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MANAGEMENT OF BEARS IN YELLOWSTONE NATIONAL PARK

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July 1967

return to →

Management 79

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NOT FOR PUBLICATION

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
INTRODUCTION	1
SECTION I - HISTORY AND PAST MANAGEMENT OF GRIZZLY AND BLACK BEARS IN YELLOWSTONE	4
SECTION II - THE PROBLEM OF MANAGING BEARS	12
Bear-Management Policy	13
Bear-Management Action	16
Control measures and visitor incidents	18
Analysis of Past Management Efforts	24
SECTION III - POPULATION DYNAMICS OF GRIZZLIES	32
Size and Structure of the Population	34
Population units	34
Population size	35
Age structure	43
Sex ratios	47
Reproductive Capacity	47
Age at sexual maturity	50
Length of reproductive life	50
Productivity	51
Mortality	56
Causes of mortality	57
Average annual mortality	58
Mortality by generations	60
Age-specific mortality	61

Page

Early-age mortality 65

Sex-differentiated mortality 71

Age structure from death records 71

Facts Applicable to Management 72

SECTION IV - SUGGESTIONS FOR MANAGING THE GRIZZLY 79

Integrated Management 88

Zoning Within the Park 88

Wildlife-management areas 89

Off-limit area 91

Elimination of refuse dumps 93

Retention of refuse dumps 97

Selective Control 99

Personnel and administrative problems 100

Zoning Outside the Park 102

Hunting Regulations 105

Control of Grizzlies Outside the Park 106

Suggestions for Future Management of the Black Bear 106

Summary of Recommendations for Management of the Grizzly Bear 107

Implementation of Findings and Continued Research 109

LITERATURE CITED 111

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Introduction

The black bear (Ursus americanus) and the grizzly bear (Ursus horribilis) became a management problem in Yellowstone National Park soon after the park was established in 1872. A lack of fundamental biological and ecological information has retarded the establishment of techniques and confused the objectives for the management of these particular species. To help rectify this situation, we initiated a study of the ecology of the grizzly bear in Yellowstone National Park.

The research began in 1959 as a joint effort between the Montana Cooperative Wildlife Research Unit[1] and the Environmental Research Institute and has been closely coordinated with the National Park Service. While conducting the biological investigations we observed, evaluated and interpreted findings in terms of management activities related to both the grizzly and the black bear. *In this report we review bear-management problems in Yellowstone, summarize past management practices, present basic population data for use in managing the grizzly, and suggest future management procedures and policy guidelines.*

The biological data presented (Section III), pertains only to the grizzly bear and have been gathered during eight years of intensive research. The results of this study are being prepared for publication in scientific journals. Normally, management suggestions would follow such publication, but because the grizzly bear has been declared an endangered species and because time is of the essence, we are making recommendations for the protection and management of the grizzly in Yellowstone and adjacent areas prior to publication of most of the supporting data. Though unorthodox, this procedure will permit administrators and wildlife managers to make immediate use of the information presented.

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[1]Fish and Wildlife Service, U.S. Department of the Interior, Montana Fish and Game Department, Montana State University, and the Wildlife Management Institute cooperating.



Plate 1

Grizzly Bear - color-marked for individual identification

In tracing the history of bear-management practices in the park it has not appeared desirable or feasible to confine our remarks to the grizzly bear. Some management problems are common to both black and grizzly bears, and past records do not always differentiate between the two species. Thus we will review control measures as they relate to both the grizzly and the black bear in order to give perspective to the entire problem of bear management, following which we will focus primarily on biology and management of the grizzly.

Specifically, the objectives of this report are:

1. To review the management history of black and grizzly bears in Yellowstone National Park.
2. To analyze bear-control statistics and ascertain the efficiency of present management methods.
3. To summarize population dynamics of the grizzly bear.
4. To offer specific recommendations and policy guidelines for improving the management of the grizzly in Yellowstone Park and surrounding areas.

The vast land areas of Yellowstone National Park and adjacent national forest areas have enabled a population of grizzly bears to survive. However, to manage and preserve the grizzly bear in the park and adjacent forest areas will require greater cooperative effort on the part of agencies charged with the responsibility of managing wildlands and wildlife than has existed previously. This effort must focus on preserving an optimum grizzly population within the park as well as providing protection outside, where special permit hunting can be used as a tool to prevent overpopulation, undesirable dispersal, and detrimental activities of bears. It will also entail more intensive work to inspire public interest in and understanding of this

large carnivore. Management must be flexible, with some concessions to man and some to the bear, but preservation of the species must be the ultimate goal.

