themselves, we believe, been a contribution justifying the time, energy, and expense involved. Further perfection and broader application of biotelemetry are planned.

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