

Grizzly Bear—Man Relationships in Yellowstone National Park¹

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INTRODUCTION

The grizzly bear, *Ursus arctos horribilis*, is an intelligent, extremely efficient omnivore and a relatively inefficient carnivore. This large bear feeds on grasses, sedges, tubers, berries, nuts, carrion, meat caches, rodents, big game, livestock, garbage, and even modern packaged foods. The propensity to seek and utilize a wide range of edibles has brought the grizzly into frequent contact with man. This ecological relationship of the omnivorous grizzly associating with omnivorous man and the predatory bear competing with the predatory human has led and will continue to lead to confrontations, property damage, and occasional conflict and injury. The grizzly has a long history of seeking and taking the food it wants with little opposition. The erratic, aggressive, and frequently unpredictable behavior of both grizzly and man increases the probability of conflict. The opportunity for confrontation and for injury to humans is small, but it is greater in national parks than elsewhere.

To understand grizzly bear—man relationships in Yellowstone National Park, we must first recognize that the ecology of bear and man has always overlapped. Within recent geological time, wherever the species existed, the grizzly bear was at or near the top of the North American food pyramid.

The North American Indian and the grizzly bear coexisted in a spacious environment. Two questions we wish to explore are—can the grizzly bear and man coexist in the congested environments of our large national parks? Specifically, can man and grizzly live together in Yellowstone? Secondly, if they can coexist, how should man achieve this? Both questions require more than theoretical or philosophical answers, ethological extrapolation, administrative decrees, or generalized guidelines.

We, our colleagues, and our graduate students sought to answer these questions 12 years ago when we began a long-term study of the grizzly bear within the 7,700 square miles of Yellowstone National Park and adjacent national forests (Craighead *et al.* 1960). Since 1959 we have captured, examined and released over 550 grizzlies, immobilized and individually color-marked 256 and logged over 40,000 man hours observing and recording their activities and behavior.

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In addition, 24 individual grizzlies have been fitted with radios and radio-monitored for approximately 30,000 hours in order to obtain data on movements, home ranges, food habits, social and denning behavior, and an understanding of bear-man relationships (Craighead & Craighead 1965, 1969, 1970).

SOME BIOLOGICAL FACTS

Using data from 324 censuses totaling 11,340 hours and from an intensive trapping, re-trapping and marking program, we have calculated a minimum of 175 grizzly bears in Yellowstone area. One-third of the adult females (about 15) breed each year and produce an average of 33 cubs or a 19% annual increment. The females first breed successfully at $4\frac{1}{2}$ years though many may not produce cubs until they are 8 or 9 years old (Craighead *et al.* 1969). The annual increment slightly exceeds the mortality rate; thus, the population grew at an average annual rate of approximately six grizzlies per year from 1959 through 1966 (Craighead & Craighead 1967). An increase in the death rate, especially of adult females, could jeopardize the population.

In the summer months, grizzlies gradually, but steadily, congregate at Trout Creek (Figure 1) and at other major open-pit dumps in and outside of Yellowstone. Grizzlies are attracted to these dumps from all portions of the Park and from the adjoining national forests. Peak densities are reached in August. Our observations indicate that there are few grizzlies in the Yellowstone back-country during this time. Mullen & Booth (1969) also found fewer grizzlies on the Shoshone National Forest adjacent to Yellowstone during August than prior

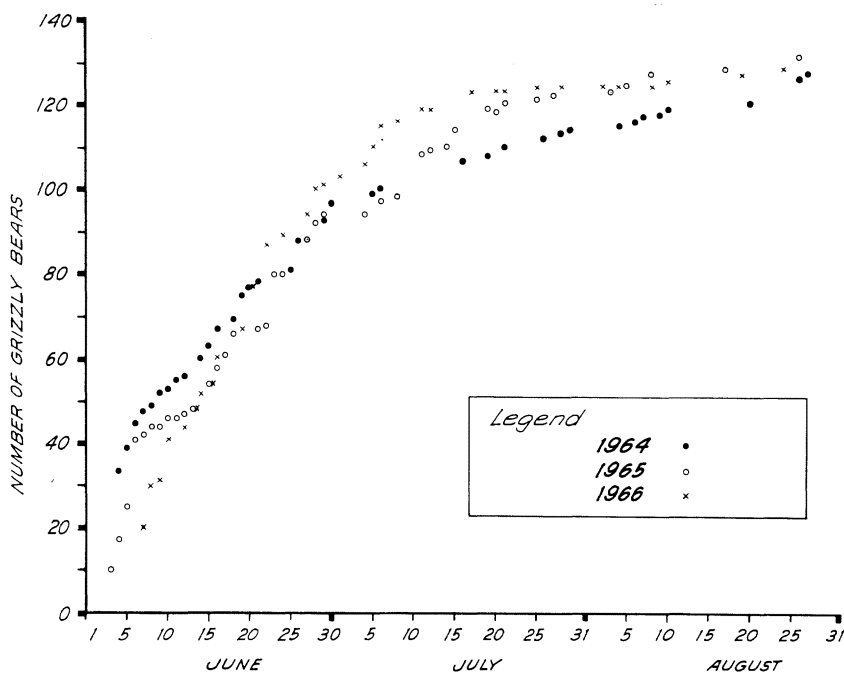


Fig. 1 Seasonal coalescence of grizzly bears at Trout Creek Dump. Each data point represents a $3\frac{1}{2}$ hour census.

to and after this month. Our census and movement data (Craighead & Craighead 1967) show that Yellowstone National Park serves as a summer refuge for many grizzly bears whose home ranges extend beyond the Park boundaries. We have computed that a 5,000 square mile area including Yellowstone National Park and an adjacent 10-mile corridor of national forest land supports an average of about one grizzly bear to every 29 square miles. Some grizzlies spend their lives entirely within the Park; others do not. Those that move outside the Park boundaries are hunted. Forty-eight percent of the grizzlies shot outside the Park from 1959-1968 were adult animals and 52% were sub-adults ranging from yearlings to four-year-olds, showing that outward movement from within the Park is not confined to young animals. These data suggest that movements of grizzlies out of the Park result from the species' natural mobility and should not be interpreted as evidence that grizzlies have exceeded the carrying capacity of their environment in Yellowstone National Park.

Studies have been made of the movements and home ranges of grizzlies inhabiting Yellowstone and adjacent portions of four national forests. Data from color-marked and radio-tagged bears show that most, perhaps all, of the grizzlies in this population feed at one or more of the earth-filled garbage dumps (Figure 2) at sometime during the course of their lives; some visit the dumps frequently, others infrequently. Thus, it is doubtful if the term 'wilderness grizzly' is useful if we mean an animal having no contact with 'artificial' food sources. For example, 114 marked grizzlies were identified at the Trout Creek Dump during the summers of 1966 through 1968. Table 1 lists the number of these marked animals identified at the dump and also in the backcountry.