Section I

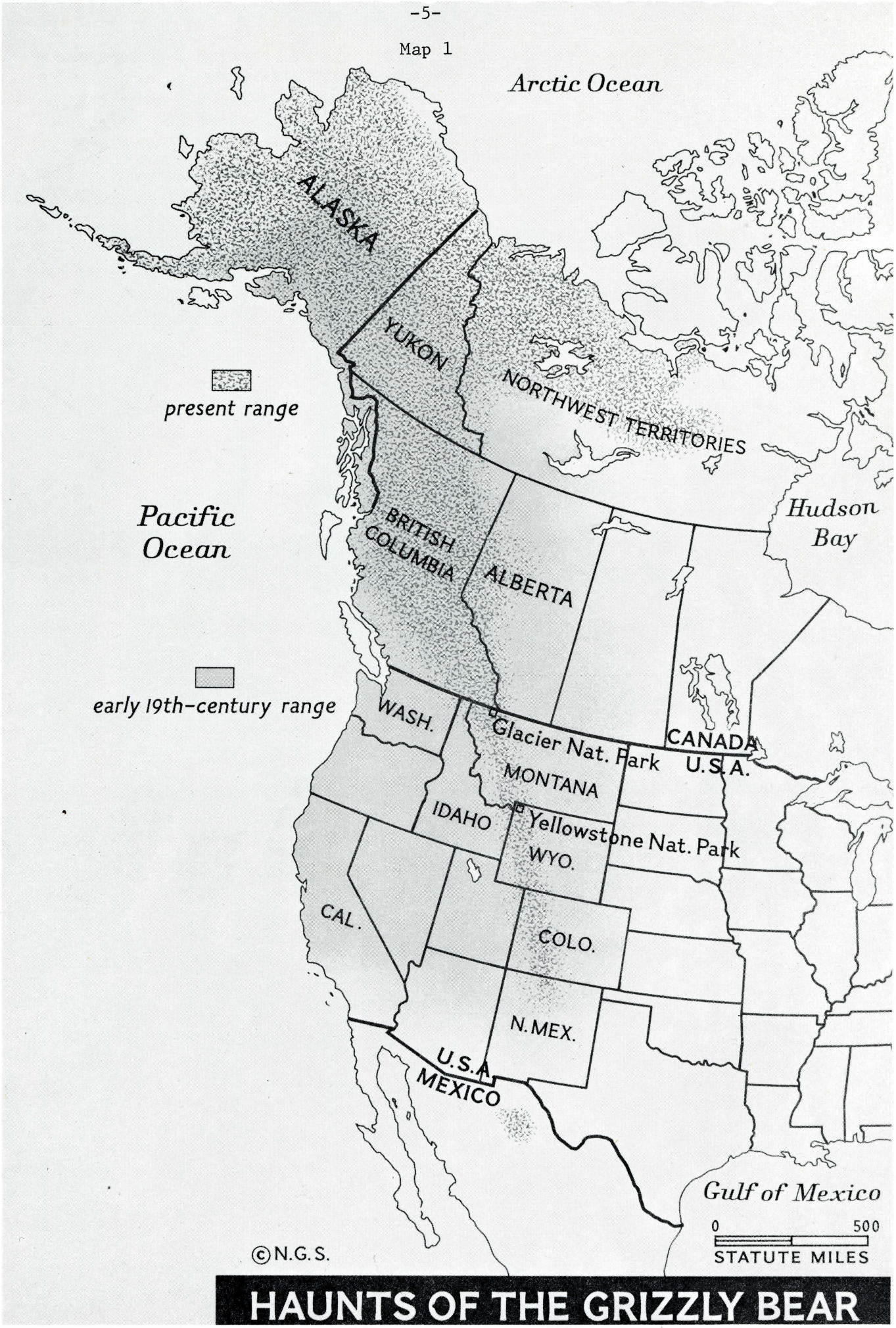
HISTORY AND PAST MANAGEMENT OF GRIZZLY AND BLACK BEARS IN YELLOWSTONE

Early records indicate that grizzly-bear populations were concentrated in the foothills of the Rocky Mountains and in the valleys of the larger rivers. Lewis and Clark encountered numbers of grizzlies along the Missouri in the vicinity of the Sun River and at the Great Falls of the Missouri (De Voto, 1953). Grinnell (1876) reported them still common along the Missouri in 1875. Grizzlies were associated with the large buffalo herds, which furnished an abundant source of food. With the near extermination of the buffalo and settlement of the valleys and foothills, the grizzly disappeared from its former range and is now found only in high-mountain wilderness areas. This wild habitat has been preserved in the 3,412 square miles of Yellowstone National Park and in the national forest areas surrounding it. Man and grizzly bears are not compatible, thus wilderness is essential to perpetuation of the grizzly.

Since Lewis and Clark first saw them on our western prairies in 1805, grizzly bears have steadily declined in number. In the continental United States (with the exception of Alaska) they now exist only as remnant populations in wilderness areas, national parks, and national forests of the Rocky Mountains (Map 1).

The grizzly has disappeared from Texas, Kansas, Arizona, New Mexico, Oregon, Utah, and the Dakotas. In California, where it was once numerous, there has been no record of a grizzly for 43 years (Storer and

Map 1



HAUNTS OF THE GRIZZLY BEAR

Tevis, 1955). Cooney (1956) reviewed the status of the grizzly in the United States and concluded that the State of Washington may have a few, Colorado possibly 10, Idaho approximately 60, and Wyoming, excluding Yellowstone National Park, not more than 50. Montana lists about 450, exclusive of those in Glacier National Park. Estimates for Glacier and Yellowstone in 1956 showed 100 and 125 grizzlies respectively. These rough estimates indicate that the number of grizzlies left in the United States, excluding Alaska, is probably between 500 and 1,000. In 1966, the Committee on Rare and Endangered Wildlife Species of the Bureau of Sport Fisheries and Wildlife officially listed the grizzly as endangered. Such a species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy and one that must have help, or extinction will probably follow.

