

PANEL 5: BEARS AND HUMAN BEINGS

Preservation and Management of Grizzly Bears in Yellowstone National Park¹

GLEN F. COLE

Supervisory Research Biologist, Office of Natural Science Studies, National Park Service, Yellowstone National Park, Mammoth, Wyoming 82190.

SUMMARY

The paper presents general information on grizzly bear (*Ursus arctos*) numbers, increases in park visitors, the extent of human developments (campgrounds, etc.), and garbage disposal facilities within Yellowstone Park. Data are also presented on grizzly relationships to developments, garbage disposal sites, humans, and the results of management. Conclusions are made on conditions which favored the preservation of a grizzly population, the desirability of eliminating artificial food sources, the effects of repeated transplants of bears, and management actions which could reduce the opportunities for injuries to humans and the need to control bears.

INTRODUCTION

The grizzly bear is part of the native fauna of Yellowstone National Park. The preservation of a representative grizzly population is integral to the park's basic purpose. This is to preserve natural environments and native biota as an integrated whole (i.e., ecosystem) for their scenic, educational, cultural and scientific values.

This paper was written to make unpublished information on the grizzly available for reference use. It shows that human influences which altered bear habits increased opportunities for injuries to visitors, conflicted with a stated objective to preserve the grizzly under natural conditions, and generally degraded the esthetic and scientific values of the grizzly. The desirability of maintaining grizzlies under natural conditions is shown by comparing the 3 injuries to humans from bears in the 'wild' over the past 40 years with the 60 injuries that were caused by bears which were attracted to high visitor use areas by natural food.

METHODS

Figures on grizzly numbers were compiled from park records. These were mainly in annual wildlife reports. Figures between 1930 and 1959 had been variously based upon yearly counts of up to 150 bears and/or estimates by park personnel. Those since 1959 had been based upon annual counts of 154-202 individually marked or unmarked bears, as reported by Hornocker

¹ This Paper has been previously published in *BioScience* 21 (16): pp. 858-864; 1971.

(1962), Craighead & Craighead (1967), plus estimates. Counts were primarily of bears that were concentrated at or in the vicinity of garbage disposal sites during the summer. Estimates generally attempted to account for bears which remained in scattered distributions in the remote portions of the park.

Information on visitor numbers, developments, garbage disposal facilities, bear injuries to humans, and management activities was obtained from current park records or reviews of past correspondence and administrative reports. Interpretations were aided by the author's association with bear control and visitor protection activities, by interviews with park rangers who had carried out such activities since the 1930's, and coincident observations of grizzlies while carrying out research on wild ungulates in both the remote back-country and more accessible portions of Yellowstone Park since 1962. Grizzlies had been individually marked from 1959-1967 as reported by Craighead *et al.* (1960 and 1969).

RESULTS

Grizzly numbers

Population estimates for 10 years in the 1930's ranged from 160 to 310 and averaged about 240; 6 years in the 1940's, 200 to 320 with an average of 235; 4 years in the 1950's, 150 to 180 with a 170 average; 9 years in the 1960's, 200 to 250 with a 220 average. The reasons for the lower estimates in the 1950's were not apparent. The accuracy of population estimates between 1930 and 1959 could not be assessed. Those since 1959 could be conservative because the portion of the population which remained in the more remote areas of the park was underestimated.

A population of 200 grizzlies within Yellowstone's approximately 3,400 square miles would represent an average density of one bear per 17 square miles; 300 grizzlies, one bear per 11 square miles. Densities of one grizzly per 9 square miles have been reported for Glacier National Park by Martinka (1969), one per 15 square miles for Mount McKinley National Park by Dean (1958) and for a northwestern Montana area by Jonkel (1967). The density figures from these Rocky Mountain regions indicate that the general estimates of about 200-300 grizzlies for Yellowstone Park since the 1930's were reasonable.

Randall's (1961) accounts of hunting and trapping grizzlies outside Yellowstone Park boundaries suggest that bears which inhabited or ranged into these areas were either eliminated or greatly reduced in number during the early 1900's. Hunting ceased in Yellowstone Park after 1886. The park grizzly population has probably since occurred at 'carrying capacity' levels. Accounts and records of bears moving outside the park, that may reflect regular or periodic emigrations, are presented by Skinner (1925), McCracken (1955), Craighead *et al.* (1964), Craighead & Craighead (1967). The carrying capacity of the peak environment for grizzlies since the early 1900's could be lower than previously because of a reduced biomass of wild ungulates (possibly one of a limiting food source complex) and/or lowered habitat security levels (Errington 1946). The latter would occur where grizzly home ranges included areas outside park boundaries that became heavily hunted.

Park visitors

Numbers of yearly visitors to Yellowstone increased from about 1,000 to 260,000 between the establishment of the park in 1872 and 1929. The average

number of visitors per year was about 0.3 million during the 1930's, 0.5 million during the 1940's, 1.3 million during the 1950's, and almost 2 million during the 1960's.