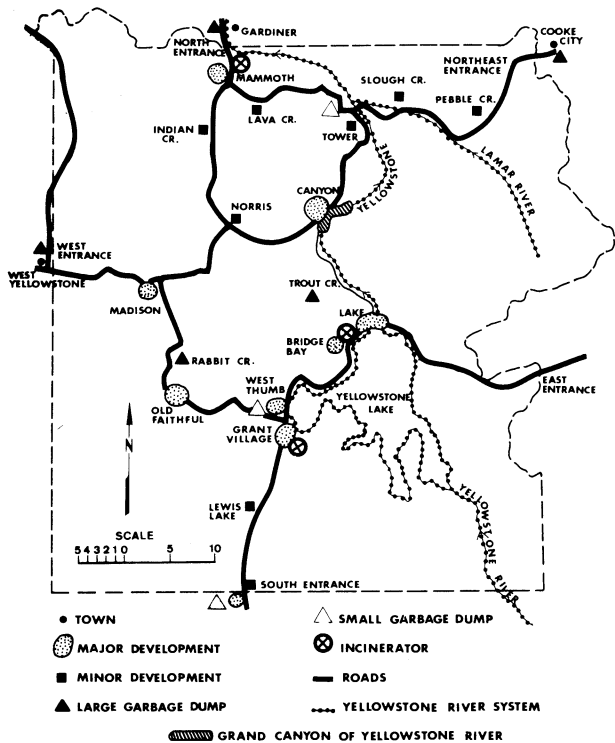


Fig. 2 Map of Yellowstone National Park showing developed areas, garbage dumps, and incinerators.

TABLE 1. COLOR-MARKED GRIZZLIES OBSERVED AT TROUT CREEK DUMP AND RE-OBSERVED IN WILDERNESS AREAS* OF YELLOWSTONE NATIONAL PARK FROM 1966-1968.

Cubs	1-year olds	2-year olds	3-year olds	4-year olds	Adults		Total
					Males	Females	
229	218	183	158	141	30	39	
230	219	202	177	144	207	40	
236	220	216	185	147	217	101	
240	221	227	211	165		112	
241	233		228	183		128	
256				188		132	
				208		141	
						163	
						172	
						173	
						187	
						228	
6	5	4	5	7	3	12	42

*Wilderness and backcountry are used synonymously in the text. They are undeveloped, roadless areas retaining their primeval character without permanent improvements or human habitation. In these areas, the earth and its community of life are untrammelled by man, and man himself is a visitor.

During a 3-year period, 37% of all the marked grizzlies that visited the Trout Creek Dump were also observed in the backcountry. Because of the pattern of human use in Yellowstone National Park, areas a mile or more from roads and developed areas conform to the definition of wilderness as it is stated in the National Wilderness Preservation Act. Approximately 95% of the 3,400 square miles in Yellowstone National Park can be considered backcountry. Most backcountry observations were made in spring and fall when the grizzlies were dispersed. As Table 1 shows, all age classes disperse throughout the Yellowstone backcountry.

Additional observations in the backcountry and at other garbage dumps during other years also show that, in the spring and fall months, the grizzlies that feed in summer at these garbage disposal areas also frequent the Yellowstone wilderness.

All Yellowstone grizzlies, regardless of their feeding habits or degree of association with man, inhabit wilderness portions of the Park and adjoining national forests from October through April. Thus, management of grizzly bears in Yellowstone Park affects not only resident animals in the Park but also grizzlies inhabiting four national forests in three states.

Food disposal areas (Figure 2) have attracted grizzlies for over 80 years.

They have shaped and are integrally meshed with grizzly bear ecology in Yellowstone. Except for the nature of the food, they are ecological equivalents of the spawning salmon runs that attract and concentrate Alaskan brown bear (*Ursus arctos middendorffi*) during the summer months. Yellowstone garbage sites concentrate the grizzly bears during a 3-month period from June through August.

Key questions posed are: Have the garbage dumps basically altered the grizzly's relationship to man? Have they increased or decreased grizzly-man conflicts in Yellowstone? Should they be eliminated and, if so, how? To answer these questions we must understand bear-man relationships and the nature of bear-man conflicts.

BEAR-MAN RELATIONSHIPS

We can classify grizzly bears inhabiting the Yellowstone area into four types based on their feeding behavior as related to humans. These are: (1) bears which forage at the garbage disposal areas during summer months; (2) those that either occasionally or habitually visit campgrounds or developed areas; (3) bears man-conditioned by food handouts at lodges and construction camps; and (4) grizzlies which reside throughout most of the year in the backcountry and rarely visit a garbage dump, campground, or other developed areas. Overlapping of types occurs, yet the four categories are quite distinct. The majority of bears fall into the first category. Those in the second and third categories, though few, are the most troublesome. Practically no Yellowstone grizzlies qualify for the fourth category

Behavior of grizzlies frequenting garbage dumps:

We have obtained no evidence that the Yellowstone area has two distinct populations of grizzlies—'wild living' animals inhabiting the wilderness country and 'garbage-addicted' grizzlies inhabiting the dumps and developed areas of the Park. On the contrary, thousands of man-hours spent observing grizzlies at open-pit dumps and hundreds spent observing these same color-marked animals and monitoring radio-instrumented bears in wilderness country divulged not two distinct populations but two distinct behavioral patterns. Many of the grizzlies that feed at the isolated, open-pit, garbage dumps exhibit less fear, and greater tolerance of man at these areas than at other areas. The same animals that ignore human scent at the dumps are quickly alerted by it in the backcountry. From hundreds of encounters that we made with grizzlies when they were half a mile or more from the dumps, we observed that in most instances, they were alert and wary and would generally flee when they heard us or got a scent. Tolerance of man while feeding on artificial food at the dumps is definitely linked with specific sites. It is not a general toleration of humans or of human scent, although in rare instances the on-site conditioning may alter behavior in other locations. Animals that feed at garbage dumps, presumably where the human scent is strong, ignore it there but not elsewhere. We have little evidence that garbage feeding changes their human avoidance behavior. Troublesome grizzlies normally develop their behavioral patterns toward humans under quite different circumstances.

The Yellowstone garbage dumps provide grizzlies with an abundance of palatable food, congregate them for an unnaturally long period of time and alter some of their behavioral patterns. Feeding at these dumps does not normally develop grizzlies into garbage-seeking animals, make them dependent on

humans (Leopold 1970) or create incorrigible animals. This does not imply that the garbage dumps are beneficial and should be kept open: it does mean that eating 'unnatural' versus 'natural' food does not, in itself, significantly alter the behavior of Yellowstone's grizzlies toward human beings.

Behavior of grizzlies frequenting campgrounds:

Of 36 grizzly bears captured and initially marked in campgrounds, 64% re-entered a campground or developed area following their release; 28% re-entered two or more times. Among 221 grizzlies initially captured and marked at garbage disposal sites or in the backcountry, 36, or 16%, were later captured in a campground or developed area. Only 9.5% re-entered two or more times (Table 2). Thus, many grizzlies initially captured and marked in campgrounds had already developed chronic campground feeding habits and they became problem animals more often than grizzlies captured and marked elsewhere.

TABLE 2. NUMBER AND PERCENT OF 257 COLOR-MARKED GRIZZLIES CAPTURED OR RECAPTURED IN A CAMPGROUND OR ADJACENT DEVELOPED AREA, 1959-1969.

	Grizzlies initially marked inside campgrounds	Grizzlies initially marked outside campgrounds	Total
Number marked	36	221	257
Percent of marked population	14.0	86.0	100
Entering campground or developed area once as a marked bear			
Number	23	36	59
Percent	63.9	16.3	23
Entering campground or developed area two or more times as a marked bear			
Number	10	21	31
Percent	28.0	9.5	12

The data in Table 2 also suggest that capturing and marking grizzlies, which was essential to document that animals' behavior and movements, did not condition them to man or convert them into troublesome bears. Had this occurred, a much higher percentage of those captured and marked outside of campgrounds would have become 'campground foragers.' Evidence indicates that most of the troublesome grizzlies were developing or had already developed into problem animals before they were captured and marked in campgrounds.