Although the grizzly was once common along the Yellowstone and Missouri Rivers and in the Jackson Hole country of Wyoming, its persecution as a predator on livestock has all but eliminated it from these areas except in the immediate vicinity of Yellowstone National Park. It is not known how the present population in the Yellowstone area compares with that of early times. But all available evidence indicates that the grizzly was common in Yellowstone prior to 1900; the black bear was apparently scarce. Early explorers frequently used the term bear when referring to either grizzlies or blacks, making it difficult to judge the relative abundance of the two species from historic records. Sightings and encounters with grizzlies were mentioned by N. P. Langford in 1870 and by W. E. Strong in 1876. Bart Henderson, in his "Journal of the Yellowstone Expedition of 1866 Under Captain Jeff Standifer," made the following comments:

July 2, 1870 "Here (Buffalo plateau) we found all manner of wild game . . . buffalo, elk, blacktail deer, bear and moose."
"Thousands of bear, elk, buffalo and deer . . . . .

July 4, 1870 "I killed several deer and three bear."

July 9, 1870 "We returned to camp after killing five bear, and doing no prospecting."

July 10, 1870 "Killed six bear today."

July 11, 1870 "I was chased by an old she bear today. Climbed a tree and killed under the tree."

July 19, 1870 "Killed three bear."

After the establishment of Yellowstone National Park, references to bears in the area were more detailed than those of early explorers, but still not explicit as to species in some instances. Grinnell (1876) noted that only one living black bear was seen in Yellowstone and vicinity, but that grizzlies were numerous in the Bridger Mountains and in Yellowstone Park. Superintendent W. Norris, in his annual report for 1880, stated that the grizzly " . . . is less numerous than some other varieties within the Park." This and subsequent observations by later superintendents are contrary to the earlier records implying numerous grizzlies but few if any black bears. Apparently black-bear numbers mounted rapidly as park visitation increased. In 1892, Superintendent G. S. Anderson stated in his annual report: "The bears are becoming very numerous and in some places quite troublesome, but as they are not in the least dangerous and their presence near the hotels is a source of great amusement, I do not recommend the destruction of any." (These remarks could only apply to black bears.)

In 1894, Anderson again noted, "Bears are numerous in the vicinity of all the hotels and have become very tame." In this same report, he

referred to shipping "an enormous grizzly bear" to the National Zoological Park in Washington, D. C.

Superintendent S. B. M. Young reported in 1897, "It is common occurrence to see six to twelve bears any afternoon feeding on the garbage dumps within a few hundred yards of the Fountain Hotel. Among the number is one large grizzly."

Hunting in the park, with almost no regulation or supervision, was permitted until 1886. Skinner (1925) believed this was responsible for a scarcity of bears at that time. Cessation of hunting probably contributed to the increase in blacks noted by superintendents between 1892 and 1900. By 1899, black bears were so prevalent that park officials considered control measures. In that year Superintendent J. B. Irwin reported that bears were numerous and were increasing: "It will, undoubtedly, be necessary to kill some . . . ." In 1907 both blacks and grizzlies were killed in control measures, and again in 1908 a grizzly was captured and shipped to the National Zoological Park. This control effort was followed in 1911 with the killing of two grizzlies and three blacks that had become troublesome. Ten grizzlies and two blacks were shipped to zoos that year, and 14 grizzlies were shipped in 1912. This procedure became routine in the years that followed.

On August 20, 1913, 32 grizzlies were counted on the refuse dump at Canyon. Superintendent H. M. Albright estimated at least 40 grizzlies in the park in 1920 and at least 100 black bear. Three years later, Skinner (1925) noted 29 grizzlies - the most he had ever seen together. At about this time he estimated that there was a total of 40 grizzlies in Yellowstone. In Albright's annual report for 1925, he estimated the black-bear population at 200, of which 75 frequented points of interest along the loop

road. He estimated the number of grizzly bears at " . . . not less than 75." His annual report for 1927 stated:

> "Recent counts of bears of this species (grizzlies) are noted as follows: Canyon 53, Lake 11, Old Faithful 10, Total 74. This total includes 22 cubs. No recent counts have been had on the bears of this species known to frequent the more remote districts of the Park. The estimated total for the whole Park is 100."

In this same report, the population of black bears was estimated at 275.

Black bears were counted again in 1928. Albright listed three counts: Canyon 91, Lake 60, Tower Falls 12, for a total of 227, including 52 cubs. On a basis of these counts, he estimated a population of 350 blacks for the park. This estimate was revised to 440 in 1929, and the following year the black-bear population was recorded as 490. No grizzlies were counted during these years, but in 1930 the number was estimated at about 167. Since estimates of both blacks and grizzlies were based on counts in areas where the two species concentrated, the figures probably indicate relative abundance of blacks to grizzlies in the more frequented portions of the park.

