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Grizzly Bear Ranges and Movement as determined by Radiotracking

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INTRODUCTION

Yellowstone National Park consists of 8,800 km^2. Additional National Forest and Wilderness areas surrounding the Park constitute an ecosystem approximately 50,000 ha in size (Craighead *et al.* 1974). Within this extensive coniferous forest habitat, movements of grizzly bears, *Ursus arctos horribilis,* were determined by observating 264 marked animals and monitoring 23 radio-tagged bears (Craighead & Craighead 1972; Craighead *et al.* 1974).

The closure of the open pit dumps and the control measure initiated in Yellowstone National Park to cope with the increased incidence of grizzlies visiting campgrounds affected movements and home ranges of grizzlies within the ecosystem (Craighead & Craighead 1971). This paper deals with the general patterns of movement and characteristics of home and seasonal ranges prior to the closure of dumps.

Many grizzlies in this vast area were seen at one or more of the earth-filled garbage dumps at some time during their life spans. In a 12-year period, 39 percent of bears censused at dumps were marked, and 76 percent of the ecosystem population was observed and counted at the dumps during this time (Craighead *et al.* 1974). Thus 76 per cent of the average population of approximately 229 animals moved to and from garbage dumps. This massive movement within and beyond Yellowstone Park affected the character of home ranges. Since this movement pattern became established over 60 to 80 years, it represented a well-established pattern, similar to movements observed in Kodiak brown bears, *Ursus arctos middendorffi,* attracted to salmon streams (Berns & Hensel 1972). Data analyses are within the context of these habitual movements to available food sources.

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METHODS

From 1961 through 1968, 48 radio instrumentations were made involving 23 different grizzlies. Twenty different ranges of grizzly bears were delineated: five in 1963, five in 1964, three in 1965, two in 1966, three in 1967, and two in 1968. Of these, seven were home ranges and one a lifetime range. Entire families were involved when one member was instrumented, thus the home ranges of family groups as well as the ranges of the radio-tagged individuals were plotted.

Grizzlies were radiomonitored up to 3 months with standard model transmitters and for as long as 9 months with extended life transmitters featuring a timer circuit that turned the transmitter on and off at 30-second intervals (Craighead & Craighead 1972; Varney 1971). Radio signals were used to accurately fix the position of instrumented bears and to determine the approximate location of bears within home or seasonal ranges. Lines connecting peripheral fixes were used to construct ranges on topographic maps (Craighead 1968). Unless there was extensive movement, usually only one daily fix was recorded. A single radio bearing often indicated whether a bear was within a tentatively established range or possibly moving beyond it. A change in signal strength with regulated volume often provided the approximate distance from signal source (bear) to the receiver.

The percentages of successful days in locating by radio were high. Failure to obtain a fix or locate an instrumented animal was due to limited receiver range or shielding effect of terrain. Ranges were delineated from fixes, bearings, and sightings while tracking.

Two hundred and sixty-four grizzlies were immobilized and color marked. Some sightings of marked grizzlies were used in determining bear movements and others supplemented radiotracking data on ranges.

RESULTS

Home Range Characteristics

Seasonal and home ranges varied in size (Tables 1 and 2) as influenced by availability and distribution of food, proximity of mates, den site requirements, habitat preference, foraging habits, age, sex and condition of the animals, and other factors. Home range with some modification is defined as 'that area traversed by the individual in its normal activities of food gathering, mating and caring for young.' (Burt 1943). An area occupied in one or more seasons or years is designated a home range if it included a den site. A seasonal range is an area utilized during spring, summer or fall but excludes the den site. The periods coincide generally with those derived from the spring and autumn equinoxes and summer and winter solstices. (Craighead *et al.* 1973). A lifetime range is the range determined for a bear throughout all or most of its life. Although a home range tends to be a stable unit, it may vary from year to year. In general a lifetime range is larger than a home or seasonal range but some seasonal ranges closely approximated home ranges, as for example the 70 km^2 area of grizzly No. 150. The den, which was not located, was either within the seasonal range or very close by (Tables 2 and 3). Home ranges varied from a maximum of 324 to the smallest of 18 km^2. Seasonal ranges varied from 435 to 20 km^2.