The large number of animals marked (over 60% of the population at one time), as well as the unmarked grizzlies, exhibited a normal range of bear behavior. However, only bear-man relationships involving marked grizzlies could be

individually and quantitatively documented. Therefore, few objective or legitimate comparisons can be made between avoidance or confrontation behavior of marked versus unmarked animals. Since we have no evidence that capturing and marking grizzlies altered their behavior toward humans, information obtained from marked animals is considered representative of both marked and unmarked ones.

From observations of marked bears and from records of radio-tagged ones, we learned that grizzlies become accustomed to campground foraging during spring and fall migratory movements when their travel routes intercept campgrounds. During this same period, grizzlies extend their home ranges searching for food. This pattern has been especially evident at the Lake and Canyon Village Campgrounds. Yearlings and 2-year-olds may wander into campgrounds following weaning, a time when they normally begin to disperse and establish home ranges of their own. For this wide-ranging, inquisitive animal, chance alone, no doubt, accounts for the discovery of and addiction to the food available in campgrounds. Those that learn to frequent campgrounds become conditioned to the near presence of humans. Those that enter infrequently remain shy and secretive. Habitual campground foragers normally develop behavioral patterns in response to the presence of man that are markedly different from those of grizzlies that feed at the isolated, open-pit dumps.

Any grizzly which frequents a campground is a potential hazard because humans may startle it at close range and be attacked. However, it is important to discriminate between habitual offenders and those that enter campgrounds for short periods of time, then move on and do not repeat the offense except infrequently over a period of years. It is difficult to define precisely the habitual offenders or incorrigible animals on a basis of frequency of visitation or frequency of recapture in campgrounds. However, until better criteria can be formulated, we have defined habitual offenders as those recaptured four or more times. Table 3 shows that among 72 grizzlies of both sexes, 69% were either never recaptured or were recaptured only once; 87% were not recaptured or were recaptured one to three times. Only 13% were recaptured four, five, or six times. These individuals constitute the habitual offenders.

Table 4 shows that 28 of the 72 bears captured in campgrounds or developed areas between 1959 and 1969, were killed or sent to zoos; 61% of these had

TABLE 3. RECAPTURE RECORD OF GRIZZLIES CAPTURED IN CAMPGROUNDS—1959-1969.

Number of times recaptured in a campground								
	None*	One	Two	Three	Four	Five	Six	Total
Males	13	16	4	4	2	1	1	41 (57%)
Females	13	8	2	3	1	3	1	31 (43%)
Total	26	24	6	7	3	4	2	72 (100%)
Per cent	36	33	8	10	4	6	3	
69		18		13				
87				13		(100%)		

* None = captured in a campground and never recaptured.

TABLE 4. HISTORY OF THE 28 GRIZZLIES ELIMINATED FOLLOWING INITIAL CAPTURE OR RECAPTURE IN CAMPGROUNDS—1959-1969.

Times recaptured in campgrounds	None*	One	Two	Three	Four	Five	Total
Number of males eliminated	4	7	2	0	1	1	15
Number of females eliminated	3	3	2	3	0	2	13
Total grizzlies eliminated in control measures	7	10	4	3	1	3	28
Percent eliminated	25	36	14	11	3	11	
	61		25		14		
		86			14		100%

*None = captured once in a campground and eliminated.

recapture records of zero or one, and 86% had recapture records ranging from zero through three. Thus, 86% of the campground grizzlies which were eliminated had not become habitual offenders. Obviously, the percentage of habitual offenders would have been greater had bears, which were initially captured or had three or less recaptures, not been dispatched. On the other hand, 51.4% of the 72 grizzlies captured in campgrounds and released had recapture records of less than four and these were not recaptured again. This suggests that grizzlies entering campgrounds should be transplanted long distances into the adjacent National Forest wilderness country following a first capture rather than dispatched. Cooperative agreements could accomplish this. Such a procedure would tend to break the reward pattern that may develop when grizzlies return frequently to campgrounds and find food. Eight grizzlies handled in this way were eventually taken as trophies by hunters outside the Park.

In general, frequency of recapture of individual grizzlies is directly related to the time a bear occupied a campground because it was routine procedure to keep traps set whenever grizzlies were observed. The incorrigible bears can be recognized because they will seek food in defiance of visitors and ranger patrols, make repeated bluffing charges at humans, and break and enter tents and trailers. Generally, such bears have a long history of campground tenancy. There is no question about the necessity of eliminating such animals. The problem is what to do with infrequent offenders. We believe great discrimination should be practiced in eliminating grizzlies after the first capture or with recapture records of one through three.

Behavior of grizzlies conditioned by food handouts:

By radio-tracking grizzlies that had been regularly fed in the presence of humans or that had developed foraging habits bringing them into frequent and close association with man, we learned that such animals developed behavioral patterns that made them extremely dangerous. They learn to associate food-getting with humans and soon lose their fear of man and human scent. They

become thoroughly conditioned to man. This conditioning is not associated with a particular feeding area, as is the case with grizzlies that feed at remote garbage dumps, but is a general conditioning to man wherever he is encountered. Such animals may coexist with people for extended periods of time but, sooner or later, these man-conditioned animals are startled by humans at close range, defy interference at a food source, or completely disregard humans in their attempts to get food. This may occur in a campground, on a trail, or in the backcountry. The result may be a bear-man encounter ending in human injury or death.

For a grizzly to lose its shyness or fear of man requires cooperation and encouragement, and the initiative is usually with man. One male grizzly, No. 202, was radio-tracked for 2 consecutive years during the summer and autumn. Yearling No. 202 was instrumented and radio-monitored for 56 days in 1965. During that time, he established a 27 square mile home range that encompassed Canyon Village, but he did not visit the campgrounds and caused no trouble. However, the following spring when he emerged from winter sleep, he swam the river and traveled the north rim of the canyon which led him directly into the Canyon Village Campground with its food supply.

As a 2-year-old, he was radio-monitored for 118 days of 1966. Though frequenting the campground, he gave no serious trouble until fall when he began visiting two construction camps in the area. He received food handouts and soon became bold enough to attempt to enter trailers and to feed fearlessly in the presence of humans. During 1966, this animal established a home range of 125 square miles with Canyon Village Campground as his center of activity.

Emerging from winter sleep as a 3½ year old animal, he returned to his old haunts in the campground. No. 202 was not an aggressive bear, had inflicted no injury and had caused little or no property damage, but he had been conditioned by food handouts, had lost his normal respect for man and, thus, became a potential menace to the safety of visitors. He was shot as a precautionary measure at the age of 3½.

Fortunately, grizzlies conditioned by food handouts at concessionaires or work camps have been rare in Yellowstone National Park. They have been more numerous in Glacier National Park. On the evening of August 13, 1967, at two widely separated locations in Glacier, grizzly attacks resulted in the deaths of two 19-year old concessionaire employees and serious injury to an 18-year old boy. Both attacks can be linked to food handouts and man-conditioned bears (Olsen 1969; National Park Service 1967; Leopold 1970; and personal communications, Gerry Atwell 1967 and Frank Evans 1867). Once man-conditioned by food handouts, the grizzly must be destroyed. The solution to such conditions is campground sanitation, frequent ranger patrols and thorough enforcement of the National Park Service regulations pertaining to the feeding of bears.