Park Service estimates of black and grizzly populations appear in Table I. Both species apparently increased from 1880 to 1958, but the estimates are crude and are chiefly of value in showing that after 1900 the black bear was more numerous than the grizzly, perhaps in a ratio of about two or three to one. In 1950 David Condon, the park naturalist, estimated 180 grizzlies. Because of his interest in the grizzly, this is perhaps the most accurate estimate prior to 1959, when intensive census techniques were initiated.

The preceding chronology indicates that the relationship between man and bears has been a persistent problem in Yellowstone Park for over 80 years. The nature of the problem has been clarified as experience has revealed the differing temperaments of black and grizzly bears. The black

bear readily adjusted to man and his ways, and as early as 1880 had become a frequenter of the roads, campgrounds, and refuse dumps in the park. The grizzly also learned to visit dumps, but unlike the black bear has never associated closely with man; it has never become a "roadside bum."

Table 1

Early Population Estimates
of Black and Grizzly Bears in Yellowstone
National Park

Year	Estimated Number of Black Bears	Estimated Number of Grizzly Bears
Prior to 1880		Grizzly more numerous than black bear
1880		Grizzly less numerous than black bear
1892	Blacks very numerous	
1894	Blacks very numerous	Grizzly bear shipped to zoo
1895	Blacks plentiful and increasing	
1899	Blacks increasing, control measures considered	
1907	Both species numerous Bear control instigated	
1913		32 counted at Canyon
1920	Estimate of 100 in Park	Estimate of 40 in Park
1922		16 seen at Canyon
1925*	200	75
1926	225	80
1927	275	100
1928	350	140
1929	440	150
1930	490	167
1931	465	180
1932	517	213
1933	525	260
1934	No estimate	
1935	500	250
1936	500	250
1937	621	268-300
1938	520	290
1939	450	270
1940	500	300
1941	510	320
1942	550	300
1943	No estimate	
1944	No estimate	
1945	No estimate	
1946	450	250
1947	450	200
1948	No estimate	
1949	360	180
1950	360	200
1951	360	180
1956-1958	No estimates	

*Population figures from 1925 to 1958 are rough estimates made by National Park Service personnel based on sporadic and incomplete counts.



Plate 2

Black bears are a major tourist attraction and a major management problem. They congregate where food is most available.



Plate 3

Black bears and grizzlies are vastly different in behavior, population status and their habitat requirements.

Section II

THE PROBLEM OF MANAGING BEARS

Although blacks and grizzlies are vastly different in behavior, habitat requirements, population status, and contact with the public, they share one trait that has created the fundamental bear-management problem in national parks: they congregate where food is most available and abundant.

This trait is characteristic of all North American bears. Innumerable references to it exist in the literature. In Yellowstone, the habit was observed and noted for both blacks and grizzlies in the superintendents' reports quoted earlier. Storer and Tevis (1955), in citing early writers on grizzlies in California, quote such phrases as "regiment of bears," "countless troops," "bears are very plentiful," "often seen in herds," "not unusual to see fifty or sixty within twenty-four hours," and "whole lake and swamp seemed alive with bears." Many of these early accounts described the grizzlies' grazing habits more thoroughly; for example, ". . . the bears congregated locally to forage in wild pastures and made seasonal migrations to such places."

Food-disposal areas attract black and grizzly bears in Yellowstone, just as the salmon streams of Alaska concentrate the Alaskan brown bear (Ursus middendorffi) during spawning runs. Many grizzlies in Yellowstone move long distances from winter dens to summering areas. This movement begins in May and early June, reaching a peak about the first of July. Extensive movement to locations providing an abundance of natural food is normal during this period. However, in Yellowstone, a special type of migration has evolved in response to the "artificial" food at refuse dumps. These sites concentrate the bears during a four-month period from June through September. Pior to and following the months of concentration,

grizzlies frequent the entire park and several thousand square miles of adjacent country.

Since black bear and grizzly bear are not compatible, and grizzlies generally dominate blacks, the two species ordinarly do not mingle except under conditions favorable to the latter. When grizzlies are present, blacks will usually stay away from food sources located in open country but may concentrate at those in forested areas. Blacks are more likely to concentrate along highways, however, where they are free of grizzly competition.

The tendency of both grizzlies and blacks to congregate to feed led to the establishment of feeding stations at Canyon and Old Faithful as early as 1919. These stations enabled the public to view the grizzlies and some blacks, but presented a danger as visitor numbers increased. The stations were discontinued in 1941, and grizzlies long accustomed to use them reestablished the habit of congregating at the refuse dumps as they had in the late 1800s and early 1900s.

An understanding of the ursine trait to gather at food sites, and of the bears' behavior when concentrated, is basic to managing them in Yellowstone National Park. Of particular importance is the fact that refuse dumps attract and hold grizzlies in certain areas for a longer period than do natural food sources alone. The implications of this in a management program will be discussed later.