The ranges were affected by a prevalence of food at the Trout Creek refuse area but natural food sources such as animal carcasses, berries and pine nuts

TABLE 1. GRIZZLY BEAR HOME RANGES DETERMINED BY RADIOTRACKING

Bear No.	Sex	Tracking Years	Tracking Days	Range Area in km^2
7	F	1963	44	275
40	F	1963-68	400	78
101	F	1966-67	125	111
150	F	1963	33	70
158	M	1964	51	57
39	F	1964	51	57
187	F	1967-68	98	104
202	M	1965-66	174	324

TABLE 2. GRIZZLY BEAR RANGES DETERMINED BY RADIOTRACKING 1963-1964.

Bear No.	No. of Bearings Used	Tracking Days	No. of Fixes	Range Area in km^2	Remarks
7	256	44	32	275	Female with yearlings
40	140	29	32	202	5-year old female
75	145	44	21	93	Female with yearlings
76	129	28	21	435	5-year old male
150	227	29	35	70	Female with cubs
6	49	19	11	31	5-year old female
14	58	41	5	31	Large adult male
34	151	34	26	34	Female with yearlings
40	106	67	27	39	Female with cubs
158	98	51	14	57	Yearling (Family of female and 3 yearlings)

influenced movements and thus the sizes of individual ranges. Some grizzlies had relatively small seasonal ranges because they foraged and denned nearer the dump in Hayden Valley and fulfilled other requirements including mating and the need to have daytime retreats and a combination of timber and open meadow in this rather localized area.

Grizzly bear No. 76 had a seasonal range of 435 km^2. His center of activity was Hayden Valley, but foraging trips from Hayden Valley to outlying areas expanded his range. In a 1-week period he was tracked for 80 airline km. His signal was lost during fall migration to the north-eastern portion of Yellow-

TABLE 3. FEMALE GRIZZLY BEAR RANGES.

Bear No.	Age	Year	Tracking Days	Range Area in km^2	Type of Range
6	5	1964	19	31	Summer & fall
7	Adult	1963	44	275	Summer
34	Adult	1964	34	31	Summer
40	5	1963	29	20	Summer & fall
	6	1964	67	39	Home
	7	1965	106	52	Home
	8	1966	76	18	Home
	9	1967	16	28	Home
	10	1968	106	58	Home
75	Adult	1963	44	93	Summer
150	Adult	1963	29	70	Summer & fall
101	Adult	1967	49	111	Home
187	Adult	1967	65	106	Home
187	5	1968	33	87	Home

stone Park, an indication that his home range was many times the size of the measured summer range and consisted of two seasonal ranges connected by a corridor. Grizzly No. 14 also had a summer range of unknown size in Hayden Valley. During fall dispersal this boar moved directly to forage in upper Pelican Valley. This seasonal range apparently included his den site and measured 31 km^2. Although the home range of No. 14 was extensive, only the approximate size was determined. A year after we plotted his fall range, he was observed at Flat Mountain Arm of Yellowstone Lake, 39 airline km away on the opposite side of the lake. This was an estimated ground distance of at least 97 kilometers from the location last observed. The home range of No. 14, though not entirely disclosed by radio fixes, was 2, 600 or more km^2 in size. Other grizzilies also had similarly large home ranges. Long term movements of some bears indicated that a large portion of the ecosystem might be covered in a lifetime. However, seasonal ranges were localized and not excessively large. The availability of food during spring, summer and fall more than any other factor tended to limit seasonal range size.

Types of Ranges

Two types of home and seasonal ranges plotted by radio consisted of a discrete, well-defined one used throughout the year and a summer foraging area connected by a migratory corridor to a late fall-early spring range that contained a winter den site. This pattern of summer and fall ranges separated by considerable distance is typical of some male and female grizzlies. As examples, boars No. 76, 14 and 12 exhibited such ranges as did sows No. 96, 164 and 34. In the course of a week No. 96 and her cubs travelled 50 airline km from her spring range and den area to her summer range. The largest discrete range

of a female was that of No. 7 measuring 275 km^2 (Table 3). This bear over the years established a summer range in the Sour Creek drainage east of Yellowstone River. Her sibling, No. 6, developed a range partially within her mother's. This group regularly foraged east of the river but periodically swam the Yellowstone River to obtain food at the Trout Creek dump. In contrast, grizzly No. 150 and her cubs had a summer and fall range of 70 km^2 west of the dump, but during the period of tracking never visited it.