Behavior of grizzlies in the backcountry:

Grizzlies, living under wilderness conditions, utilize natural food but may be attracted to food made available by humans, and may become man-conditioned. For example, in 1961, a crew working on the control of blister rust experienced frequent confrontations and attacks from a 3-year-old, male grizzly in the Washburn Range, miles from a developed area. At first the bear was shy and avoided the men. Over a period of several weeks, he gradually lost his shyness. He excavated buried lunch trash and then accepted lunch scraps thrown to him. Eventually he approached boldly for food and made bluffing charges. On five occasions, he treed members of the crew and then rifled their packs and lunch

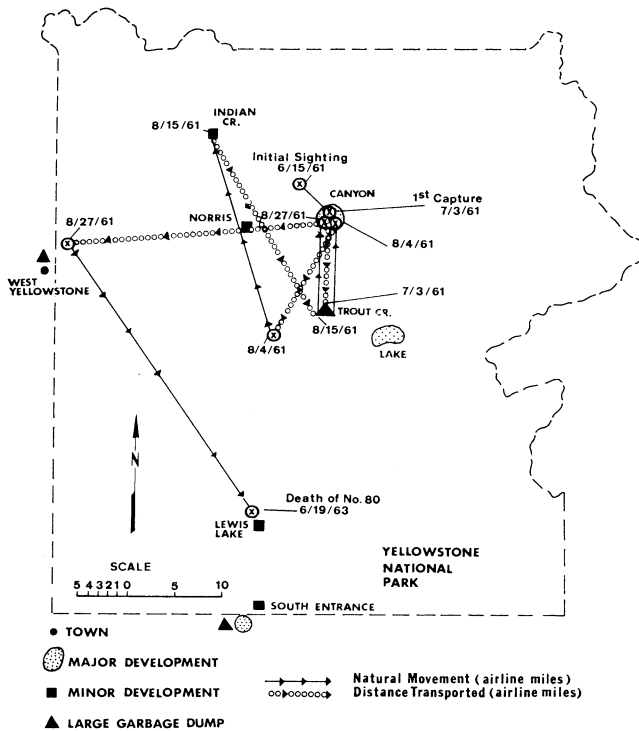


Fig. 3 Movements of Grizzly No. 80

pails. We later captured, color-marked and numbered this animal. He became No. 80; his movements to and from campgrounds are shown in Figure 3. This thoroughly man-conditioned grizzly was shot in June 1963 by Park rangers after molesting visitors camped in wilderness country near Lewis Lake. This documented account illustrates the role of food handouts in developing incorrigible bears. Generally, conditioning to man evolves in developed areas, but it is not necessarily limited to them.

BEAR-MAN CONFLICTS

The probability of being injured or killed by a grizzly bear in Yellowstone National Park is very small. From 1900 to 1970 there have been two fatalities from grizzlies (National Park Service, 1880-1970). Both occurred in the early 1900's. From 1931 to 1970, when more detailed records were kept, official National Park Service records show 63 injuries and no fatalities. During these 39 years, an average of a million people per year visited the Park. Thus, the injury rate from grizzlies has been one person per 600, 000 visitors.

Although grizzly bear attacks on man are rare, they provide exciting news copy and generate apprehensive public response. This, in turn, has initiated control action often with over-reactionary measures that have been harmful to the coexistence of the grizzly and man. Following the 1967 fatal incidents in Glacier National Park, four female grizzlies were shot and a cub was wounded. Only one of these animals was conclusively linked with the attacks. The

National Park Service Report, 'Grizzly Bear Attacks at Granite Park and Trout Lake in Glacier National Park, August 13, 1967', suggested garbage feeding as a conditioning factor, but did not mention the frequent feeding of grizzlies on garbage and food handouts in the presence of human viewers. This conditioned the bears at Granite Park to lose their normal respect for humans and may have man-conditioned the particular animal responsible for the tragedy.

Lightning storms, age and physical ailments of the bears, and unknown reasons, were listed as possible causes of the Trout Lake fatality. Cosmetics, hair sprays and menstrual odors were cited as the probable causes for this particular attack. Subsequently signs were erected at trail heads, warning—'Women—Do not travel in the backcountry during menstruation.'. This presumed cause for the attack—to our knowledge unsubstantiated—was widely publicized and probably deterred many women from making wilderness hikes.

Personal injury records:

Personal injuries caused by grizzly bears have been recorded in Yellowstone National Park for the past 40 years (1931-1970). We have found it difficult to evaluate these records because the injuries have varied in severity from bruises and minor wounds, requiring no professional medical attention, to those that required hospitalization. Also, there has been doubt whether some injuries were inflicted by grizzlies or by black bears. We have accepted with reservations the data which show 62 known and probable injuries from grizzlies, or 1.55 per year.

From 1959 through September 1970, we worked closely with Park rangers to keep more accurate records of personal injuries inflicted by grizzlies (Table 5). Injuries during this period averaged two per year or approximately one injury for every 900,000 visitors. This is hardly a record that would support the removal of all grizzlies from Yellowstone (Moment 1968) or a drastic control program within the Park. However, during 3 years of the Park Service's present program of bear management (1968-1970), injuries averaged 3.33 per year. In comparison, injuries were only half as numerous from 1959-1967—averaging 1.67 per year. We believe that the increase is due largely to the present management practices that have forced grizzly bears into campgrounds and developed areas of the Park (Figure 4).

Control measures:

Control of grizzlies within the Park is performed by the ranger staff. Troublesome animals are either killed or shipped to zoos. The term 'dispatch' includes both of these control measures. From 1931-1970, 140 grizzlies have been killed; this is a 40 year average of 3.50. The exact number shipped to zoos during this period is unknown.

Seventy-four grizzlies have been dispatched by the Yellowstone administration during our 12-year period of research. This averages 6.17 grizzlies per year (Table 5). During 9 years of this period (1959-1967), prior to the enactment of the Park Service's present program of bear management, control averaged 4.1 per year. During 3 years of revised management (1968-1970), control averaged 12.3 grizzlies per year. Twenty-two grizzlies were eliminated from the Yellowstone population in control measures in 1970. Information on the number of deaths occurring from other causes during 1970 is not yet available. However, there was an average of 11 such deaths per year from 1959 through 1966. These represent only those deaths where the causes of death were known. If we assume that 11 grizzly bears will die in addition to those eliminated by control, the total loss from the population during 1970 will be 33.

TABLE 5. INJURIES FROM GRIZZLY BEARS, AND CONTROL MEASURES IN YELLOWSTONE NATIONAL PARK, 1959-1970.

Year	Park visitors*	Personal injuries	Control measures		Total
			Grizzlies killed	Grizzlies sent to zoos	
1959	1, 408, 667	0	6	1	7
1960	1, 443, 288	0	4	0	4
1961	1, 528, 088	1	1	2	3
1962	1, 925, 227	2	4	0	4
1963	1, 872, 417	6	2	4	6
1964	1, 929, 316	1	2	1	3
1965	2, 062, 476	4	2	0	2
1966	1, 130, 313	1	3	0	3
1967	2, 210, 023	0	3	2	5
1968	2, 229, 657	1	5	0	5
1969	2, 193, 814	6	10	0	10
1970†	2, 200, 000	3	14	8	22
Total	22, 133, 286	25	56	18	74

*Data obtained from Yellowstone Park records, 1959-1969.

†We estimated visitor numbers for 1970.