From the late 1880's through the 1920's most visitors traveled to the park by train and stayed at inns or hotels. After 1930 most visitors came by car and increasing numbers camped outdoors. Eleven campgrounds with a total of 1,119 campsites were present in 1940; 14 campgrounds with 2,253 sites in 1969. During 1969, about 16 percent of 2.1 million visitors stayed an average of 2.6 nights in park campgrounds.

Developments

Approximately 95 percent of Yellowstone Park's 2.25 million acres are wild lands. The remaining land is in roads or developments, such as campgrounds, hotel, inn and cabin sites, and miscellaneous other visitor or administrative facilities. Units which were a campground-other-facility complex, as well as those which were only campgrounds, are collectively called 'developed areas' or 'developments.' The locations of six major (with 200 or more campsites) and nine minor developments are shown on Figure 1. None were fenced to exclude bears.

Garbage disposal

Approximately 7 thousand tons of garbage were collected and disposed of within the park each year between June 1 and September 15 of 1968 and 1969. The location of dump and incinerator sites are also shown on Figure 1. Only the Mammoth area incinerator was completely enclosed within a bearproof fence. The two other incinerators near the Grant Village and Bridge Bay developments left sufficient unburned food to attract bears during periods of mechanical difficulty or when the volume of garbage was greater than their burning capacity. Garbage dumps were unfenced pits.

Grizzly relationships to developments

The number of campsites in different developed areas, the distances to the nearest garbage sources at dumps and incinerators, and the relative use of areas by grizzly bears (as reflected by control actions) are shown in Table 1.

Habitual use was considered to involve repeated intrusions into developed areas by individual bears between June and September, as well as seasonal intrusions between May and mid-July or September and October. Seasonal intrusions occurred from animals traveling through a developed area to some place else, from breeding season movements and associations of males with females, and from food-seeking by particular bears before garbage became available at disposal sites (usually in June) or after sites ceased to be used in the fall.

Five of the six major developed areas were 8 miles or less from garbage dumps. Table 1 shows these areas were habitually used by grizzly bears. Two incinerators that were within $\frac{1}{4}$ to 2 miles of three of these developments probably contributed to habitual use. Intrusions into the major Madison development and nine other areas with approximately 100 or less campsites were comparatively rare or not known to occur.

Relatively high numbers of grizzly control actions (numbers of bears transplanted or destroyed) have occurred in 1935, 1937, 1942, 1949, 1959, and during at least four years since 1963. Conditions that may have contributed to the

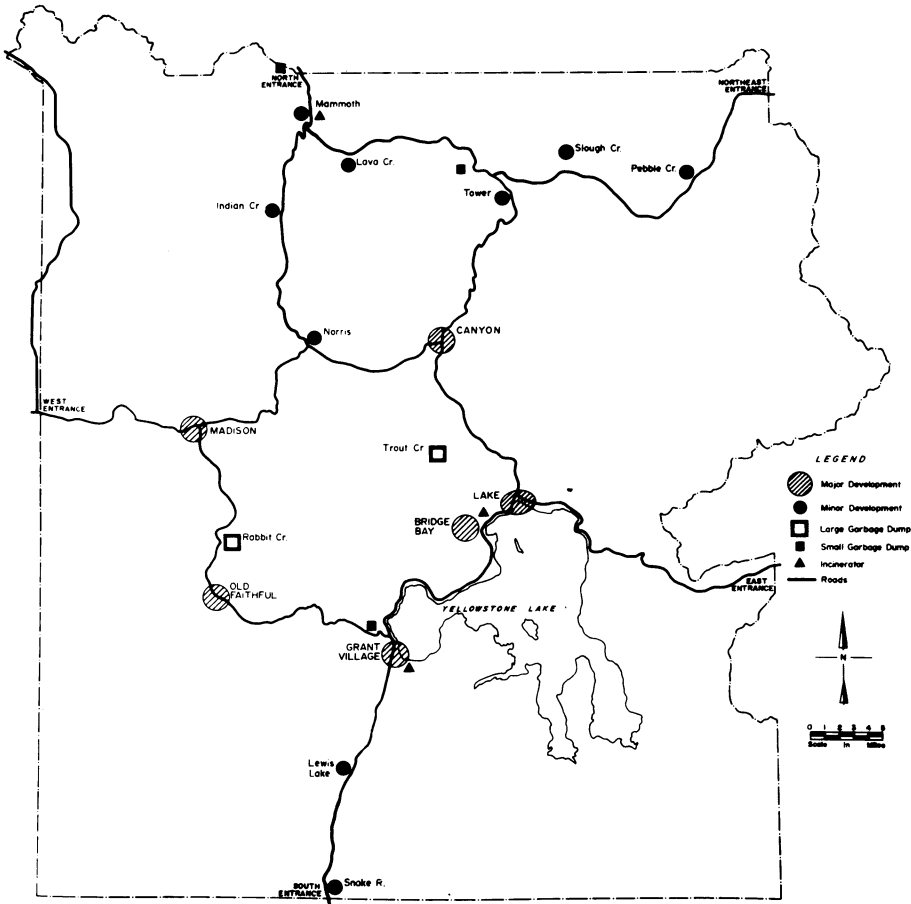


Fig. 1 Location of park developed areas and garbage disposal sites.

