GRIZZLY BEAR RANGES AND MOVEMENT AS DETERMINED BY RADIOTRACKING

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INTRODUCTION

Yellowstone National Park consists of 3,400 sq miles (8,800 km_2). Additional National Forest and Wilderness areas surrounding the Park constitute an ecosystem approximately five million acres in size (Craighead et al., 1974). Within this extensive coniferous forest habitat, movements of grizzly bears, Ursus arctos horribilis, were determined through observation of 264 marked animals and monitoring 23 radiotagged bears (Craighead & Craighead, 1972; Craighead et al., 1974).

The closure of the open pit dumps and the control measures 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.

Our data analyses showed that 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 the dumps were marked ones, and 76 percent of the ecosystem population was observed and counted at the dumps during this time (Craighead et al., 1974). Thus 76 percent of the ecosystem average population of approximately 229 animals moved to and from garbage dumps. This massive movement within and beyond Yellowstone National 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

Over an eight year period from 1961 through 1968, 48 radio instrumentations were made involving 23 different grizzlies. Twenty different ranges of grizzly bears were delineated: 5 in 1963, 5 in 1964, 3 in 1965, 2 in 1966, 3 in 1967 and 2 in 1968. Of these, 7 were home ranges and 1 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. For example, No. 39, the mother of the instrumented yearling No. 158 and his litter-mates all had a home range of similar size (Table 2).

Grizzlies were radiomonitored up to three 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-sec intervals (Craighead & Craighead, 1972; Varney J., 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 (Fig.2) (Craighead F., 1968). Unless there was extensive movement, usually only one daily fix was recorded. A single radio bearing could often indicate 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 range limitations of the portable receivers or sheilding effect of terrain. Ranges were delineated from fixes, bearings, and sightings while tracking. (Tables 1).~~and 2)~~

Two hundred and sixty-four grizzlies were immobilized and color marked and nearly 600 bears were captured and recaptured. Some sightings of these marked grizzlies were used in determining bear movements and others supplemented radiotracking data on ranges as indicated.

BEAR NO.	NO. OF BEARINGS USED	NO. OF TRACKING DAYS	NO. OF FIXES	RANGE AREA MI^2	RANGE AREA KM^2	REMARKS
7	256	44	32	106	275	Female with yearlings
40	140	29	32	8	202	5-year old female
75	145	44	21	36	93	Female with yearlings
76	129	28	21	168	435	5-year old male
150	227	29	35	27	70	Female with cubs
6	49	19	11	12	31	5-year old female
14	58	41	5	12	31	Large adult male
34	151	34	26	13	34	Female with yearlings
40	106	67	27	15	39	Female with cubs
158	98	51	14	22	57	Yearling (family of female and 3 yearlings)

Table 1. Grizzly bear ranges determined by radio 1963 - 1964

BEAR NO.	SEX	TRACKING YEARS	TRACKING DAYS	RANGE AREA MI^2	RANGE AREA KM^2
7	F	1963	44	106	275
40	F	1963 - 68	400	30	78
101	F	1966 - 67	125	43	111
150	F	1963	33	27	70 -69-
158	M	1964	51	22	57
39	F	1964	51	22	57
187	F	1967 - 68	98	40	104
202	M	1965 - 66	174	125	324

Table 2. Grizzly bear home ranges determined by radio

RESULTS

Home Range Characteristics

Seasonal and home ranges were found to vary in size (Table 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). The area a bear roamed over 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 by a bear during spring, summer or fall but it does not include the den site. The periods coincide generally with those derived from the spring and autumn equinoxes and the summer and winter solstices. (Craighead, J. 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 sometimes declining in size, in other years including some areas previously not utilized or visited, thus evolving into a lifetime range. In general a lifetime range is larger than a home or seasonal range but some seasonal ones closely approximated home ranges, as for example the 27 sq mile (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 125 to the smallest of 7 sq miles (324 and 18 km_2). Seasonal ranges varied from a minimum of 8 to 168 sq miles (20 and 435 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 influenced movements, thus size of individual ranges. Some grizzlies such as No. 40 and 34 (Table 1) 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 168 sq miles. His center of activity was Hayden Valley, but foraging trips from Hayden Valley to outlying areas expanded his range. In a one week period he was tracked during a 50 airline mile (80 km) trek (Fig 2). His signal was lost during a fall migration to the northeastern portions of Yellowstone National 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 which apparently also included his den site, measured 12 sq miles (Fig 3). 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, 24 airline miles away, on the opposite side of the lake. This was an estimated ground distance of at least 60 miles from the location last observed. The home range of No. 14, though not entirely worked out by radio fixes, was 1,000 or more sq miles in size. Other grizzlies 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 (Fig. 3). This pattern of summer and fall ranges separated by considerable distance, is typical of some male and female grizzlies. As examples, boars No's. 76, 14 and 12 exhibited such ranges as did sows No's. 96, 164 and 34. In the course of a week No. 96 and her cubs travelled 31 airline miles from her spring range and den area to her summer range. The largest discrete range of a female was that of No. 7 measuring 106 sq miles or 275 km_2 (Table 3). This bear, over the years, established a