Ranges of mature and young males were larger than those of females (Table 4). The summer range of male No. 76 was 435 km^2, the home range of No. 202 was 324 km^2, and the fall range of No. 14 was 31 km^2. However, the home range of No. 14 was many hundreds of km^2 and his lifetime range was several thousand or more km^2. Yearling male No. 158 had a home range of 57 km^2, a range influenced by and identical to that of his mother No. 39. Before weaning, grizzly No. 188 had a range identical in size to his mother's, 52 km^2. His summer range was reduced following weaning, but in fall he travelled rapidly to an unknown but distant denning site, thus expanding his individual range over that of the family range before we lost his radio signal. He developed a pattern of a summer range separated by a migratory corridor from a late fall-early spring range. The range of grizzly No. 202 was taking on the pattern of a discrete range expanding in size from 70 km^2 in 1965 to 324 km^2 in 1966 (Table 4). The control-killing of this bear in August 1966 prevented further study of his life range. He denned on the steep slope of Yellowstone Canyon, within a home range which included Canyon Village campground where he associated food, in some cases handouts, with man. This foraging habit cost him his life. Had this grizzly followed the movement pattern of many sub-adult boars, be might eventually have left this early established range to forage or to wander and thus either establish a migratory corridor to a new summer or fall range or greatly expand his life range.

Range Overlap and Territoriality

Although grizzly bear ranges conformed to two patterns, they were discrete entities with only minor modifications. Within any one spatial entity, numerous grizzlies conducted daily and seasonal activities without major conflict or defense. Ranges overlapped and thus were not spatially separated as with territorial species (Craighead & Craighead 1956). Grizzlies congregated at

TABLE 4. MALE GRIZZLY RANGES DETERMINED BY RADIO-TRACKING.

Bear No.	Age	Year	Tracking Days	Range Area in km^2	Type of Range
14	Adult	1964	41	31	Fall
76	Young Adult	1963	28	435	Summer & fall
158	1	1964	30	57	Home
188	1	1965	19	52	Summer
202	1	1965	56	70	Home
	2	1966	118	324	Home

such food sources as refuse dumps, carrion, berry patches, pinenut stands, clover fields, and sedge seepages. Their daytime beds were made nearby in dense timber, and numerous grizzlies regularly used the same timbered retreats simultaneously. When 'closing in' on an instrumented grizzly, we on separate occasions jumped 7 and 13 bears within several hundred meters. Territorial defense of seasonal or home ranges has not been observed, and all behaviour indicates that defense activities are largely non-existent. Range peripheries are definitely not defended, feeding areas are sometimes temporarily defended, and den sites are not defended against mature members of the same sex. Grizzlies No. 40 and 101 with their families visited one another's dens regularly (Craighead & Craighead 1972). Occasionally at refuse dumps or around carcasses a show of dominance is used to temporarily delay communal feeding.

Observations in April and May 1965, revealed a slight indication of territorial defense related to status in the bear social hierarchy. This hierarchy is based on aggressive-submissive behaviour (Hornocker 1960). We had been watching a large unmarked boar feeding on a buffalo, *Bison bison*, carcass on an island in the Yellowstone River. The radiotagged sow No. 40 and her yearling No. 188 also approached this food source. The sow and her yearling usually waited on a nearby river terrace and fed only toward morning after the boar had left. On one occasion the boar, sow and yearling approached the carcass at the same time. The boar upon detecting the sow turned and slowly circled in a manoeuver to get between the sow and a wooded retreat. This caused the sow and yearling to retire keeping 250 to 450 m from the boar. As the boar circled, the sow also moved back. This could be interpreted as an exhibition of territorial defense of an extensive area surrounding a temporary food source, but was more akin to submissive behaviour in the presence of an aggressive male.