relatively high numbers of control actions during 1968 and 1969, were yearly carryovers of animals that repeatedly returned from transplant sites (discussed later), the presence of garbage in non-bearproof cans within some campgrounds, and an experimental 'phasing out' of artificial food sources that involved dumping separated 'edible' garbage for bears at the Trout Creek site. The latter may have contributed to some bears intruding into certain park developments by intensifying the behavioral interactions among the variously dominant and subordinate animals that fed at this dump.

About two-thirds of the grizzlies that were removed from the Canyon, Lake Outlet, and Bridge Bay developments in 1968 and 1969 were marked animals (discussed later). Data were not available, but it is suspected that most of these bears had been marked at or near the Trout Creek dump, or had a history of occurring at this dump area either prior to or in conjunction with their use of developed areas. During 1968 and 1969, only unmarked bears were observed or captured in the Grant Village development which was 18 miles from the Trout Creek dump. Some of these unmarked animals were believed to have come from the small dump about 4 miles from Grant Village. This dump was

TABLE 1. RELATIONSHIPS BETWEEN CAMPGROUND SIZE, DISTANCES TO GARBAGE DISPOSAL SITES WITH AVAILABLE FOOD, AND GRIZZLY BEAR USE DURING 1968 AND 1969.

Developments	No. campsites		Miles to nearest		Control actions [†]		Habitual use by grizzlies
	1940	1969	Dump	Incinerator	1968	1969	
Old Faithful Canyon	300	Closed	4		1(1) [‡]	‡	Yes
Lake Outlet	250	340	8		14	16(4)	Yes
Grant Village	300	428	7	2	16(3)	25(5)	Yes
Bridge Bay		433	4*	1/2	20(1)	5(1)	Yes
Madison		230	7	1/4	8	9	Yes
Norris	35	292	9				No
Lewis Lake	20	116	13			1	No
Mammoth		100	11			1	No
Indian Creek	100	91	5*				No
Tower Fall		78	10				No
Four other units	30	53	4				No
	84	92	8-20				No
Totals	1119	2253			59(5)	57(10)	

* Closed or garbage not available after 1967.

[†] Number of times bears removed by capturing for transplanting or destroyed with latter in parentheses.

[‡] Repeated attempts to capture other grizzlies unsuccessful.

closed in 1968. The lower number of control actions in the Grant Village development in 1969 apparently resulted from partially successful transplants of grizzlies which first intruded into this area in 1968.

Other factors also influenced grizzly bear use. Bearproof garbage cans were not present in all portions of the Canyon and Lake Outlet campgrounds until the fall of 1968; nor Grant Village and Bridge Bay campgrounds until the spring of 1969. Such 'bear-proofing' reduced the amount of artificial food for bears within these campgrounds. During the summer of 1969, the only available food within park campgrounds was from visitors failing to put their edible camp supplies in the trunks of cars or a similarly secure place. Despite distributed and posted warnings that this would attract bears, enough camp food was available in larger campgrounds to attract some grizzlies.

The locations of the Canyon, Lake Outlet and Grant Village developments at the edge of physiographic barriers (rugged canyon or Yellowstone Lake) probably placed these areas in the path of grizzly travel routes. The locations of the first two on or adjacent to large unforested areas with fertile alluvial

soils (with relatively high densities of rodents and bulbous plants) also placed these in what appeared to be superior spring and, in some years, fall habitat for the bears. The suggested overall relationships were that habitual grizzly use was influenced by the physiographic locations of developments, the distances developments were from garbage dumps or incinerators, and the quantity of garbage or edible camp supplies within larger campgrounds.

Grizzly relationships to garbage disposal sites

Hornocker (1962) reported from his studies in Yellowstone Park that grizzlies traveled long distances to concentration sites that centered around garbage dumps. Individual bears traveled from areas within as well as outside the park. The numbers using a dump progressively increased from June to a peak around August 1. Dispersals of bears from concentration sites occurred rapidly after about mid-August and while dumps were still operating. Hornocker concluded that garbage food sources affected bear distributions and movements, but were not a major factor in determining population numbers.