BEAR NO.	AGE	YEAR	ANIMAL TRACKING	AREA OF RANGE MI^2	KM^2	TYPE OF RANGE
6	5	1964	19	12	31	Summer & Fall
7	Adult	1963	44	106	275	Summer
34	Adult	1964	34	12	31	Summer
40	5	1963	29	8	20	Summer & Fall
	6	1964	67	15	39	Home
	7	1965	106	20	52	Home
	8	1966	76	7	18	Home
	9	1967	16	11	28	Home
	10	1968	106	22	58	Home
75	Adult	1963	44	36	93	Summer
150	Adult	1963	29	27	70	Summer & Fall
101	Adult	1967	49	43	111	Home
187	Adult	1967	65	41	106	Home
187	5	1968	33	34	87	Home

Table 3. Female grizzly bear ranges

BEAR NO.	AGE	YEAR	ANIMAL TRACKING DAYS	AREA OF RANGE MI^2	KM^2	TYPE OF RANGE
14	Adult	1964	41	12	31	Fall
76	Young Adult	1963	28	168	435	Summer & Fall
158	1	1964	30	22	57	Home
188	1	1965	19	20	52	Summer*
202	1	1965	56	27	70	Home
	2	1966	118	125	324	Home

*Area determined through instrumental mother

Table 4. Male grizzly ranges determined by radio

summer range in the Sour Creek drainage east of Yellowstone River. Her sibling, No. 6, developed a range partially within her mother's (fig. 4). 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 27 sq miles (70 km_2) west of the dump, but during the period of tracking never visited it (Table 3) (Figs. 2 and 5).

Ranges of mature and young males were larger than those of females (Table 4). The summer range of male No. 76 was 168 sq miles (435 km_2), the home range of No. 202 was 125 sq miles (324 km_2), and the fall range of No. 14, twelve sq miles (31 km_2) but his home range many hundreds of sq miles with a lifetime range of a thousand or more sq miles. Yearling male No. 158 had a home range of 22 sq miles (57 km_2), a range influenced by and identical to his mother No. 39 (Table 2). Before weaning, grizzly No. 188 had a range identical in size to his mother's, 20 sq miles (52 km_2). His summer range was reduced following weaning (Fig. 6), 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 (Fig. 3). 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 27 sq miles (70 km_2) in 1965 to 125 sq miles (324 km_2) in 1966

(Table 4, Fig. 7). The control-killing of this bear in August 1966 prevented further study of the development of his life range. He denned on the steep slope of the Yellowstone Canyon, within a home range which included Canyon Village campground where he learned to associate 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, he may eventually have left this early established range to forage or to roam and to wander thus either creating a migratory corridor to a new summer or fall range or greatly expanding the area of 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 spacial entity, numerous grizzlies conducted daily and seasonal activities without major conflict or defense. Ranges overlapped (Fig. 3) and thus were not spacially separated as with territorial species (Craighead & Craighead, 1956). Grizzlies congregated at such food sources as refuse dumps, carrion, berry patches, pinenut stands, clover fields and sedge seepages. Their daytime beds were made in nearby dense timber and numerous grizzlies regularly used the same timbered retreats at the same time. When "closing in" on an instrumented grizzly, we once jumped 7 and 13 bears within several hundred yards. Territorial defense of a seasonal or home range has not been observed and all behavior