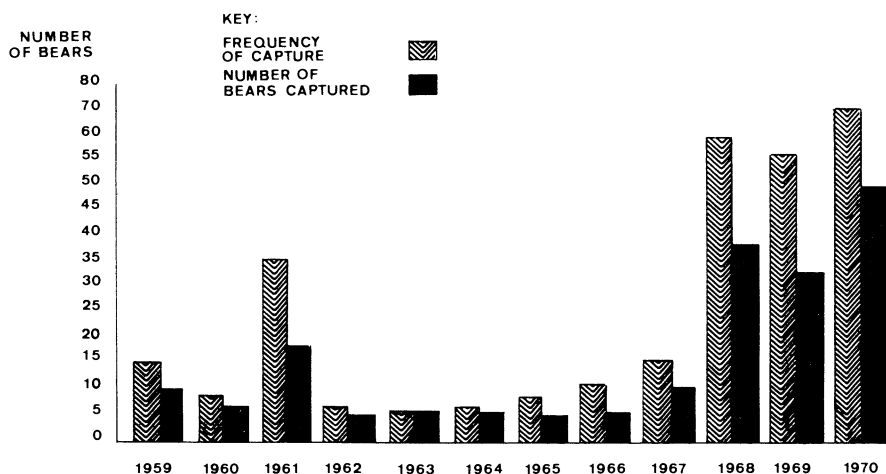


Fig. 4 Frequency of capture and number of grizzly bears captured in campgrounds.

This just equals the average annual increment (Craighead & Craighead 1967), but statistics compiled during our study indicate that as many grizzlies die each year from unknown as from known causes. Consequently, the population loss for 1970 will greatly exceed the average annual increment. It is obvious that the Yellowstone grizzly population cannot long sustain such losses.

A comparison of the annual control figures and personal injuries with Park visitation from 1959 through 1970 (Table 5, Figure 5) shows no correlation with the increase in visitor numbers. A correlation should be expected. We attribute the lack of one to the fact that the open-pit dumps served to concentrate and isolate the grizzly bear population during the tourist season. Also public use of these areas has been restricted, thereby reducing the probability of grizzly-visitor interactions. We believe that the increased number of bears killed or sent to zoos (Table 5) during 1968-1970 was directly related to the abrupt phasing out of the Trout Creek Dump and the closure of the Rabbit Creek Dump, which forced grizzly bears into campgrounds. This destroyed the effective zoning of grizzly and man that prevailed from 1959 through 1967. As we have shown, the average number of grizzlies dispatched during the last 3 years is three times the average for the preceding 9 years. Using 200 grizzlies as a maximum population estimate (based on 324 census of 3½ hours each totaling

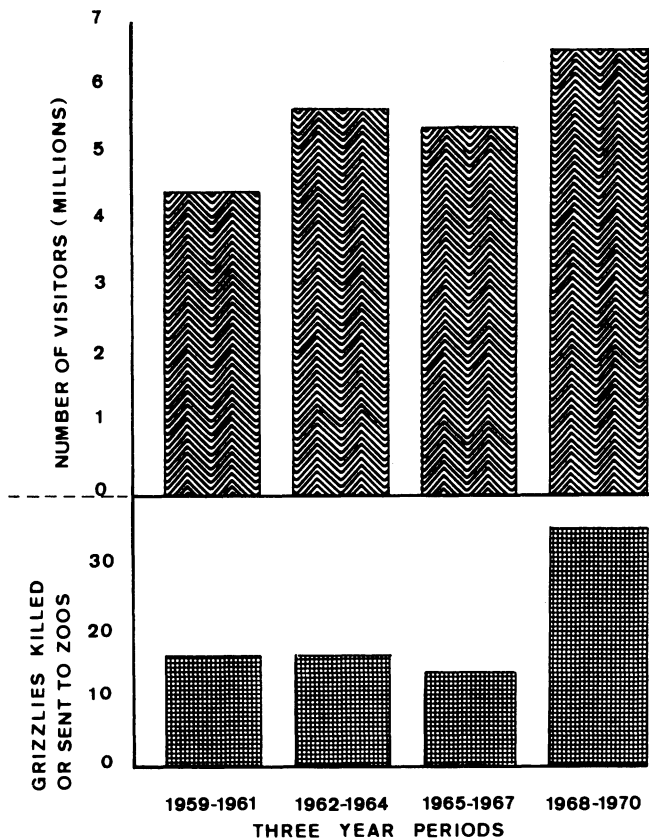


Fig. 5 Comparison of number of visitors and number of bears dispatched at Yellowstone National Park during 3-year periods, 1959-1970.

11,340 hours, Craighead & Craighead 1967), we can calculate that the population reduction effected by control measures for 1970 alone (22 grizzlies through September 15) will exceed 10% of the Yellowstone population.

Control methods must differentiate between the dangerous, but relatively few, man-conditioned animals in the population and those essentially wild animals that for generations have fed at the remote garbage dumps and, in the course of seasonal movements or rare periods of natural food scarcity, have entered developed areas. Grizzlies become man-conditioned by eating in the presence of humans.

Transplants:

For many years, troublesome campground grizzlies in Yellowstone National Park have been transplanted to remote areas within the Park. To evaluate the effectiveness of transplant and release as a technique for disrupting the campground foraging habits of grizzlies, we marked captured animals and released them at suitable sites from 1959 through 1967. We then recorded their movements by recapturing them. Starting in 1968, this task has been performed by Park rangers. Table 6 shows that over an 11 year period, there were 145 releases of grizzlies within Yellowstone National Park at varying distances from

TABLE 6. RECORD OF THE RELEASE OF GRIZZLIES AFTER INITIAL CAPTURE IN A CAMPGROUND OR DEVELOPED AREA AND SUBSEQUENT RECAPTURE, 1959-1969.

	Distance grizzlies transported (Airline miles)				Totals
	0-10	11-20	21-30	31-40	
Number of releases after initial capture	75	46	20	4	145
Number of recaptures in any campground or developed area after release	53	32	12	1	98
Percent of recaptures in any campground or developed area after release	70.7	69.6	60.0	25.0	67.6

the campgrounds or developed areas where they were captured. Our data show that 68% of these animals returned to the same or another campground following release. Although the percentage returning decreased with the distance transported, the capture-transport-release technique within the Park is clearly only a partial solution for dealing with troublesome grizzlies. Information from campground bears radio-tracked for extended periods of time further supported this conclusion. We believe more distant releases on federal lands adjacent to the Park would prove more successful.

Campground management:

A concerted effort has been made to remove food from campgrounds or make it unavailable to bears. The installation of numerous, bear-proof garbage cans

has helped the sanitation problem. However, campgrounds are still attractive to bears and will probably remain so as long as visitors are careless with their food or deliberately distribute table scraps to entice birds, bears and other animals.

BEHAVIOR OF GRIZZLIES IN RESPONSE TO REVISED MANAGEMENT PRACTICES

In 1941, officials of Yellowstone National Park abruptly closed the Canyon Village and Old Faithful feeding stations where large numbers of grizzlies and black bears were viewed by the public. The following year, rangers found it necessary to kill 28 grizzlies and 54 black bears when these animals dispersed to campgrounds and the hotels at Canyon Village, Lake and Old Faithful in search of food. An emergency situation existed that year, even though only 191,830 visitors were recorded in the Park.

From 1968 through 1970, with visitor numbers exceeding 2,000,000 per year, the Yellowstone administration proceeded to repeat this type of management by abruptly phasing out the Tower, West Thumb, Trout Creek and Rabbit Creek open-pit garbage dumps. In 1967, prior to this decision, we had made a report to the National Park Service, *Management of Bears in Yellowstone National Park* (Craighead & Craighead 1967). In that report, we recommended slow phasing out of the open-pit garbage dumps, cautioning that:

'Because phasing out of refuse dumps will disperse the grizzlies by destroying an attractive, if not essential, food source, the transition from pits to incinerators must proceed gradually, enabling the grizzlies to develop new feeding habits as well as altered social behavior and movement patterns. If the transition is slow and follows a recommended procedure, it is possible that no severe changes in population level, distribution or behavior will result. If, on the contrary, the phasing out operation is abrupt, and a carefully planned procedure is not followed, the result most certainly will be increased grizzly incidents in campgrounds, accelerated dispersal of bears to areas outside the Park, and greater concentrations of grizzlies at the public dumps in Gardiner and West Yellowstone, where food will be available but where adequate protection will not. The net result could be tragic personal injury, costly damages and a drastic reduction in the number of grizzlies.'