Bear-Management Policy

As early as 1880, the annual reports of Yellowstone superintendents contained estimates of bear numbers (Table 1). Recording of bears killed or shipped to zoos began in 1907 (Table 2), but not until 1931 was the necessity of systematically managing the park's bears officially recognized. At that

Table 2

Bear-Control Measures in
Yellowstone National Park Prior to 1931

Compiled from Annual Reports of the Superintendents

	Black Bear		Grizzly Bear	
Year	Killed	Shipped to Zoos	Killed	Shipped to Zoos
1907	1		2	
1908			1	1
1911	3	2	2	10
1912				14
1913			5	5
1914				8
1915				3
1916	6		2	
1918*				
1920			7	
1930	3			
Totals	13	2	19	41

*Nine bears were killed, species not recorded.

Note: Records of bear control were not mandatory and do not appear for all years in the superintendent's reports.

time park administrators began to keep more accurate records of personal injuries and property damage caused by bears as well as the number of offending bears killed. From 1931 to 1956 data on the control of blacks and grizzlies were lumped. Not until 1959 were distinctions made between the two species with regard to personal injury, property damage, and control measures. Prior to 1960 the management of both blacks and grizzlies consisted essentially of warning the visiting public and of capturing and disposing of "nuisance" bears.

In 1960 the National Park Service issued guidelines for a comprehensive bear-management program. These guidelines were limited to management of the black bear and were largely in response to public complaints of personal injury and property damage caused by roadside and campground bears. The program was based on the hope that a wholly wild population of black bears could be reestablished by removing all the "spoiled" bears and by eliminating the practices and conditions that caused the "spoiling." The result, it was thought, would be a black-bear population in keeping with the original and fundamental concept of the national parks.

Since there was no scientific evidence that distinct roadside and back-country populations existed in Yellowstone, a modification of the national policy to suit the particular circumstances of the park was clearly needed. Such a policy was formulated in the summer of 1960 and has been revised periodically in the years following. The present stated bear-management policy for Yellowstone recognizes that drastic control will not solve the bear problem, that visitors are entitled to view black bears, that viewing can best be provided along the roads, and that management must be designed to accomplish this while keeping hazards to a minimum.

Policy for managing grizzlies has not been as clearly defined as that for managing blacks. Management of sorts has evolved from administrative

decrees prohibiting public visitation at refuse dumps habitually frequented by grizzlies. Also, zoning of grizzlies and visitors has developed of itself in Yellowstone from the traditional visitor-use pattern, which has largely been sightseeing tours by horse-drawn coaches or motor vehicles rather than back-country hikes or pack trips. This pattern has tended to keep visitors close to major roads and away from wilderness country and possible contact with the grizzly.

The significance of this pattern, in terms of bear management, is illustrated by a comparison of personal-injury incidents and control kills in Yellowstone with those in Glacier National Park, where there are few roads and where hiking is a primary visitor activity. In Yellowstone, during the seven years from 1959 through 1965, there has been one personal injury by grizzlies for every 17.5 by blacks; the control kill has been one grizzly to every 12.6 blacks. In Glacier, during the same period, there has been one personal injury by grizzlies for every 1.8 by blacks, with a control kill of one grizzly to every four blacks (Table 3).

The above figures show that whereas the close-to-the-road pattern of visitor use in Yellowstone has helped to zone the grizzly from visitors it has had the opposite effect with regard to the black bear. Recent bear-management policy in Yellowstone, based on visitor incidents and control measures, is therefore directed primarily toward the blacks.

Bear-Management Action

To implement the 1960 bear-management guidelines for Yellowstone National Park, action was taken to prevent the concentration of black bears along roads and in campgrounds, to enforce regulations against feeding bears at these places, and to alert visitors more effectively to the danger of bears. The reporting procedures for control action, personal injury, and property

Table 3

Comparison of Black-Bear and Grizzly-Bear Incidents in Yellowstone and Glacier National Parks, 1959-1965

Year	Personal Injury				Bears Killed											
					Control				Accidental				Total			
	Black		Grizzly		Black		Grizzly		Black		Grizzly		Black		Grizzly	
	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G
1959	41	4	0	1	24	8	6	3	40	0	0	0	64	8	6	3
1960	69	6	0	4	86	10	3	7	17	1	1	0	103	11	4	7
1961	57	3	1	1	58	5	1	0	11	0	0	0	69	5	1	0
1962	40	1	2	1	48	6	4	0	8	2	0	0	56	8	4	0
1963	30	1	6	2	18	3	2	2	15	0	0	0	33	3	2	2
1964	28	1	2	0	10	4	2	0	8	3	0	1	18	7	2	1
1965	33	2	6	1	9	14	2	0	7	2	0	0	16	16	2	0
Totals	298	18	17	10	253	50	20	12	106	8	1	1	359	58	21	13

Yellowstone - Control kill - 1 grizzly : 12.6 black bears

Total mortality - 1 grizzly : 17.5 black bears

Glacier - Control kill - 1 grizzly : 4 black bears

Total mortality - 1 grizzly : 4.5 black bears

damage were standardized throughout the park. Specific instructions for removal of offending bears were prepared, with emphasis on the use of immobilizing drugs, utilizing techniques developed in the grizzly-bear research program and imparted to Park Service personnel for immediate implementation. Control action was confined to permanent ranger personnel (it had previously been carried out by seasonal rangers as well), and documentation and approval became mandatory before destroying habitual offenders. These innovations reflect the dynamic nature of the bear problem in Yellowstone as well as the continuing severity of the problem.