indicates that defense activities are largely non-existent. Range peripheries are definitely not defended, feeding areas sometimes are temporarily and quite locally; nor have den sites been defended against mature members of the same sex. Grizzly No.'s 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 made 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 behavior (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 maneuver to get between the sow and a wooded retreat. This caused the sow and yearling to retreat keeping 300 to 500 yards (270 to 457 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 behavior in the pre-

sense 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 one sq mile area, obtaining pre-hibernation food requirements within this restricted locale (Fig. 8). Their efficiency as omnivorous foragers was revealed. Two heavily utilized foods were meadow mice, Microtus spp, at peak population densities and the grass showy melic, Melica spectabilis, whose starchy, onion-like bulbs form a staple fall food for Yellowstone grizzlies (Fig. 9). 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, F., 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, 10 in 1962. Radio fixes plus sightings revealed that her seasonal range as a subadult was about 8 sq miles (21 km_2) but this did not include her den site. In 1963 as a mature sow her range was 8 sq miles, but again this did not

AGE	YEAR	TRACKING DATES	ANIMAL TRACKING DAYS	AREA OF RANGE MI^2	AREA OF RANGE KM^2
5	1963	8/7 - 9/4	29	8	20
6	1964	9/4 - 11/9	67	15	39
7	1965	6/28 - 9/6 10/13 - 11/16	106	20	52
8	1966	9/1 - 10/29 10/30 - 11/15	76	7	19
9	1967	9/11 - 9/26	16	11	29
10	1968	7/25 - 9/4 9/5 - 11/17	106	22	57
		Total Area Lifetime Range - - -		30	78

Table 5. Lifetime range of female grizzly No. 40

include the den site (Fig. 10). In 1964 No. 40 and her cub were tracked 67 days and her den located. The cub was one of her initial litter of two. One disappeared and was presumed dead. The observed increasing foraging activity with a cub and movement to a den site at higher elevations expanded the size of her home range to 15 sq miles or 39 km_2 (Table 5). In 1965 she was tracked for 106 days. In the early spring she extended her known range to the east by crossing the Yellowstone River with her yearling. (Figs. 10 & 11). They had moved here to feed on the carcass of a bison. 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 20 sq miles (52 km_2). Her range was smaller in 1966 though within the same area as in 1965. With two cubs she was successfully tracked to a new den. In 1967 she roamed over 11 sq miles (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 22 sq miles (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 15 sq miles (39 km_2). The attraction of various foods such as pine nuts, huckleberries and carcasses (Fig. 12) 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 30 sq miles (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 Lake utility area about three linear miles (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.

This animal revealed that her basic range remained substantially the same year after year. The first major movement away coincided with the drastic cut-off in a previously dependable food supply. No. 40 developed a discrete range; not the pattern of a separate fall and spring range connected by a migratory corridor of some grizzlies. It was smaller than ranges of many females and definitely smaller than the ranges of most mature males. Food abundance and availablility altered grizzly bear ranges more than any other factor. An abundance and variety of food limited the range size; 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 five-year period (1959-1963) 72 movements involving forty-three different marked bears were determined by measuring the distance between the position where captured and the location where they were recaptured or re-observed. The average linear distance moved was 21 miles (34 km). The maximum distance travelled

during this study was 60 linear miles (96 km) over extremely rugged terrain.

From observing marked animals and monitoring of radio-instrumented grizzlies, eight types of movement were identified typical of bears within the Yellowstone ecosystem from 1959 through 1968. (Fig. 13).

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 three mile trip to a refuse dump starting approximately 1800 hours and taking one and one-half hours to cover the distance. 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 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 2.3 linear miles (3.7 km) and No. 7 averaged 3.2 miles (5.1 km_2) in 12 movements. The maximum linear distance travelled in one direction by No. 150 and No.

7 were 5 and 6 miles (8 km and 9.6 km) respectively. Both females foraged within relatively small areas and fed extensively on meadow mice and the bulbs of showy melic. Their daily activity and movement can be summed up as considerable roaming without moving very far.

The daily movement of males under similar conditions was greater than the females. No. 76 averaged 7.2 airline miles (11.5 km) for eight 12-hour movements. The longest airline distance covered by No. 76 in a 12 hour period was 10 miles (16 km) recorded on four different occasions. He travelled nine miles (14 km) in a single afternoon.