Phase-out of open-pit dumps:

During the summers of 1959 through 1967, approximately 1,000 cans of unsorted edibles and trash had been deposited daily at Trout Creek. The refuse was lightly covered with soil, usually on the day of deposit. The volume of food attracted and held grizzlies in the area during the summer months. During 1959-1967 we documented the effect of this artificial feeding situation on the habits and behavior of grizzlies.

In 1968, the volume of garbage taken to Trout Creek was drastically reduced and we documented the effect of this on grizzly behavior. Edibles were partially separated from trash and dumped, but not buried. The sorted food consisted of approximately 50% non-edible trash. Most of the refuse formerly dumped at Trout Creek was handled by the newly installed incinerator at Bridge Bay which had an operating capacity of 6,000 lbs. per hour. Our records, made when the refuse was dumped, showed that a maximum of eight cans per day were deposited from June 3 through June 14; between June 15 and July 15, the

number gradually increased to 40 per day. During the remainder of the summer, the number was not increased significantly except when the Bridge Bay incinerator broke down.

The early summer cut-off of food, followed by a drastic reduction in edibles during the summer of 1968, dispersed the grizzlies throughout the Park. Our documentation of marked animals showed that many found their way into campgrounds, traveling between Trout Creek and the Canyon Village and Lake Campgrounds. Other moved back and forth between Trout Creek and the dumps at Rabbit Creek and West Yellowstone. This type of movement did not occur from 1959 through 1967 prior to the phase-out. Our censuses of population units in the vicinity of each major dump showed that these units tended to be self-contained with very little exchange of animals (Craighead & Craighead 1967).

Many unmarked grizzlies also entered campgrounds. Fifty-four percent of the 37 grizzlies captured in campgrounds in 1968, 48% of 33 captured in 1969, and 41% of 49 captured in 1970 were unmarked. The movement of practically all the Trout Creek grizzlies, marked and unmarked, was greatly accelerated. A measure of this movement and disruption of long established habits is reflected in the frequency of capture and the numbers of grizzlies captured in campgrounds each year during the period 1959-1967, as compared to similar data for 1968-1970. The number of individual grizzlies captured in 1968 is approximately four times the average for the previous 9 years and double the previous high of 1961. Frequency of capture was the highest recorded in 10 years (Figure 4).

In 1969 we continued on-site measurements of the volume of garbage dumped at Trout Creek. Between 130 and 170 cans were deposited daily from June 15 through August. Most of this was in plastic bags. Only about half the contents were edible. As in 1968, the garbage and trash were not buried, so the grizzlies that arrived at the dumps first were able to consume most of the food by evening; this left little to hold animals which arrived later. From 1959 through 1967 the general procedure was to dump trash with garbage and partially cover it with soil each day. This provided a long feeding period and allowed numerous animals to share the food. This procedure had, in the past, kept the grizzlies concentrated.

The dispersal of grizzlies that began in 1968 continued in 1969. The slight increase in the amount of garbage, designed to rectify the situation, was ineffective. The frequency of capture as well as the number of grizzlies captured in campgrounds and developed areas remained high (Figure 4). In 1970, following the closure of the Rabbit Creek Dump, frequency of capture of grizzlies in campgrounds climbed still higher to a peak of 72; just twice the value of the 1961 peak. The number of individual grizzlies captured was 49, the greatest number ever recorded (Figure 4). Thus, data on the number of individual grizzlies captured in campgrounds during the three years of revised management clearly show that the new management practices have been creating problem bears that then must be dealt with by the Park administration. In Table 7, the frequency of capture and the number of individuals captured in campgrounds and developed areas during 1959 through 1967 was totaled and compared with similar data for 1968 through 1970. The rate of capture for 9 years (1959-1967) was 117; for the past three years it was 190. The number of individual grizzlies captured for the same periods also increased.

Of the total number of grizzlies involved in campground foraging it is particularly revealing that 57 were captured during the 9 years prior to the rapid phase-out of the open-pit dumps, whereas 70 were captured during the first

3 years of phase-out (Table 7). Thus, from 1959 through 1967 an average of six grizzlies became campground foraging bears each year, but during the rapid cut-back in garbage (1968 through 1970), an average of 23 grizzlies became campground oriented each year. Data in Table 7 also show that Grant Village, which was first opened to the public in 1967, presumably had no problem bears that year, as none were captured. The following years it was visited by grizzlies. Twenty-five were captured during the three-year period of revised management. Similarly, no grizzlies were captured at Slough Creek, Tower

TABLE 7. FREQUENCY OF CAPTURE AND THE NUMBER OF GRIZZLY BEARS CAPTURED IN CAMPGROUNDS.

Campgrounds and developed areas*	1959-1967		1968-1970†	
	Frequency of capture	Individual bears captured	Frequency of capture	Individual bears captured
Canyon Village	48	33	42	24
Lake	40	26	73	48
Old Faithful	9	9	23	17
West Thumb	17	11	7	6
Grant Village	—	—	30	25
Norris	1	1	2	2
Lewis Lake	0	0	1	1
Indian Creek	2	2	0	0
Slough Creek	0	0	3	3
Tower Fall	0	0	3	3
Mammoth	0	0	1	1
Madison Junction	0	0	5	3
Totals	117	82	190	133
Corrected totals‡		75		124
Total individuals involved		57		70

*Canyon Village includes—Canyon Village and Otter Creek Campgrounds. Lake includes—Lake, Fishing Bridge, Bridge Bay and Pelican Creek Campgrounds. Grant Village opened in 1967 when the National Park Service began phasing out open-pit dumps.

†Unmarked grizzly bears entering campgrounds during 1968 and 1969 could not be individually marked because of Park Service policy prohibiting marking of any animals in Yellowstone. Thus, in addition to marked animals, a minimum number of unmarked individuals, determined by criteria of sex, age and time of capture were recorded for this period.

‡In 16 instances, bears were captured in two areas during a year. The corrected total of individual grizzlies captured per year corrects for this bias.

Fall, Madison Junction and Mammoth from 1959-1967, but grizzlies were captured at these campgrounds from 1968-1970.

We must conclude that the new bear management practices, programmed to quickly phase-out the open-pit dumps in Yellowstone without first adequately sanitizing the campgrounds, greatly increased the probability of bear-man conflicts as more grizzlies entered congested visitor areas. This program has rapidly 'created' troublesome campground grizzlies. The administration's policy formulated to deal with this situation has been to kill or ship to zoos all two-time offenders entering campgrounds or developed areas within a successive 2-year period.

In 1969, the Natural Sciences Advisory Committee of the National Park Service met with Park administrators, biologists and consultants to review grizzly bear management in Yellowstone National Park and to formulate a bear management policy and program (Natural Sciences Advisory Committee Report, 1969). The Committee summarized the management goals as follows:

1. To maintain populations of grizzly and black bears at levels that are sustainable under natural conditions as part of the native fauna of the Park.
2. To plan the development and use of the Park so as to minimize conflicts and unpleasant or dangerous incidents with bears.
3. To encourage bears to lead their natural lives with minimum interference by humans.

The ultimate objective agreed upon by all participants was the sanitary disposal of trash and garbage in a manner that would deny this food source to bears.