Craighead *et al.* (1969) considered the movements of grizzlies to use artificial food at refuse dumps during the summer 'a special type of migration.' Distances between the summer and autumn ranges of individual bears were reported to be 10-75 miles or more. The migrations of some grizzlies from distant areas to a garbage disposal site probably resulted from previous garbage feeding experience as a young animal. Jonkel (1967) postulated such relationships for black bears (*Ursus americanus*). Some adult males may have initially encountered garbage food sources during the course of breeding season movements or mid-May to mid-July mating associations with females (Craighead *et al.* 1969) and not have been 'garbage-raised' as young animals.

Jonkel (1967) reported that most black bears that used natural food either lost or maintained their weight during the period after they emerged from hibernation to mid-July. Studies by Murie (1954), Martinka (1969) and Tisch (1961) indicate that the natural summer foods of grizzlies and black bears are primarily herbaceous plants. Apparently garbage or camp groceries are a highly palatable supplement to natural summer diets which do not result in weight gains.

Murie (1961) reported that the behavior of grizzlies was one factor in keeping animals widely distributed in McKinley National Park. The home ranges of single adults, family groups and weaned young overlapped broadly, but spacing (between individuals and social groups) was usually maintained by what could be considered avoidance behavior. The agonistic behavior of female grizzlies was pronounced in the defense of young. Dispersals of weaned young from family associations were gradual or occurred abruptly as a result of the agonistic behavior of maternal females. Murie considered the close association of 30 grizzlies he observed on a Yellowstone Park dump as an apparent loss of 'wild natural habits.' Aggregations of about 20-30 bears were known to occur at the Trout Creek and Rabbit Creek dumps during the summer of 1969. Craighead *et al.* (1969) reported that between 98 and 132 grizzlies were annually attracted in summer to the Trout Creek area.

The concentration of grizzlies at garbage disposal sites, in combination with the behavior of adult animals, may have contributed to greater intrusions of young bears into park developments, i.e., as compared to young animals remaining on or dispersing from more scattered summer home ranges. Hornocker (1962) reported a definite peck order and what could be considered high levels of agonistic behavior among variously dominant and subordinate animals

that fed at a dump. Weaned young, separated from females, and young adults ranked as the most subordinate animals.

Some grizzlies that fed at garbage dumps became conditioned to accept (i.e. not avoid) the presence of humans and/or to respond positively to the appearance of garbage-hauling equipment. Young bears, females with young and some adults may have made such behavior adjustments to obtain food before it was appropriated by other dominant, but more wary (of humans) animals. The indicated overall relationships were that garbage food sources altered the natural summer distributions of a substantial portion of the park grizzly population and placed concentrations of interacting bears within comparatively short distances of certain park developments.

Grizzly-human relationships

Two grizzly-caused fatalities have occurred within Yellowstone Park over the past 97 years. One in 1907 involved a visitor who chased a cub up a tree, prodded it with an umbrella, and was fatally injured by the responding female bear. The other fatality occurred in 1916 when a Government employee attempted to chase a large grizzly from a freight wagon containing edible camp supplies.

Sixty-three known and probable grizzly-caused injuries to humans have occurred within the park over the 40 years since 1930 (Table 2). The data show that less than proportionate increases in injury rates occurred with increases in visitor numbers during all but the 1950's. As will be discussed later, the decrease in injury rates during the 1950's mainly resulted from differences in bear control procedures.

TABLE 2. VISITOR NUMBERS, INJURY RECORDS AND NUMBER OF BEARS KILLED FOR CONTROL IN YELLOWSTONE NATIONAL PARK, 1930-1969.

Period	Average No. visitors (millions)	No. known and probable injuries*		Injury rates per visitor	No. grizzlies killed for control
		Visitor	Employee		
1930's	3.2	4(1)	2	1: 800, 000	23
1940's	5.5	9	3(1)	1: 610, 000	42
1950's	13.6	5(4)	1	1: 2, 720, 000	25
1960's	19.5	38(12)	1	1: 510, 000	37
Totals	41.8	56(17)	7(1)	1: 746, 000	127

* Number circumstantially probable in parentheses.

Table 2 also shows that consistent relationships did not exist between increases in visitors and the numbers of grizzlies killed for control. Some direct relationships between higher injury rates to humans and bear kills were indicated, but this was additionally influenced by control procedures.

About 75 percent of the 63 grizzly-caused injuries to humans were minor to the extent that they required only first aid, sutures, or lesser treatment on an out-patient basis (Table 3). The other 16 injuries (25 percent) entailed overnight or longer periods of hospitalization for treatment of shock and/or injuries.

Grizzly-caused injuries occurred predominantly in park campgrounds and to visitors (Table 3). Of the 60 known and probable injuries in such areas since 1930, 43 occurred while persons were in sleeping bags or bedrolls either in the open or in tents; 4 resulted from walking confrontations in areas where bears had been fed for tourist viewing; 7 were walking confrontations in campgrounds (6 during daylight and 1 at night); 3 resulted from attempts to chase bears away from camp food; 1 from an attempt to pet a bear in a culvert trap; and 2 from unknown circumstances.