3. Movement to new food sources: When bears detected food through their keen sense of smell, usually animal carcasses, they moved directly to its source. (Fig. 14). One grizzly travelled rapidly 18 miles (29 km) to feed on a carcass; just when and how detected was not determined. In 36 hours No. 37 travelled an airline distance of 19 miles (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 one and three-quarters miles (2.8 km) away when the wind was unfavorable.
4. Fall dispesal to den sites or foraging areas: Such movements were often rapid as when instrumented grizzly

No. 34 and family, and boar No. 14 travelled 15 linear miles (24 km) overnight and 15 miles in 24 hours, respectively, from summer to fall ranges. No. 7 travelled 12 miles (19 km) in 2 days to a fall foraging area. Male No. 76 and female No. 96 left summer ranges and travelled rapidly for 20 and 40 airline miles (32 km and 64 km) to fall ranges. Within a 12 hour period No. 164 moved 16 miles (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 the 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 20 or more miles to a den site. Number 194 with three other yearlings left their summer range and travelled rapidly westward an undetermined distance, but over 15 miles (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 coincidental movement of population members to distant areas, some beyond park boundaries. Conversly, there was an annual return movement, though 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 50 miles (80 km). He was shot during the fall hunting season at this location.

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 50 airline miles (80 km) from a point observed late the preceding fall. Yearling No. 52 travelled an airline distance of 55 miles (88 km) in 20 days and was shot in Grand Teton National Park 13 miles (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 34 airline miles (54.4 km) over rugged country in 62 hours to return to her point of capture. When again trapped and released, she returned a distance of 53 miles (84.8 km). Released male grizzly cub No. 78 travelled an airline distance of 27 miles (43 km) in a week to return to his point of capture. Male grizzly No. 38 when released

on Promontory Point in Yellowstone Lake travelled 31 airline miles (49.6 km) in four days to return to his established summer range.

A radiotagged sow and two yearlings, jumped while being tracked, covered a timed distance of one mile (1.6 km). They ran this measured mile in three minutes; an average speed of 20 miles an hour across rolling sagebrush country.

Rivers, canyons or rough country did not deter grizzlies. Sow No. 34 and her family made 11 known crossings of the Yellowstone River in a 23 day period in August. Number 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 in the canyon and up the other side to the high slopes of Mount Washburn.

The type of movements involving long distance travel 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 ecosytem (approximately 7,800 sq miles or

20,000 km_2 (Craighead et al., 1974) we can determine that this land supported an average of one grizzly per 34 sq miles (88 km_2). 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 two sq miles (5 km_2), or a density of one bear to approximately .02 sq miles (0.05 km_2) or 44 bears per sq mile (2.59 km_2). During daylight hours these same grizzlies were dispersed over an area of approximately 12 sq miles (31 km_2) with a density at this time of one bear to .14 sq miles (.36 km_2), or about seven grizzlies per sq mile.

Daily and seasonal movements of grizzlies is obviously in response to available food which alters their density over any given area. Extrapolations of bear numbers are 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 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 and concentrating them away from campgrounds at times of high park visitor use. A maximum number of 23 grizzlies was attracted to a single carcass

at one time. The greatest distance which a marked grizzly was known to move to a carcass over a three-day period was 18.5 air-line miles. Whether or not this movement was a coincidence is unknown but grizzlies appear to locate carcasses and other food sources from considerable distances. Both their movements and their densities per unit of area can be temporarily influenced by strategic placement of baits.

At the suggestion of the author, the U.S. Forest Service and the Wyoming Game & Fish Department conducted a census throughout 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 the 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, L., 1969, and Winter, K., 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, L., personal correspondence). 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 the grizzlies' habits and known movements. According to Mullen (personal correspondence) 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 of bears 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 National 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 moved back and forth between Yellowstone Park, administered by the National Park Service, and four National Forests administered by the U. S. Forest Service. This movement, though now altered, still exists. There is no coordinated management program between the federal agencies and state departments which have jurisdiction over the wildlife both inside and outside the Park. An urgent need exists for cooperative management within this ecosystem, involving state and federal jurisdiction. Unilateral decisions by one agency resulting in excessive mortality could endanger the grizzly population over the entire area. In a three year period (1969-71) revised Park Service management including abrupt closure of dumps caused the known mortality of 120 grizzlies, all from the Yellowstone ecosystem population. In a 5 year period (1968-1972) the known and