The report continued:

'But, in the meantime, there is disagreement as to the sequence of steps leading to the elimination of garbage from availability to grizzlies. One view is to cut off all garbage quickly, forcing the bears to turn immediately to natural foods. The opposite contention is to phase out garbage feeding over a period of time, 'weaning' the bears gradually. The issue hinges on which of these procedures will result in the least number of bears going into campgrounds.'

In 1970, following the distribution of the Advisory Committee report, the Park continued its phase-out policy for garbage dumps by completely closing the pit at Rabbit Creek, which prior to this time attracted and held a population that fluctuated between 22 and 48 grizzlies. Our censuses showed an 8-year average of 32 grizzlies in the area during the summer months (Craighead & Craighead 1967). Five airline miles away a fenced sanitary land-fill dump was installed at Nez Perce Creek as a replacement for Rabbit Creek. With this accomplished, grizzlies with traditions of feeding at Rabbit Creek were completely and abruptly denied a long-established food source.

Movements of individual grizzlies in response to reduced food at the Trout Creek Dump during 1968-1969:

Five female grizzlies which frequented the Trout Creek Dump were color-marked between 1960 and 1962 (Table 8). They were captured in campgrounds or developed areas for the first time following the reduction of food at Trout Creek in 1968. The long interval between marking and first capture in a campground can be explained if these bears increased their daily movements and

TABLE 8. CAMPGROUND CAPTURES OF FIVE FEMALE GRIZZLIES FOLLOWING THE RAPID PHASE-OUT OF TROUT CREEK DUMP, 1968-1969

Bear No.	Year Marked	Date of first capture in campground	Interval in years between marking & first capture in campground	Age at first capture in campground*	Number of capture areas	Frequency of capture by years	Number of offspring produced between marking & first recapture	Status of female 1969
34	1960	1969	9	19½	1	1969-1	6	Alive
39	1960	1968	8	13½	2	1968-2 1969-5	5	Alive
40	1960	1969	9	11½	1	1969-1	7	Killed for control
109	1961	1969	8	8½	1	1969-2	0	Alive
128	1962	1969	7	18½ Min.	1	1969-1	10†	Alive

* Age in years—all bears were aged by cementum layer technique. Ages designated minimum (Min) represent minimum cementum layer age. (Craighead *et al.* 1970)

†No. 128 produced 3 more cubs in 1970.

extended their home ranges in search of food. The home ranges of No. 39 and No. 40 had been established earlier by radiotracking (Craighead & Craighead, in prep.).

No. 39 extended her home range in 1968 to include Lake Campground and the Bridge Bay developed area. During 1968-1969, she was captured five times at the Bridge Bay incinerator and twice in adjacent developed areas. In both years she was probably attracted there by odors from the incinerator.

We radiotracked No. 40 for 8 consecutive years (Craighead & Craighead, in prep.). While this female was radio-monitored, she was never tracked into a campground or developed area. However, she entered the Lake developed area in 1969 and was shot.

Since grizzlies of all ages made initial campground entries in 1968 and 1969, we do not think that the advanced age of three of the five grizzlies listed in Table 8 was a factor altering their behavior and movements. They were in excellent condition when last captured; all had reproductive records. No. 128 had produced ten cubs prior to her capture in 1969. She bore three more in 1970, at a minimum age of $19\frac{1}{2}$ —a total of 13 cubs during the 9 years she was marked. From 1960 to 1970, the five females bore a total of 28 offspring (Table 8). It is evident that management practices which 'force' productive females into developed areas where they are subject to control could rapidly alter the population level.

Scarcity of the staple natural foods during 1968 and 1969 did not cause the movement, since the availability of these during the period was not importantly different from other years. Our data on the utilization of natural foods by grizzlies and on the relative abundance of these foods throughout a 12-year period cannot be presented here, but these fully support this conclusion. We, therefore, conclude that the five females recorded in Table 8, as well as 11 other marked grizzlies of both sexes, were captured for the first time in campgrounds in 1968 and 1969 primarily because of the acute food shortage at Trout Creek. Thirty-five unmarked individuals were also captured in campgrounds or developed areas for the first time.

Figure 6 and Table 9 show the movements from Trout Creek of 34 marked grizzlies and two recognizable cubs. Records of these movements were obtained by capturing the animals or by observing their individualized color markings. Sixteen individuals visited the Lake developed area, eight entered Canyon Village, and ten moved to the Rabbit Creek Dump. Two moved to Cooke City, three to Tower, three to West Yellowstone, one to Norris, and one to Grant Village. Eight of the marked bears visited two campgrounds or developed areas (Table 9), thus accounting for the total of 44 bears shown in Figure 6.

Dispersal of individual grizzlies following the closure of Rabbit Creek Dump in 1970:

Grizzlies inhabiting Rabbit Creek dispersed widely following the closure of that open-pit dump in 1970. Figure 7 shows the movements of 12 color-marked and 2 recognizable grizzlies to new feeding areas. All of these grizzlies were observed and recorded at Rabbit Creek for between 3 and 11 years prior to the closure (Table 10). Therefore, all could be considered resident members of this population unit.

Seven grizzlies moved 18 airline miles to the West Yellowstone Dump, which lies outside of the Park. Two joined the grizzlies at Trout Creek, 19 airline miles away; these also visited the West Yellowstone Dump. Grizzlies No. 2 and

TABLE 9. DISPERSAL OF 34 COLOR-MARKED GRIZZLIES AND TWO RECOGNIZABLE CUBS FROM TROUT CREEK FOLLOWING MANAGEMENT CHANGES AT TROUT CREEK DUMP DURING 1968 and 1969.

Marked Bear No.	Campgrounds and developed areas visited by marked grizzlies							
	Lake	Canyon Village	Grant Village	Norris	Cooke City Dump	Tower Dump	West Yellow- stone Dump	Rabbit Creek Dump
7								x
10 + (2)*						xxx		
30	x							
34					x			
39	x							
40	x							
88								x
109	x							
112		x						
128	x							
130			x					x
141	x	x						
144		x						
147								x
166							x	x
183	x							
188		x						
189								x
190							x	
194								x
201								x
207	x	x						
208	x	x						
210	x							
211	x			x				
213							x	x
217	x							
218								x
228		x						
236	x	x						
240	x							
214	x							
242					x			
256	x							
Totals	16	8	1	1	2	3	3	10

*The cubs of bear No. 10 dispersed with their mother and could be recognized.

TABLE 10. MOVEMENT OF GRIZZLIES FOLLOWING THE CLOSURE OF RABBIT CREEK DUMP IN 1970

Bear No.	Sex	Number of years previously observed at Rabbit Creek Dump	New area visited‡	Airline distance from Rabbit Creek Dump to new area
2	M	11	Old Faithful Grant Village	5 14
8	F	11	Grant Village	14
57	M	10	West Yellowstone Dump	18
139	F	7	West Yellowstone Dump	18
			Trout Creek Dump	19
147	M	7	Trout Creek Dump	19
164	F	7	Old Faithful	5
171	M	6	Old Faithful	5
213	M	5	Trout Creek Dump	19
217 A	M	3	West Yellowstone Dump	18
			Trout Creek Dump	19
219 A	M	3	West Yellowstone Dump	18
224 A	M	3	West Yellowstone Dump	18
226 A	M	3	West Yellowstone Dump	18
UM*	M	4	West Yellowstone Dump	18
UM†	M	10	Old Faithful	5

*This male identified by size, conspicuous wound over left eye and white patches of hair on shoulders. (UM = unmarked.)

†Large male identified by a wound exposing the upper left canine. (UM = unmarked.)

‡New area visited was determined by observation or capture of marked or recognizable animals.