Only three persons are known to have been injured while hiking in park back-country areas between 1930 and 1969. Two of the injuries occurred in 1966; one in 1960. All were caused by female bears with young. Martinka (pers. comm., 1969) reported that 8 and possibly 9 of the 10 injuries that occurred while persons were hiking (one photography attempt) in Glacier National Park over the past 20 years resulted from natural defensive actions of female bears with young. The two fatalities and three other injuries to humans within Glacier Park during this period were caused by animals that habitually frequented developed areas to obtain garbage or camp food.

The suggested relationships in Yellowstone Park were that human influences in the form of artificial food were basically responsible for most (95 percent) of the grizzly-caused injuries over the past 40 years. The three injuries that occurred in the 'wild' resulted from the natural defensive behavior of females with young.

Management

Park objectives to preserve a grizzly population under natural conditions and provide for the safety of visitors appear to have been formalized during the 1930's. Management to accomplish these objectives has involved removing bears which come into developed areas and regulating human activities or influences to decrease the opportunities for bear-caused property damage or injury to humans. Grizzlies were removed from developed areas by capturing them with culvert live traps or immobilization drugs (after 1962) and by shooting.

The removal or control of bears by shooting during years between 1930 and 1962 appeared to be variously *responsive* and *preventive* in relation to the incidence of injuries (Figure 2). Removals during years without injuries or prior to the occurrence of injuries were considered preventive. Removals by shooting between 1963 and 1965 were apparently deferred despite high injuries. Those since 1966 reflect a progressively increasing response to a somewhat sustained occurrence of injuries.

Changes in removal procedures after 1962 were influenced by increased concern for the grizzly as a rare species. Bears that had become trap-shy from previous experiences with culvert live traps and would have been destroyed in previous years were repeatedly captured and transplanted by the use of immobilizing drugs. Additional deferments from destroying particular bears were made because marked animals were important to research studies and critical public reactions to 'destroying too many bears.' These deferments

TABLE 3. RECORDS ON GRIZZLY-CAUSED INJURIES TO HUMANS IN YELLOWSTONE NATIONAL PARK, 1930 TO 1969.

Periods	No. of injuries*		Conditions			Treatment		Persons	
	Devel- oped areas	Back- country areas	Sleeping in			Out-patient	Hospitalized	Visitor	Employee
			Bag [†]	Tent	Other				
1930's	6(1)	0	1	1	4	3	3	4	2
1940's	12(1)	0	3	5	4	12	0	9	3
1950's	6(4)	0	4	1	1	4	2	5	1
1960's	36(12)	3	7	21	11	28	11	38	1
Totals	60(18)	3	15	28	20	47	16	56	7

* Number attributed to grizzly by circumstantial evidence shown in parentheses.

† Sleeping bag or bedroll on ground.