Control measures and visitor incidents: Sporadic control of both black and grizzly bears began as early as 1907 (Table 2). During the 23-year period from 1907 through 1930, 15 blacks and 60 grizzlies were killed or shipped to zoos. This record is not complete but does show that during the early years of the park grizzlies were a greater problem than blacks.

As noted previously, more complete records were kept from 1931 to the present. These data, recorded in Table 4, show the number of bear incidents and the control exercised in an attempt to keep bear-man contacts at a level tolerable to both the public and the park administrators. The personal-injury and property-damage figures include both grizzlies and blacks. Annual control measures, the two species lumped, are illustrated in Figure 1.

Most of the incidents prior to 1956 are attributable to the black bear. Personal injuries and property damage in Yellowstone over the past 35 years have been respectively 17 and 45 times more numerous from the black than from the grizzly. As shown in Table 5, when grizzlies come in contact with park visitors, the ratio of property-damage incidents to personal-injury incidents is about two to one, whereas in the case of the blacks it is about six to one.

When data for both species are lumped, as in Table 4, they show that property damage and personal injury have occurred consistently and frequently

Table 4

Bear Incidents and Control Measures in
Yellowstone National Park, 1931-1965

Year	Personal Injuries (Both species)	Property Damage (Both species)	Black Bears Killed for Control[a]	Grizzlies Killed for Control	Black Bears Killed Accidentally	All Bears Killed for Control	Total Bear Mortalities	Park Visitation
1965	39	289	9	2	7	11	18	2,056,198
1964	30	224	10	2	8	12	20	1,962,742
1963	36	278	18	2	15	20	35	1,870,644
1962	42	112	48	4	8	52	60	1,923,063[b]
1961	58	247	58	1	12	59	71	1,525,368[b]
1960	69	358	85	4	17	89	106	1,440,463[b]
1959	41	269	24	6	40	30	70	1,406,831[b]
1958	39	117	26	2	12	28	40	1,425,680
1957	91	125	20	1	18	21	39	1,595,875
1956	109	106	14	-	7	14	21	1,457,782
1955	73	121	18	5		23		1,368,515
1954	43	115	6	5		11		1,328,893
1953	43	66	10	1		9		1,326,858
1952	40	84	8	1				1,350,295
1951	38	75	40	4		44		1,166,346
1950	51	48	20	-		20		1,109,926
1949	47	26	11	8		19		1,133,516
1948	36	27	5	3		8		1,013,031
1947	40	9	8	-		8		932,503
1946	15	20	4	-		4		814,907
1945	2	7	2	-		2		178,296
1944	2	18	9	3		12		85,347
1943	5	38	14	-		14		64,144
1942	29	118	54	28		83		191,830
1941	90	102	26	-		26		581,761
1940	41	75	12	-		12		526,437
1939	73	92	23	-		23		486,936
1938	97	81	46	-		46		466,185
1937	115	81	41	10		51		499,242
1936	42	34	10	4[c]		14		432,570
1935	36	141	66	3		69		317,998
1934	25	38	2	-		2		260,775
1933	22	146	22	-		22		161,938
1932	34	451	55	-		55		157,624
1931	78	209	34	-		34		221,248
TOTALS	1,678	4,347	859	99	144	958	1,102	32,842,267
35 Yr. Average	48	124	25	28	-	27	21	938,350

[a] Does not include bears accidentally killed
[b] Travel only through October 31
[c] Museum specimens