Range Activity Centers

Within their seasonal or home ranges grizzlies spent much of their time in localized areas or activity centers. For example, grizzly No. 150 and her three cubs foraged within approximately a 25 km^2 area, obtaining prehibernation food requirements within this restricted locale. Their efficiency as omnivorous foragers was revealed. Two heavily utilized foods were meadow mice, *Microtus* spp., at peak population densities, and grass showy melic, *Melica spectabilis*, whose starchy, onion-like bulbs form a staple fall food for Yellowstone grizzlies. Pocket gophers, *Thomomys talpoides*, were also preyed upon. The size of this activity center which was determined by available food and nearby timbered retreats indicated the potential carrying capacity of an open meadow, grass-sagebrush sub-climax for grizzlies (Craighead 1968).

Lifetime Range

A lifetime range was plotted for female grizzly No. 40 from age 3.5 years to death. She was instrumented for 8 consecutive years from 1961 through 1968 (Table 5). She was tracked by radio for 32 days in 1961 and 10 days in 1962. Radio fixes plus sightings revealed that her seasonal range as a subadult was about 21 km^2 but this did not include her den site. In 1963 as a mature sow her range was 21 km^2, but again this did not include the den site. In 1964 No. 40 and her cub was tracked 67 days and her den located. The cub was one of her initial litter of two. One disappeared and was presumed dead. The increasing amount of foraging with a cub and movement to a den site at higher elevation expanded the size of her home range to 39 km^2. In 1965, she was tracked for 106 days. In the early spring she extended her known range eastward by crossing the

TABLE 5. LIFETIME RANGE OF FEMALE GRIZZLY NO. 40

Age	Year	Tracking Dates	Tracking Days	Range Area in km^2
5	1963	8/7-9/4	29	20
6	1964	9/4-11/9	67	39
7	1965	6/28-9/6 10/13-11/16	106	52
8	1966	9/1-10/29 10/30-11/15	76	19
9	1967	9/11-9/26	16	29
10	1968	7/25-9/4 9/5-11/17	106	57
		Total Area Lifetime Range ...		78

Yellowstone River with her yearling. They had moved here to feed on a bison carcass. She weaned her yearling, No. 188, in May and mated. We tracked this pregnant sow throughout the summer and to a new winter den. Her 1965 range was 52 km^2. Her range was smaller in 1966 but within the same area as in 1965. With two cubs she was tracked to a new den. In 1967, she roamed over 29 km^2 in approximately the same area but a den was not located. In 1968, when No. 40 again had cubs, she covered an area of 57 km^2. Some of this was new territory where she had not previously foraged. Some expansion was due to movements in search of pine nuts.

The basic size of this sow's range, including her den sites, was about 39 km^2. The attraction of various foods such as pine nuts, huckleberries, *Vaccinium* spp., and carcasses caused her to slightly alter or extend her range from one year to another so that the total area covered in a lifetime was approximately 78 km^2. In 1969, at age 11, No. 40 moved from this changing but well-established range when food at the Park Service Trout Creek dump was greatly reduced. Her range included this regular source of summer food that supplemented her natural diet. With her yearlings she travelled to the Yellowstone Lake utility area about 5 km beyond the boundaries of her established life range. This was an abrupt movement into new territory. Here two of her cubs were captured in culvert traps and she was shot by a park ranger while protecting her offspring.

The basic range of this animal remained substantially the same year after year. The first major movement away coincided with the drastic curtailment of a once dependable food supply. No. 40 developed a discrete range not the pattern of a separate fall and spring range connected by a migratory corridor. It was smaller than ranges of many females and definitely smaller than ranges of most mature males. Food abundance and availability altered grizzly bear ranges more than any other factor. An abundance and variety of food kept range size small and food scarcity increased range size. Apparently variations in food supply, whether natural or man-caused, will alter grizzly bear ranges, but will not change their fundamental nature.

Movement

During a 5-year period (1959-1963) 72 movements involving 43 different marked bears were determined by measuring distances between the positions where captured and where recaptured or re-observed. The average linear distance moved was 34 km. The maximum linear distance travelled was 96 km over extremely rugged terrain.