documented mortality was 160 with 42 percent females. Since identifying grizzly ranges and determining the bears' movements, this abrupt elimination of dumps has diverted bears into campgrounds (Craighead & Craighead, 1971) and has altered fall and spring dispersals and migrations. Some grizzlies that formerly moved into Yellowstone during summer months are no longer doing so and are subject to legal hunting pressure and predator control activites 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 problem grizzlies from one area to another, managers should consider their strong homing instincts. It appears that grizzlies when moved no more than 50 miles 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 et al., 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 tend to change grizzly bear ranges and movements. Knowledge of such movements can be incorporated in management plans and can help develop techniques to estimate bear populations and decrease grizzly mortalities. Emphasis should currently be placed 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 grizzlies in 1967. (Craighead et al., 1974).

Baiting grizzlies using animal carcasses can be an effective management technique to census grizzlies throughout the Yellowstone ecosystem. The location of baits and timing are important as is the duration of observation periods. The placing of animal carcasses to entice grizzlies from campgrounds and away from visitors could be a more realistic and effective management policy than capturing, transplanting and eventually killing those that return (two-time offenders).

Baiting bears for hunting has until recently been permitted in Wyoming. Its desireability 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 the

sporting way of shooting a grizzly, ostensibly a trophy animal. However, baiting has an advantage of permitting a hunter to be selective, that is, to take a large or old bear rather than a young one. Baiting can also be used to lure grizzlies away from outfitter's camps. Annual spring and fall baiting by hunters and outfitters provides a substanial food source for grizzlies. The sudden elimination of baits could further alter established grizzly bear movements as well as behavior, 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 two years starting January, 1975. Montana amended the big game regulations in 1974 to exclude grizzly hunting adjacent to Yellowstone National Park. If these measures are supplemented with a management policy in Yellowstone National Park based on minimizing grizzly deaths due to control programs, it should reverse or at least halt the downward trend of the population.

Management of the grizzly bear population 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 justified could arouse public antagonism detrimental to the grizzly.

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Late April 1963

start

Ranges & Territoriality

Marian on buffalo carcass - YR - Marian at the carcass in Upper Hoppler Valley - Oct. 14/63

Brief mention of hierarchy as related to Marian

July 12 & 13, 19

next

Definition of territory 1

Definition of ranges 2

Determination of ranges by radio

Overall movement pattern.

Within the complexity of bear society Marian has her own range or niche

During 1st year Marian was instrumented we plotted fixes & connected peripheral ones to determine range

1963 plotted range of #40 8 sq mi. - range similar in size in 1961 & 62

Range nuclei - 1963 report page 5

Marian produced 2 cubs in 1964 at age of 6 years

Spring of 1965 weaned yearling - moved in range

✓ Tracking #150 Reg Reg.

✓ Tracking #76, 34

✓ Tracking Bruno # 14 (rel. of summer range to #40 a)

#40 on carcass rivers - Oct. 6, 1963

1961-3 - 8 sq. mi

1964 (cubs) - 15

1965 yearling 20

1966 2 cubs 7.3

1967 — 11.1

1968 3 cubs — 22.2

Reunion of SW & Cubs #65 - Sept. 7, 1960 - Large male range

#34 & cubs - July 29, 1964 reunion swimming river. 1964 report (typed)

* ✓ 1968 tracking to Den - yearling like bear range extension

Death of Marian 1968

✓ Elk carcass 1965, July 13 black bear

✓ 40 & 101 at den

Summary of range data

1965

First grizzly tracks seen April 4 (Terry Davenport)

We saw tracks April 23 at Old 7.

April 23 saw sow #150 + 3 yearlings at Trout Creek Monad

Sandhill cranes

April 25 – Raven Raven trying to kill another raven (note April 29)

April 26 – Uinta ground sq. out at Canyon

Buffalo died after spring arrived – apparently couldn't digest food.

April 27 – Started trip into Marion's den (sunny temp. 54° in sun + 45°F in shade at 1:30 P.M.

Skis often dropped down & poles went down to top of handles in sun.