Note: Data in this table obtained from National Park Service records

Figure 1

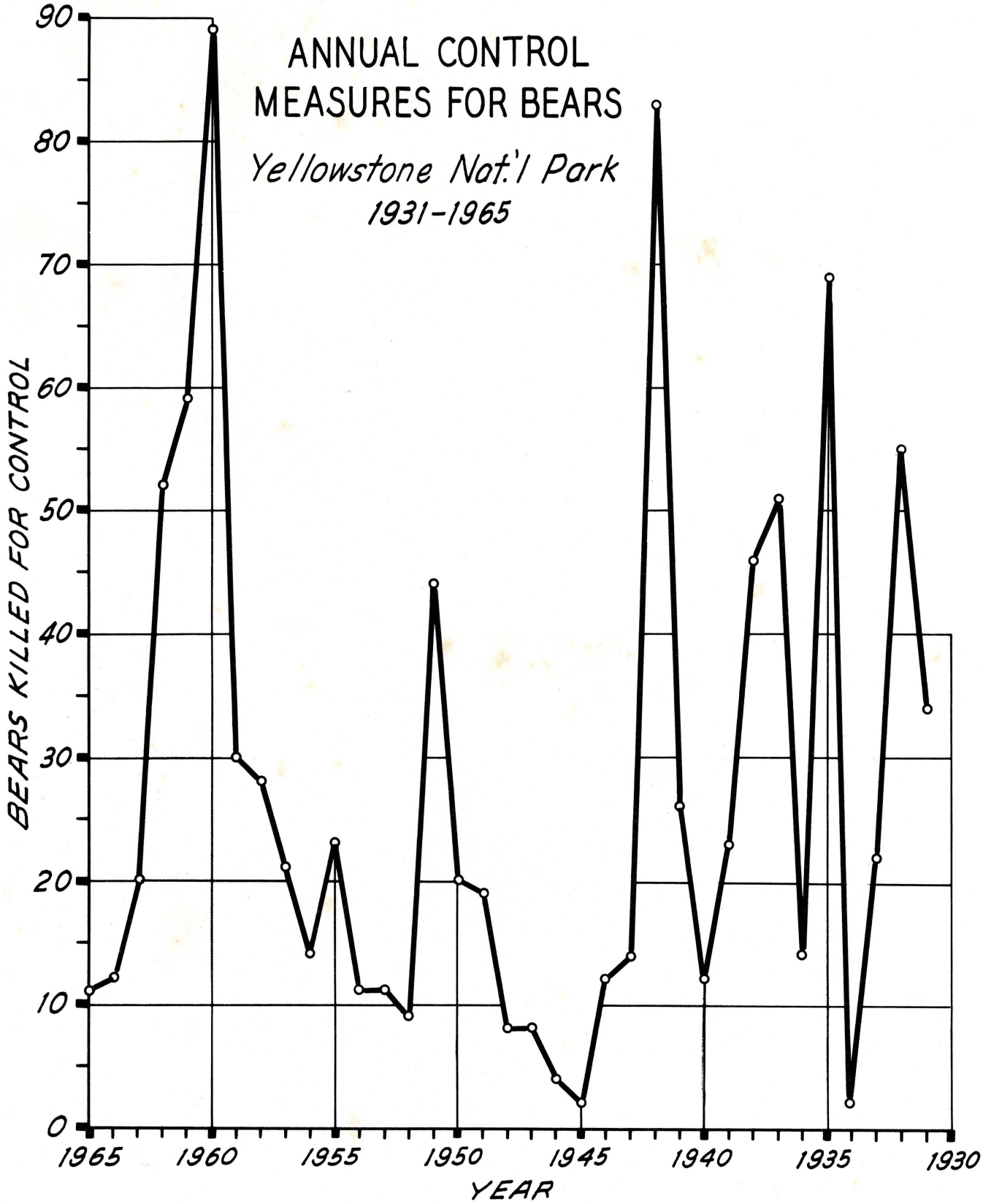

ANNUAL CONTROL
MEASURES FOR BEARS
Yellowstone Nat.'l Park
1931-1965
BEARS KILLED FOR CONTROL
90
80
70
60
50
40
30
20
10
0
1965
1960
1955
1950
1945
1940
1935
1930
YEAR

Table 5

Comparison of Black-Bear and Grizzly-Bear Incidents in Yellowstone National Park, 1959-1965

Black Bear

Year	Personal Injury	Property Damage	Bears Killed		
			Control	Accidental	Total
1959	41	267	24	40	64
1960	69	346	86	17	103
1961	57	242	58	11	69
1962	40	107	48	8	56
1963	30	273	18	15	33
1964	28	220	10	8	18
1965	33	283	9	7	16
Totals	298	1,738	253	106	359

Bears Killed - Average - 51 per year (all causes)
Average - 36 per year (control)

Grizzly Bear

1959	0	2	6	0	6
1960	0	12	3	1	4
1961	1	5	1	0	1
1962	2	5	4	0	4
1963	6	5	2	0	2
1964	2	4	2	0	2
1965	6	6	2	0	2
Totals	17	39	20	1	21