From observing marked and monitoring radio-instrumented grizzlies, eight types of typical movement are identified.

1. Regular and routine daily movement from a daytime retreat to a dependable food supply (dump or animal carcass): this was intra-range movement within an established seasonal range. This type of movement was typified by grizzlies No. 40 and No. 75. For example, No. 40 habitually made a 5-km trip to a refuse dump starting approximately 1800 hours and taking 1.5 hours. She was usually resting back in her daytime bed by 0600 or 0700 hours.

2. Daily foraging consisting of short linear distances covered but considerable and continuous amounts of travel performed: this again was intra-range movement well illustrated in the fall of 1963 by radio-instrumented grizzlies who were active day and night, resting only at short intervals. Their airline movements were measured between radio fixes made approximately 12 hours apart. In 13 movements, No. 150 travelled an average of 3.7 linear km and No. 7 averaged 5.1 km in 12 movements. The maximum linear distances travelled in one direction by No. 150 and No. 7 were 8 km and 9.6 km, respectively. Both females foraged within relatively small areas and fed extensively on meadow mice and bulbs of showy melic. Their daily activity and movement can be summarized as considerable roaming without moving very far.

   The daily movement of males under similar conditions was greater than of females. No. 76 averaged 11.5 airline km for eight 12-hour movements. The longest airline distance covered by No. 76 in a 12-hour period was 16 km recorded on four different occasions. He travelled 14 km in a single afternoon.

3. Movement to new food sources: when bears detected food, usually animal carcasses, by their keen sense of smell, they moved directly to it. One grizzly travelled rapidly 29 km to feed on a carcass. It was not determined just when and how the carcass was detected. In 36 hours, No. 37 travelled an airline distance of 30 km from one food source to another. However, it took instrumented sow No. 150 approximately 60 hours to locate and move to a carcass only 2.8 km away when the wind was unfavorable.

4. Fall dispersal to den sites or foraging areas: such movements were often rapid as when instrumented grizzly No. 34 and family, and boar No. 14, travelled 24 linear km overnight and 24 km in 24 hours, respectively, from summer to fall ranges. No. 7 travelled 19 km in 2 days to a fall foraging area. Male No. 76 and female No. 96 left summer ranges and travelled rapidly for 32 and 64 airline km to fall ranges. Within a 12-hour period No. 164 moved 25.6 km from a fall foraging area to a winter den. All were mature radio-instrumented animals travelling to den sites and foraging areas previously used.

5. Fall dispersal of young bears into territory previously unvisited: this was exemplified by a movement of No. 202 from a summer range to a fall

site where he denned and by yearling No. 188 who left an established summer range and travelled rapidly 30 or more km to a den site. No. 194 with three other yearlings left its summer range and travelled rapidly an undetermined distance, but more than 24 km, to a winter den area.

6. Migration: the fall dispersal of grizzlies from summer feeding areas annually resembled a migration, that is a simultaneous movement of population members to distant areas, some beyond park boundaries. Conversely, there was an annual return movement, although more irregular, from winter dens and spring-fall ranges to more bounteous summer food supplies. One of the longer migratory movements was made by a large marked boar who travelled from Rabbit Creek to Hawk's Rest just outside the southeast corner of Yellowstone, an airline distance of 80 km.

7. Wandering: this seemed to consist of the wandering of young, insecure bears that were seeking food and establishing home ranges. Number 37 was shot by a hunter in spring south of Yellowstone Park, having travelled a minimum of 80 airline km since late the preceding fall. Yearling No. 52 travelled an airline distance of 88 km in 20 days and was shot in Grand Teton National Park 21 km south of the Yellowstone Park boundary.

8. Induced movement and homing: most grizzlies trapped and distantly transported returned to established ranges. Instrumented grizzly No. 170, when trapped, transported and released, travelled 54 airline km over rugged country in 62 hours to return to her point of capture. When again trapped and released, she returned a distance of 85 km. Released male grizzly cub No. 78 travelled an airline distance of 43 km in a week to return to his point of capture. Male grizzly No. 38 when released on Promontory Point of Yellowstone Lake travelled 50 airline km in 4 days to return to his established summer range.