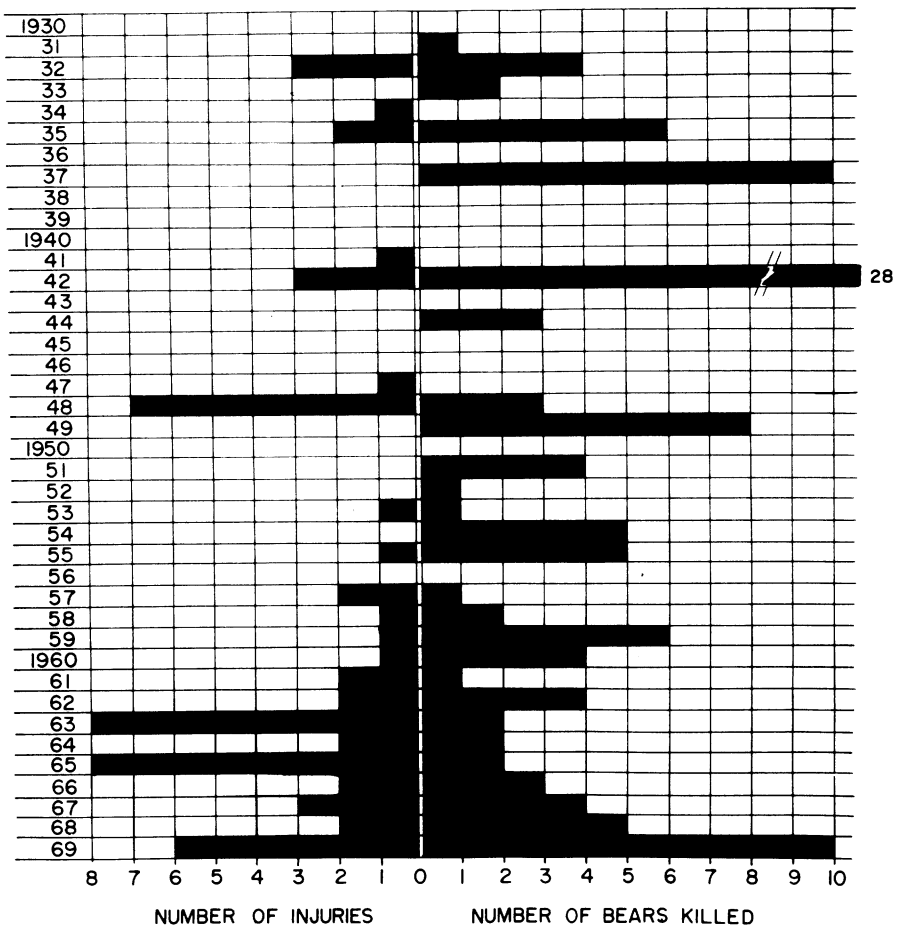


Fig. 2 Grizzly-caused injuries in developed areas in relation to grizzlies killed for control, 1930-1969, Yellowstone National Park.

resulted in individual bears, mating animals and, finally, family units habitually frequenting certain developed areas.

Figure 2 shows an average of three grizzlies was destroyed and about one injury occurred each year over the 1930 through 1962 period of both responsive and preventive control. An average of 2.5 grizzlies was destroyed and 0.6 injuries occurred each year during the 1950's. Preventive control was most continuous during this period. From 1963 through 1969 an average of four grizzlies was killed and 4.5 injuries occurred per year in park developed areas. These values are not without influence from increases in visitor numbers, but they indicate that the attempts to substitute repeated transplanting within the park for the destruction of bears that habitually frequented developed areas contributed to increased injuries to humans and, ultimately, the number of bears destroyed.

The relatively high control kill of 28 grizzlies in 1942 may have been partially due to the 1941 closure of the bear feeding and viewing site within 3 miles of

Canyon. Other coinciding circumstances were an apparent deficiency in natural food which increased intrusions of both black and grizzly bears into park developed areas, and a greatly reduced ranger force for trapping and transplanting bears as a result of World War II.

Unmarked grizzly bears that were captured in or near park developments were transplanted a total of 47 times during 1968 and 1969. Twenty individually marked grizzlies and one recognizable grizzly were transplanted a total of 54 times during the same period. Eleven of these identifiable bears returned from transplant-release sites to the same development a total of 32 times, or to another development a total of 4 times. The distances these transplanted grizzlies returned are shown in Table 4. Five of the 10 marked bears that did not return were transplanted 8 miles from capture sites. The other five were transplanted 18-26 miles from capture sites.

TABLE 4. NUMBER OF TIMES AND DISTANCES IN MILES THAT MARKED GRIZZLIES RETURNED FROM TRANSPLANT SITES IN 1968 AND 1969.

Bear No.	No. times returned	Distances returned: (airline miles)
1	6	8, 8, 7, 28, 27, 8
2	6	7, 16, 16, 20, 20, 17
3*	4	8, 20, 26, 15
4*	3	8, 20, 15
5	4	8, 8, 26, 20
6	4	8, 26, 15, 26
7	3	8, 8, 8
8	2	25, 26
9	1	7, 7
10	1	16
11	1	7

* In campground as cub and as yearling with first two returns in association with adult female.

The shorter return distances of 7-8 miles shown in Table 4 were between the Canyon, Lake Outlet and Bridge Bay developments and the Trout Creek dump. Apparently neither the use of this dump nor more distant release sites prevented certain bears from returning to these developed areas. Most marked bears were adults, but four independent returns by two yearlings to the same area from transplant distances of 15-26 miles indicate this age class has homing capabilities. The greatest airline distance a bear could be transplanted by vehicle from any centrally located park development without placing

animals near other developments was about 36 miles. This distance may not be great enough to overcome the homing capabilities of most adult grizzlies. Transplants of adult animals into areas where population units already occurred at equilibrium densities could have adverse population consequences (Davis 1949).

Three sites where bears had been purposefully fed garbage to facilitate tourist viewing were closed between 1930 and 1941. Two were in the immediate vicinity of the Old Faithful and Canyon developments; one was within 3 miles of Canyon. Four open pit garbage dumps were also closed between 1950 and 1969. These were closed to disperse concentrations of bears that either contributed to intrusions into developed areas or caused injuries. Injuries mainly resulted from persons attempting to view or photograph grizzlies at close range.

Other controls on human influences or activities have involved installing bear-proof garbage cans in campgrounds, limiting access to existing dumps or incinerator sites to authorized personnel, regulating the use of certain campgrounds to avoid May and June or fall intrusions by bears, and distributing and posting informational literature on how to travel and camp in bear country. A monitoring system maintains daily records of grizzly sightings, incidents of property damage or personal injuries, and bear control actions. Records on the location of female grizzlies with young or particularly high densities of bears are used to advise appropriate precautions to hikers and restrict foot travel or camping in certain areas.