April 29 – Sedge skunk out – see 1974 notes

Big grizzly feeding on dead buffalo back of Mud Volcano. (winter kill)

April 30 – Trout Creek Monad 5:30 PM. saw Drge. just after he swam Gallatin River – rolled in remains of buffalo ~~carcass~~ carcass (see note)

May 4 – Marion at buffalo carcass in Yellowstone River. 1st appearance May 1 & 2 (Marion)

Coyote

May 5 – Marion + Yearling on Buffalo carcass

John, L, Charlie R. (extended range)

May 7 Marion digging

Canada geese nesting in isl. in river

~~Snipe~~ making flights, Osprey, Pelicans great gray owl hooting near cab

NOTES FOR CHAPTER FIVE Ranges & Territoriality

One definition of territory is that: A territory is that physical area from which an animal excludes all others of its species, except certain selected individuals. Inside territorial boundaries residents reigh supreme no matter what their relative rank, order, or positions are on neutral ground.

October 5, 1963: Bears eating grass bulbs Melica (~~Marca~~ spectabilis).

October 6, 1963: Visited buffalo kill early in morning at third bridge up Trout Creek. Sow and three yearlings, one marked (#47) around carcass. Marian was nearby and cautiously approached. Took stills and movies. Lots of ravens around and bears let them feed on carcass at same time. _____(?) yearlings kept #40 away. No attempt as yet to bury carcass.

October 7: #48, Sow with three cubs and one of Owl Faced Sow on buffalo. Also unmarked bear. Other five were leaving as we approached. These animals are in Marian's territory or range but still keep ;her off carcass.

October 7, 1963: Visited elk carcass. Bears had cleaned it up. Four large droppings of two to three lbs. each completely filled with grass bulbs. One contained some leafy vegetation. Bears digging after mice. _____(?) (saw or sow) feeding in open field,

October 7, 1963 Mice abundant. Some small areas vegetation completely removed. Bear scats contained mice.

Sept. 28, 1963: Death of #75 - see Notes.

Sept. 5, 1963: Shot Inge with drug and took blood sample and flash stills. The Owl-Faced Sow, #148, charged the pickup in the dark and the hit was so hard that she dented it. The impact broke her neck and killed her instantly. She had three cubs and was protecting them. Mike and Dick were driving up incline from dump.

Sept. 4, 1963: While tracking checked one ummarked bear as we entered woods. Passed #75 and then jumped her - Must of passed within 100 feet of her. We just got a glimpse of her, but found two fresh beds.

Quote: The dollar cost of scientific projects increases as the square of the number of men engaged in them and therefore as the fourth power of the number of good men or the amount of good work done.

November 2, 1963: I made a record of Margaret Duvals account of grizzly attack.

July, 1963:(27th) Obtained information from John Wort that he had shot #37 at Pole Cat Creek about 2-1/2 miles southof South Gate. Another bear was killed June 22, 1963 by

xxxx

June 22, 1963: (Continued) Slim Edna Linville at Huckleberry Ridge Mountain. A female, about three years old - no tags. Bear #109 was two years old in 1963 with club foot. His name became Club Foot. #76 Peg Leg with a stiff left rear leg. #110 was the littler mate of Club Foot. The short-eared boar was second to Inge in 1963. One ear at a slant - brown colored.

Notes on Owl Faced Sow and #48 who have somewhat similar looking cubs --get them mixed up--

July 9, 1963: Female grizzly #96 appeared with collar still on and xxxxxxxxxxxxxx riding well. She came in with only one cub but had had two when observed earlier at Cache Creek. She was at Trout Creek dump at 7:30 p.m. with one cubb — 31 airline miles away
By July 9, a total of 103 different bear had come into Trout Creek so far.

July 9, 1963: Inge chasing Short Ear, who's second in command, in toward Scar Neck and new boar.

Sow #34 with two cubs chased the cub of #96 a distance of ten feet or so when he tried to mix with her family.

A new bear that appeared in 1963 on July 9 was Raowl.

July 9, 1960? (census) Mae West came in with two cubs and another sow with two cubs. We have counted 23 cubs to date, maybe 26. 80 grizzlies came in tonight & 107 total for the season so far. 19 of 25 yearlings have been accounted for to date. Three people were bitten July 9 in Canyon Campground by grizzly and tents torn. We got up in middle of night to help rangers but did not see the bear.