   A radiotagged sow and two yearlings, intercepted while being tracked, ran a measured distance of 1. 6 km in 3 minutes, and average speed of 32 km hr across rolling sagebrush country.

Rivers, canyons or rough country did not deter grizzlies. Sow No. 34 and her family made 11 known Yellowstone River crossings in a 23-day period in August.

Male No. 76 circled Mount Washburn and made five crossings of the Yellowstone River including traversing the steep-walled canyon. Instrumented sow No. 7 made six Yellowstone River crossings in 44 days, two down the canyon and up the other side to the high slopes of Mount Washburn.

The type of movements involving long distances revealed that Yellowstone Park grizzlies ranged far beyond park borders so their management is the responsibility of several resource management agencies.

Population Densities Influenced by Movement

Using the computed population average of 229 grizzlies in the Yellowstone ecosystem, approximately 20, 000 km^2 (Craighead *et al.* 1974), we can determine that this supported an average of one grizzly per 88 km. Such densities occur in early spring and late fall when grizzlies disperse throughout this extensive area. In summer most grizzlies within this ecosystem were concentrated at five sites within the park. Trout Creek has attracted between 98 and 132 grizzlies annually (Craighead & Craighead 1971). These grizzlies covered an area no greater than 5 km^2, a density of one bear to approximately 0. 05 km^2. During daylight hours these same grizzlies were dispersed over an area of approximately 31 km^2 with a density at this time of one bear to 0. 36 km^2.

Daily and seasonal movements of grizzlies is obviously in response to available food which alters their density over any given area. Extrapolation of bear numbers is questionable unless bear movements in time and space are well known and documented. Likewise grizzly bear densities computed for large areas from data based on local concentrations must take movement factors into consideration.

During our research we experimented with animal carcasses or baits to attract grizzlies. One objective was to see how effective this might be in moving grizzlies away from campgrounds at times of high park visitor use. A maximum of 23 grizzlies was attracted to a single carcass at one time. The greatest distance a marked grizzly moved to a carcass in a 3-day period was 47 airline km. Whether this movement was coincidental is unknown but grizzlies appear to locate carcasses and other food sources from considerable distances. Both movements and densities can be temporarily influenced by strategic placement of baits.

At the suggestion of the author, the U.S. Forest Service and the Wyoming Game and Fish Department censused the Clark's Fork and Wapiti Districts of the Shoshone National Forest bordering Yellowstone National Park. One purpose was to determine whether there were small, local population units unaffected by seasonal movements. Fifteen bait stations (animal carcasses) were placed out during the August peak of grizzly bear concentration in Yellowstone. During this census only three grizzlies were observed at bait stations, but 41 black bear were sighted (Mullen 1969; Winter 1969). In addition more grizzlies were observed throughout this extensive area in spring prior to migration to the Park and in the fall after bears dispersed throughout the Park and beyond the borders (Mullen, pers. comm.). The results suggested that few grizzlies resided in areas surrounding the Park at the height of grizzly bear concentration within Yellowstone. This was expected, based on grizzly habits and known movements. According to Mullen (pers. comm.) approximately 25-30 percent of the grizzlies seen during 1969 and 1970 in Shoshone National Forest were marked animals tagged in Yellowstone. The results tended to confirm our findings that because of annual movements to long established earth-filled dumps in Yellowstone, few grizzlies did not at some time feed at the garbage dumps (Craighead & Craighead 1971). Grizzly bear population figures determined for Yellowstone Park during periods of high local grizzly density represented a grizzly population inhabiting a far more extensive area, the Yellowstone ecosystem.