CONCLUSIONS

A representative grizzly population has been preserved within Yellowstone Park. This was primarily due to the park being sufficiently large and ecologically intact to sustain a population and the existence of large blocks of wild land without conflicting human uses or developments. Except for limited mortality from control operations that averaged about three animals annually, and occasional scientific collections or shipments of animals to zoos, the resident grizzly population was essentially naturally regulated. Emigrations or movements of animals from the park population contributed to sport hunting and intrusions into settled areas outside park boundaries. The latter was mainly in response to available artificial food.

Management actions to remove all artificial food which alters grizzly bear habits and directly or indirectly causes some animals to intrude into developed areas could restore conditions more appropriate to the park's basic purpose and the objective of preserving a grizzly population under natural conditions. These actions, in conjunction with consistent preventive removals of bears from developed areas, could be expected to reduce the opportunity for injuries to visitors and, ultimately, the need to control bears. Repeated transplants of grizzlies which habitually frequent developed areas maintain these animals in the population, but eventually increase injuries and place bear control on a 'sustained yield' basis. The abnormally high incidence of injuries from such bears tends to make the park's attempts to preserve a wild grizzly population controversial.

Fencing existing incinerators and relocated land-fill dumps or hauling garbage outside the park would abruptly terminate garbage-influenced aggregations of bears in the vicinity (within 8 miles) of park developed areas. This would also preclude young bears from acquiring garbage-influenced habits. Abrupt exclusions of bears from garbage food sources could result in an initially greater

number of intrusions into park developed areas than a gradual withdrawal of such food. Gradual withdrawals could result in a greater total number of intrusions over time because young animals would continue to learn to use artificial food sources and concentrations of interacting bears would continue to occur on decreasing amounts of garbage.

Consistent preventive removals of grizzly bears from park developed areas could reduce the opportunities for injuries to visitors, with either abrupt or gradual exclusions of the animals from garbage food sources. Distant transplants to reestablish grizzly populations in suitable remote wilderness areas in the Rocky Mountain region would serve as an alternative to destroying animals that could not be transplanted sufficient distances within the park to overcome their homing capabilities. Animals destroyed for control purposes within the park can be salvaged as scientific specimens and donated to educational institutions.

The total number of grizzlies that would need to be removed from the park by distant transplanting or shooting could be greater with gradual reductions in artificial food. It is unlikely, however, that these or any subsequent removals that were confined to bears which came into developed areas, would be of sufficient magnitude to have lasting consequences on the park's grizzly population (i.e. prevent the reestablishment of environmental and behavior-influenced densities). The opportunities for injuries to visitors and the need to control bears within developed areas could be additionally reduced by imposing and publicizing fines for allowing the animals to feed in campgrounds (as a result of not properly storing food), and either converting campgrounds within superior grizzly habitat to day-use picnic areas or enclosing them within bear-proof fences.

POSTSCRIPT

Following reviews of data and recommendations from a Scientific Advisory Committee,¹ park administrators directed that a program be implemented which would reduce injuries to visitors and restore a natural grizzly population. An outline of this program, the general design for evaluation studies, and a report on first-year results have been presented by Cole in the foregoing paper. The program mainly lists steps for removing all artificial foods that attract bears into park developed areas, procedures for controlling bears and protecting visitors, and an open-ended schedule for closing two large garbage dumps that were used by grizzlies. Evaluation studies involve testing hypotheses that relate to injury rates, bear control actions, and indices of 'naturalness' in the grizzly population.

The following is a brief summary of 1970 results. One of the two large open-pit dumps in the park was closed. Some portion of 30 control actions that involved 18 different grizzlies could be attributed to closing this dump and the presence of garbage cans without bearproof lids in one hotel and cabin complex. The remaining 40 control actions that involved 32 different bears were mainly due to intensified efforts to promptly remove grizzlies from campgrounds.

¹ 'A bear management policy and program for Yellowstone National Park.' Report to the Director by the Natural Sciences Advisory Committee of the National Park Service, 1969, 7 pp., typewritten.

Thirty-nine different bears were transplanted within the park a total of 50 times. Sixty percent of these transplants were successful in preventing subsequent returns to developed areas. Six bears that returned from transplants and one injured animal were intentionally destroyed. Eight bears were donated to zoos. Five other bears were unintentionally removed from the population because of drug malfunctions, or the animals charging personnel who were attempting immobilizations. Attempts to donate grizzlies to states to reestablish populations in suitable historical habitats were unsuccessful. Destroyed animals were processed as scientific specimens for educational institutions.