July 10, 1963: We shot grizzly #121 in Canyon campground at night. Rangers figured this was one that had bitten three people and tore up tents. The bear got up with 100 miligrams in her. The dose hit the shoulder blade and all did not get to her. We had to give her more and kill her. #121 weighed 140. We had taken blood samples from this bear late in 1961 or 62.

July 11, 1963: We trapped the Owl Faced Sow. She weighed 355 and now becomes #148. We put her out with 40 miligrams of Secostrin and 20 cc's of Penta. We had to hold her down to inject the Penta. Her two cubs were around the trap and John photographed them earlier. We put markers on #148 and had her instrumented but upon checking found weak signal so we removed collar. While working on collar she got up and ran then came back at us, running in circles and occasionally falling.

July 19, 1963 We found a dead cub in the vicinity of the dump. We're not sure just how it was killed. Examined cub in evening and found it was definitely killed by another bear. Two teeth entered the skull - one at the base and the other thru the side.

July 21, 1963: Bapa was at Canyon. Took pictures of Bapa with grizzly no. 155.

July 29, 1963: Caught #145 at Trout Creek. Gained 2 pounds per day for last month.

July 29, 1963: #96 is coming in with one cub of her own and a cub of #150.

July 29 96 Immobilized #96. She dropped in water and we had to rush in to pull her out. #7 in vicinity of Wrangler Lake.

July 31, 1963: Hill north of Wrangler Lake has lots of huckleberry plants, but not too many berries.

August 8, 1963: Worked on #159, Short Ear. Gene Peterson took movies. Bear's weight: 640 lbs.

Aug. 27, 1963: Trapped #163 at Canyon and #162 at Trout Creek. Four times in seven days.

Aug. 28, 1963: Marian's bed in a jungle of windfall. She is foraging in an area where huckleberries are numerous. She's also digging around in squirrel caches.

Aug. 30, 1963 Tracking #75 - numerous mouse diggings, lodgepole stripped of bark. We jumped #75 with yearlings at a distance of less than 50 yards. We didn't see her, but she gave a warning call. We found her bed about 100 or 150 feet from where we stood - saliva on earth and numerous droppings around.

June 26, 1964: #150 at Trout Creek with three cubs. She is much lighter colored than last fall and cubs are reddish and much lighter colored than last fall. Also thinner. #150 very ~~xxxxx~~ pugnacious. Charged and fought boar, #88, and chased off several others. She is much more on the defensive than last year.

June 26 #39, Dump Sow, observed with three yearlings. Yearlings of #150 are nursing.

July 3, 1964: Completed transmitter assembly. We worked on sow #150 and her two cubs, #168 & 169 - both males. Number #170 green & white rope in left ear, right ear white flag. She weighed 237 lbs. Instrumented her at 1:30 p.m. Sow trapped at Gardner.

July 10, 1964 Instrumented #6, the First Cub.

July 20, 1964: Report from Brian Harry on grizzly #142. This animal put him up a tree near Pebble Creek campground. Cleaned out his pack.

July 22, 1964 Jumped #6 at a distance of 110 feet. Didn't realize that we were so close to this animal.

July 23, 1964: Instrumented #34 at 11:30 a.m. It took us two minutes. Female weighed 325 lbs.

July 24, 1964: Way up Trout Creek a black bear was foraging by turning over buffalo chips.

July 24 Went with Jim Cole to den of #164 and measured and photographed it.

July 24 Gerald Jones, ranger, informed us that a hiker also named Jones had been treed by three grizzlies near Marl[illegible] Lake.

July 29, 1964: Tracked #34 and jumped her at a distance of 100 feet or less. Mother & yearling were lying side by side. The yearling had been processed and marked yesterday xxxx morning. Sow and yearling got together during night. Other yearling is in trap and was shot at the dump last night. Another bear was jumped a few seconds later, about 150 feet from sow #34. Two cow elk were in timber about 75 yards from sow #34 and less than 50 yards from another unidentified grizzly. #34's yearlings are #177 & #178.

July 30 At 8 p.m. they all came into the dump together. #178 must have joined mother last night.

Aug. 6, 1964: Us & Bill Staninger left for six day elk spotting hike along eastern border of Park.