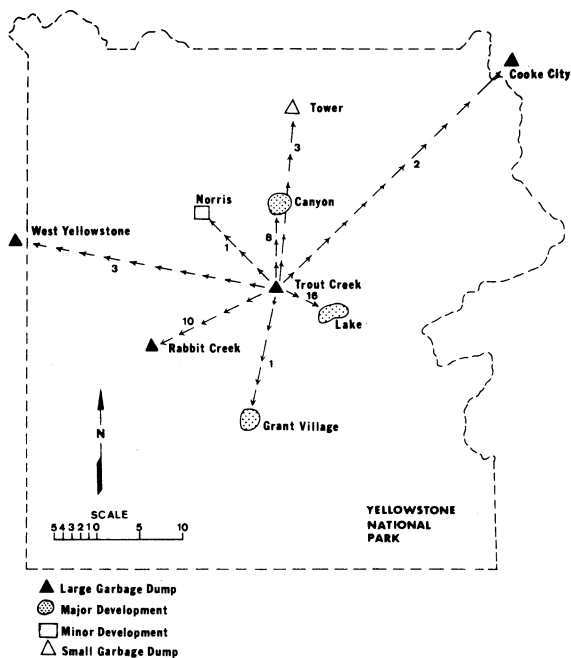


Fig. 6 Dispersal of 34 marked and two recognizable grizzlies following management changes at Trout Creek Dump during 1968 and 1969.

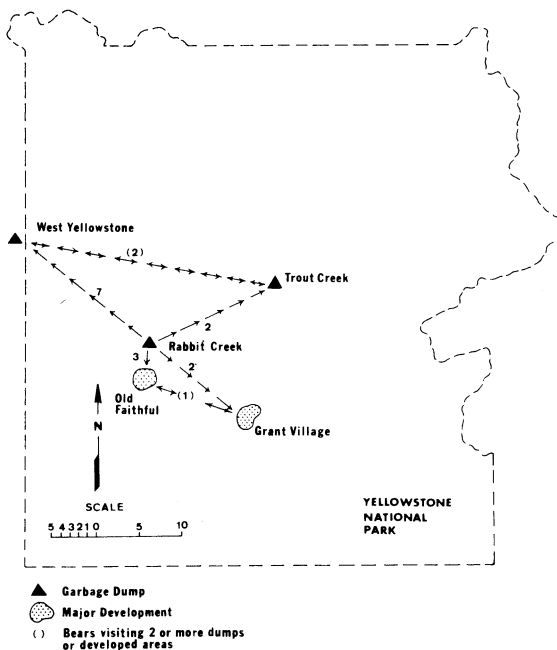


Fig. 7 Movement of 14 marked or recognizable grizzlies following closure of Rabbit Creek Dump, 1970.



Fig. 8 Two families of marked grizzlies. The reproductive history of individual females was recorded during a 12 year period.



Fig. 9 Grizzly bears feeding at the Trout Creek Dump. Rapid phase out of this dump in 1967 and 1968 forced grizzlies to extend their home ranges and many entered campgrounds.



Fig. 10 A grizzly individually marked for identification, following immobilization with the drug phencyclidene hydrochloride.



Fig. 11 A female grizzly exhibiting an aggressive posture at the close approach of a large male.

TABLE 11 CAMPGROUND CAPTURES OF FIVE GRIZZLIES FOLLOWING THE CLOSURE OF RABBIT CREEK DUMP, 1970.

Bear No.	Sex	Year Marked	Interval in years between marking and first capture in campground	Age at first capture in campground	Capture Areas	Frequency of Capture	Status in 1970
2	M	1959	11	$15\frac{1}{2}$ - $16\frac{1}{2}$	Old Faithful Grant Village	2	Killed for control
8	F	1959	11	$19\frac{1}{2} \pm 2$	West Thumb Grant Village	2	Killed for control
164	F	1963	7	$12\frac{1}{2}$	Old Faithful	1	Alive—Yellowstone
171	M	1964	6	$9\frac{1}{2}$	Old Faithful	3	Zoo for control
UM*	M	1960	10	$22\frac{1}{2}$ - $25\frac{1}{2}$	Old Faithful	1	Killed for Control

*Large male unmarked but identifiable during a 10-year period by a wound exposing the upper left canine.

No. 8 moved 14 airline miles to the Grant Village Campground and developed area. Three grizzlies, including No. 2, moved to the Old Faithful area only 5 airline miles distant. Comparison of the 1970 census data taken at Trout Creek and West Yellowstone with other years suggests that many of the unmarked grizzlies from Rabbit Creek also moved to these other open-pit dumps.

In 1970 five Rabbit Creek grizzlies were captured in campgrounds or developed areas and four were dispatched. None of these had previous campground records. The long intervals between marking and first capture in a campground or developed area (Table 11) show that the policy of rapidly closing the long established open-pit dumps was still creating problem bears in Yellowstone. The official solution was still to dispatch the animal. There is circumstantial evidence that No. 8 severely mauled a Park visitor in Grant Village on September 3, 1970. This color-marked animal had not been captured or observed in a campground during an 11 year period prior to this time.

The Park Service plans to completely close the Trout Creek Dump during the spring and summer of 1971. At the same time the West Yellowstone Dump will be moved and fenced. This will disperse approximately 180 grizzlies in one season. This action, in all probability, will create more acute bear problems in campgrounds and developed areas in and near the Park than have existed in a 100 years of Park history.

DISCUSSION

Grizzly bears and man have coexisted in Yellowstone since the establishment of the Park in 1872. They have shared this environment during the past decade with about a 900,000-to-1 chance of confrontations leading to personal injury. The open-pit garbage dumps that came into existence with the establishment of Yellowstone Park have become traditional feeding areas for grizzlies. A long-term study showed that these dumps have altered the bear's behavior patterns at these sites, but they have not made grizzlies dependent on man or created the incorrigible animals that are a threat to the visiting public. On the contrary, the isolated dumps, with restricted public access, have effectively concentrated grizzly bears during the height of the visitor season. They have been extremely effective in reducing the probability of grizzly-man encounters and injury.

In order to induce the Yellowstone grizzlies to adopt more natural feeding habits while preserving an optimum grizzly bear population and adequately protecting Park visitors, the long-established feeding sites must be phased out over a period of many years. Thorough sanitation of campgrounds and developed areas, both inside and outside the Park, must precede the closure of the major open-pit dumps in Yellowstone. In 1968, the Yellowstone administration initiated a management program; its major objective of rapidly eliminating open-pit garbage dumps has drastically disrupted long established grizzly bear patterns of feeding and movement. This has forced grizzlies into areas of high visitor use and vastly increased the probability of bear-man conflicts. Rapid elimination of 'artificial' food at the dumps is not forcing the Yellowstone grizzlies to quickly adjust to an all-natural food diet, but is instead moving them into unsanitized areas inside and outside of the Park.

Since practically all of the grizzlies in the Yellowstone area have fed at open-pit garbage dumps during some time in their lives, a 'wild-population' cannot be made by denying this food and then dispatching all grizzlies that find it elsewhere in campgrounds and developed areas of the Park. The present rapid

phase-out policy, combined with the elimination of two-time offenders, could reduce the grizzly bear population of the Yellowstone Park -National Forest Ecosystem to a dangerously low level in a relatively short period of time. We believe that grizzly bears and man can coexist in this vast ecosystem if management is tailored to the facts of bear behavior, if all campgrounds and developed areas are sanitized, if open-pit dumps are slowly phased out, if the visiting public is willing to accept a small risk, and if all agencies having a vested responsibility in solving the problem work cooperatively toward common objectives.

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