GRIZZLY BEAR MOVEMENTS AND RANGES AS RELATED TO MANAGEMENT

Information on grizzly bear ranges and movement reveals that the grizzly bear population shifted between Yellowstone Park, administered by the National Park Service, and four National Forests administered by the U.S. Forest Service. This situation, though now altered, still exists. There is no coordinated management programe between federal agencies and state departments having jurisdiction over the wildlife inside and outside the Park. An urgent need exists for cooperative state and federal management within this ecosystem. Unilateral decisions by one agency resulting in excessive mortality could endanger the grizzly population over the entire area. In a 3-year period (1969-71) the Park Service's revised management policies, including abrupt closure of dumps, caused the known mortality of 120 grizzlies. In a 5-year period (1968-1972) the known and documented mortality was 160, with 42 percent females. Since identifying grizzly ranges and determining bear move-

ments, elimination of dumps has diverted bears into campgrounds (Craighead & Craighead 1971) and altered fall and spring dispersals and migrations. Some grizzlies formerly moving into Yellowstone during summer months are no longer doing so and are subject to legal hunting and predator control activities outside.

Problem grizzlies, resulting from dump closures, when transported to areas adjoining the Park have in most cases returned only to be eliminated (Craighead & Craighead 1971). of 17 such transplants by helicopter, only one was known to be alive a year later and 13 known to be dead (Greer 1972). When transplanting grizzlies from one area to another, managers should consider their strong homing instincts. It appears that grizzlies when moved no more than 80 km return quickly to the point of capture.

The currently changing movement pattern throughout the Yellowstone ecosystem needs to be studied in relation to population numbers and distribution, to make wise management decisions. Movement data could be obtained through instrumenting grizzlies and monitoring migratory movements by satellite (Craighead *et al.* 1972; Craighead *et al.* 1971). Likewise satellite (ERTS-1) multispectral scanner imagery can be used in habitat delineation and analysis (Varney 1973). To a degree the size of grizzly bear ranges can be altered through habitat manipulation, perhaps based on extensive satellite surveys. Any alteration of well established food sources, such as dump closures and elimination of bait annually placed out for hunting, will change grizzly bear ranges and movements. Knowledge of such movements can be incorporated in management plans as an aid toward developing techniques to estimate bear populations and decrease grizzly mortalities. Emphasis should be on decreasing mortalities, particularly among mature females. Such precautions seem mandatory when a small population is declining and the size of a viable population is unknown. The most probable figure for the grizzly bear population of the Yellowstone ecosystem was computed to be 136 in 1974, a decline from a peak of 245 in 1967 (Craighead *et al.* 1974).

Baiting with animal carcasses can be an effective management technique to census grizzlies throughout the Yellowstone ecosystem. The location and timing of baits are important as is the duration of observation periods. Placement of animal carcasses to entice grizzlies from campgrounds could be a more realistic and effective management policy than capturing, transplanting and eventually killing those that return.

Baiting bears for hunting has until recently been permitted in Wyoming. Its desirability is being debated. Grizzlies can only be hunted under special permit. Twelve permits were issued for 1974, none for 1975. Hunting over bait is certainly not a sporting way of shooting a grizzly, ostensibly a trophy animal. However, baiting has an advantage of permitting selectivity, that is, taking large or old bears rather than young ones. Baiting can also be used to lure grizzlies away from outfitter camps. Annual spring and fall baiting by hunters and outfitters provides a substantial food source for grizzlies. The sudden elimination of baits could further alter established grizzly bear movements as well as behaviour, especially during seasonal food shortages. The result could increase grizzly bear mortalities.

The State of Idaho does not permit grizzly hunting. Wyoming plans to close the grizzly season for at least 2 years starting January 1975. Montana amended big game regulations in 1974, to prohibit grizzly hunting adjacent to Yellowstone Park. If these measures are supplemented with a management policy in Yellowstone Park based on minimizing grizzly deaths due to control programs, it should reverse or at least halt the populations' downward trend.

Grizzly bear management outside the Park through trophy or special permit hunting appears to be a sensible approach to preserving yet regulating a definitely dangerous and at times destructive carnivore. Under some conditions, particularly when and if grizzly populations again expand, they can be detrimental to man's economic interest. Grizzly management, though aimed at preservation, should include means of control as necessary. Hunting by special permit can accomplish needed control. If it becomes necessary to classify the grizzly as an endangered species, steps to control troublesome individuals will be more difficult. Likewise, insufficient control when control is justified could arouse public antagonism detrimental to the grizzly.

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