Two persons were injured in a campground by one grizzly bear in 1970. This is lower than average incidence of injuries for the previous 10 years (Figure 2), but valid tests for differences will require data from a series of years. One additional injury occurred in a backcountry area when a hiker approached too close to a female grizzly with a cub. This was the fourth such incident over a 41-year period.

The scheduled closure of the last open-pit dump for 1971 or 'the earliest possible later date' could result in some bears visiting developed areas that do not already do so. Fewer such 'new' visits may be expected to the extent that (1) successive generations of young bears do not become habitually linked to food supplied by humans, and (2) the interactions between the variously dominant and subordinate animals that use this dump are not intensified or prolonged by gradually reducing the amount of garbage that is hauled to the dump.

Contingencies listed in the park's program if bear visits to developed areas 'exceed control capabilities or lead to excessive numbers of animals being destroyed' are: continue to use the dump beyond the scheduled closure; manipulate campground opening or closing dates; restrict camping to trailer or pickup units; temporarily close campgrounds, if necessary.

Removals of incorrigible bears are expected to not exceed 10 percent of the population during 1971, and to decline to negligible levels in subsequent years. Only a temporary minor depression of grizzly population numbers seems possible, because the annual production of cubs exceeds any envisioned removals of bears, and an increase in the survival rate for young animals appears imminent. Martinka's (1969) comparisons of data from his studies with that from Yellowstone Park and other areas indicate that a high first-year mortality of young grizzlies (35 to 40 percent) occurs in population segments that concentrate at garbage dumps. Comparative mortality rates from the cub to yearling class in two naturally distributed bear populations were about 5 and 7 percent.

ACKNOWLEDGMENTS

I wish to thank Dr. Adolph Murie, Moose, Wyoming, Dr. A. Starker Leopold, University of California, and Mr. Clifford J. Martinka, National Park Service, for reviewing the manuscript. Yellowstone Park Rangers Dale H. Nuss, Gary N. Brown and Gerald E. Mernin provided information and reviews of manuscript sections on bear control and visitor protection activities that greatly aided interpretations of management results. Administrative reports and file records had been maintained by the Ranger Division of Yellowstone National Park. The paper is a contribution from the National Park Service's Office of Natural Science Studies, Project YELL-N-38.

REFERENCES

- CRAIGHEAD, J. J., HORNOCKER, M. G., WOODGERD W. & CRAIGHEAD, F. C. Jr. 1960. Trapping, immobilizing and color-marking grizzly bears. *Trans. N. Am. Wildl. Conf.* 25: 347.
- , CRAIGHEAD, F. C. Jr. & RUFF, R. L. 1964. An ecological study of grizzly bear. Environ. Res. Inst. and Mont. Coop. Wildl. Res. Unit, Sixth Ann. Rep. 18 p. (mimeo.)
- , & CRAIGHEAD, F. C. Jr. 1967. Management of bears in Yellowstone National Park. Environ. Res. Inst. and Mont. Coop. Wildl. Res. Unit Rep., 113 p. (multi.)
- , HORNOCKER, M. G. & CRAIGHEAD, F. C. Jr. 1969. Reproductive biology of young female grizzly bears. *J. Reprod. Fert.* Suppl. 6: 477-475.
- DAVIS, D. E. 1949. The role of intraspecific competition in game management. *Trans. N. Am. Wildl. Conf.* 14: 225-331.
- DEAN, F. C. 1958. Investigations on grizzly bear in interior and arctic Alaska. *Alas. Coop. Wildl. Res. Unit. Quart. Rep.* 9(4): 61-71.
- ERRINGTON, P. L. 1946. Predation and vertebrate populations. *Quart. Rev. Biol.* 21: 144-177, 221-245.
- HORNOCKER, M. G. 1962. Population characteristics and social and reproductive behavior of the grizzly bear in Yellowstone National Park. M. S. Thesis, Mont. State Univ., Missoula. 94p.
- JONKEL, C. J. 1967. Black bear population studies. Job Compl. Rep. W-98-R, Mont. Fish and Game Dept. 147 p.
- McCRACKEN, H. 1955. *The beast that walks like man*. Hanover House, New York. 319 p.
- MARTINKA, C. J. 1969. Grizzly ecology studies, Glacier National Park. Nat. Park Serv. Prog. Rep. 43 p. (mimeo.)
- MURIE, A. 1961. *A naturalist in Alaska*. The Devin-Adair Co., New York, 302 p.
- MURIE, O. J. 1954. Progress report on the Yellowstone bear study. 16 p. (typewritten).
- RANDALL, L. W. 1961. *Footprints along the Yellowstone*. The Naylor Co., San Antonio. 186 p.
- SKINNER, M. P. 1925. *Bears in Yellowstone*. A. C. McClurg and Co., Chicago. 155 p.
- TISCH, E. L. 1961. Seasonal food habits of the black bear in the Whitefish Range of northwestern Montana. M.S. Thesis, Mont. State Univ., Missoula. 108 p.