Aug. 6 #34 & her family swam Yellowstone River at 8:40 p.m. Bears growl just before entering water & apparently while swimming. I only saw them as they came out of the water, but I'd been following them by radio.

Aug. 9 Red huckleberries are ripe and numerous. Bears are feeding on them.

Aug. 10 While tracking #34 we jumped approximately 10 large bull elk in thick timber near where we had seen cow elk previously. #34 & yearlings were very close to this group. Checked the burrow-like den of #6 and she had enlarged it until it was nearly den-like.

Aug. 11 Give some dosages of Sonom ? for various bears. Inge #150, and a yearling.

Aug 11 In the evening hit Inge with 650 miligrams, but he took off in the dark and we lost him.

Aug 19 #39 weighed 415 lbs.

Aug. 19 Started hunting for a transmitter dropped by #150 Sow and yearlings jumped from bed lined with dry grass. Strawberries & huckleberries are ripe in the big wooded island.

August 20, 1964: We hit #29 with Sucostrin but couldn't get her. She bit Harry on the boot. Shot and got Marian's cub and yearling of #96.

Aug. 23 ~~Crows~~ marten populations low compared to 1963. Short=eared owls and hawks much lower in numbers.

Aug. 25, 1964 The last signal from #34 in the area of Big Burn north of Pelican Cone. This was when she apparently took off for her fall foraging area and possible winter den site.

Sept. 1 We hit and immobilized Bruno and the brown boar, #195. Took some flash stills.

Sept 3 Took movies of yearlings of #48, two of the Four Muskateers. This is when we took stills of yearlings chasing John and Bob Rudd.

Sept. 3 Took photos of Marian with head out of window in trap. Marian's neck 25 inches. Inside diameter of collar after cutting & padding was 26 inches. Marian had been feeding on pine nuts. We put collar on Marian at 12:30 p.m.

Sept. 6 In evening we shot Bruno, #14, and instrumented him. Also weighed him. Took blood sample and footprint.

Sept. 14 Bruno in the area of Pelican Cone.

Sept. 20 In tracking Marian, found out she & cub had dug up side of hill where squirrels had cached cones. They had several large beds here as well. There were a lot of White Bark trees around here and they had lots of cones this year.

Sept. 24 We jumped Marian at close range and found two beds, both lined with grass.

Sept. 26&27 Was tracking Bruno in Pelican Cone area. Cow elk barked close to camp and several bulls bugled. Rationed our food. Huckleberries numerous throughout this area.

Oct. 10, 1964 Bull elk bugling close to our camp. Two spikes ~~xxxx spying~~.

Oct. 16 Instrumented #94, one of the Four Muskateers, the litter of #48 or the Brown-headed Sow.

Nov. 5 Still tracking. Did not sleep with receiver so cannot check for signals until receiver is warmed over fire. Breakfast: one package of potato soup, crackers & coffee.

Nov. 5 Return from trek to locate Marian's & #158's den.

Nov. 6 Drove to Mammoth with John & Dr. Hugh Lamprey.

Nov. 10 Packed gear, snowing lightly. Barometer at 7:00 p.m., 29.3. At 6:45 next morning read 29.2. Packed gear in car and took off for South Gate. Drove through

November 10, 1964 - Continued: snowstorm and 18 inches of snow around Lewis Pass.

Nov. 14 Left Moose to drive East.

Movement within ranges

Often it could be described as considerable roaming without moving very far — This as determined by measuring their daily airline movements between radiotrips made approximately 12 hours apart.

Both the Sun Creek Sow & the Allen Creek Sow daily foraged relatively short distances but covered quite a few miles. The former averaged 3.2 miles in 12 movements and the latter 2.3 miles in 13 movements The maximum straight line distance that these two grizzlies travelled day after day while foraging were five miles for one bear and six for the other. The movement of males under similar conditions was greater than the females. Peg-leg averaged 7.2 airline miles in 8 eight 12-hr periods but he also travelled nine miles in a single afternoon.

When the grizzlies detected carrion they moved directly to it. One grizzly (name) travelled a distance of 18 miles to feed on a carcass and No. 37 travelled an airline distance of 19 miles from one food source to another. Nevertheless it took the Allen Creek Sow 60 hours to locate & move to a carcass only one and three-quarters miles away when the wind was unfavorable.