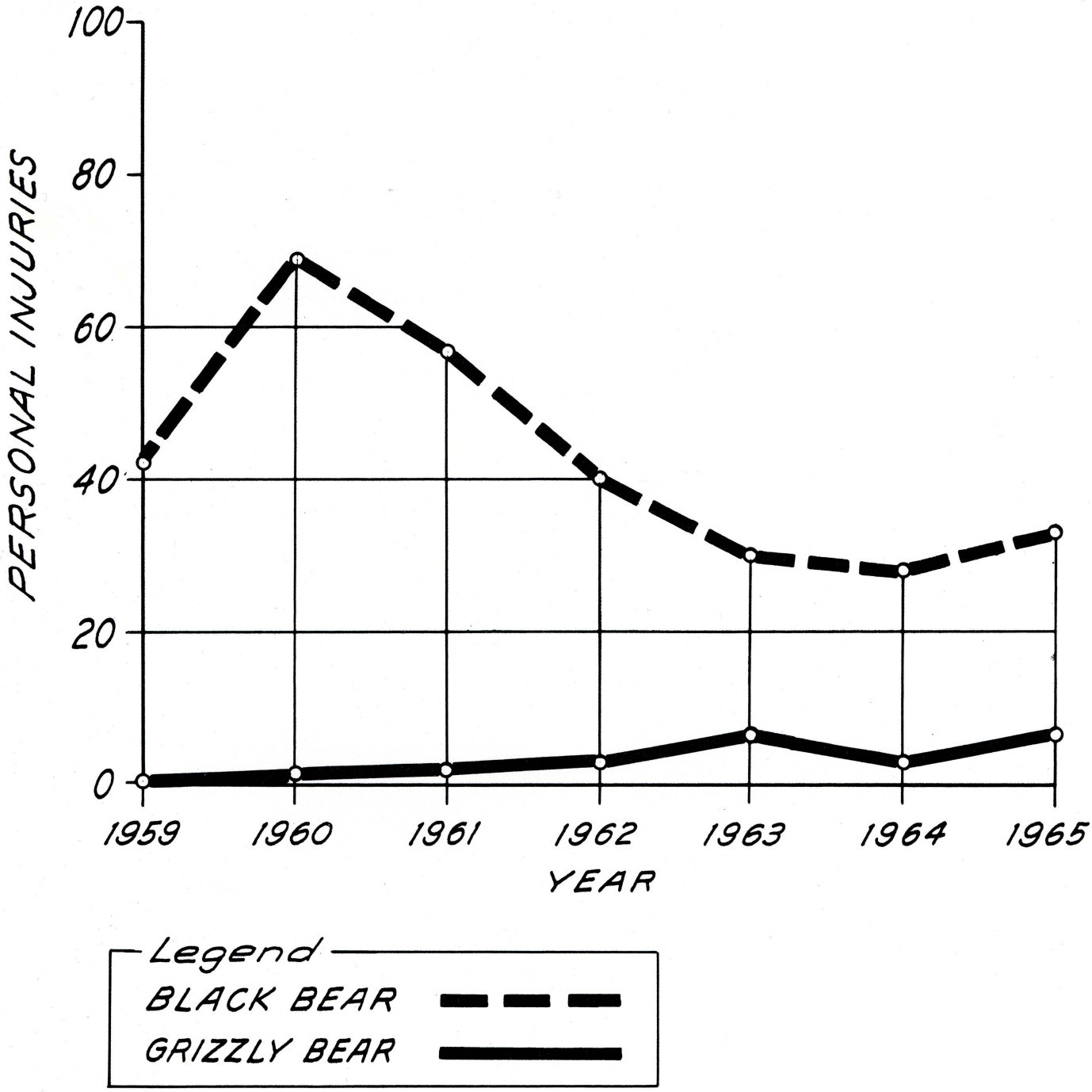
Bears Killed - Average - Three per year (control)

Figure 2

PERSONAL INJURIES FROM BLACK AND GRIZZLY BEARS

1959-1965

Yellowstone National Park



over a 35-year period, with a ratio of property damage to personal injury of about three to one. Many damage incidents of a minor nature have not been recorded. The number of personal-injury incidents resulting from contact with grizzlies and blacks is illustrated in Figure 2.

The maximum control measures for black bears occurred in 1960, when 85 were destroyed and an additonal 17 were killed unintentionally. As far back as 1932 and 1935, heavy control was practiced, with 55 and 66 blacks reportedly destroyed. Some black bears were killed during each of the 35 years for which records are available (Table 4, Figure 1).

Control of the grizzly since 1931 has been far less intensive and more erratic than control of the black, with kills reported for only 20 of the 35 years. Maximum control measures occurred in 1942, when 28 grizzlies were disposed of. The ratio of grizzlies to blacks in the control kill during the 35-year period is approximately 1:8, whereas in the seven years from 1959 through 1965 (Table 5), it has been approximately 1:17, if all blacks listed under accidental deaths are considered part of the kill. On the other hand, records indicate a heavier kill of grizzlies than blacks from 1907 to 1930 (Table 2).

Over the seven-year period from 1959 through 1965 (Table 5), an average of 36 blacks and three grizzlies were killed annually in control measures. In addition (Table 5), 106 black bears are listed as accidentally killed. Many of these accidental deaths resulted from incompetent administration of drugs by rangers attempting to immobilize bears, and probably should be recorded under the control kill. If we consider these as part of the control kill, then Table 5 shows that the average annual kill of 51 black bears for the period 1959-1965 is more than double the 35-year annual average of 25 blacks shown in Table 4. Since records of accidental deaths for years

prior to 1956 are not available (Table 4), accidental and control deaths occurring before the late 1950s cannot be compared and evaluated.

Analysis of Past Management Efforts

Certain conclusions can be drawn from the 35-year record of bear control in Yellowstone National Park. For convenience of interpretation, the information in Table 4 has been grouped into five-year periods and is summarized in Table 6. These data show that from 1931 through 1965 the park administration reported 1,678 personal injuries resulting from bear-visitor contact and 4,347 cases of property damage. To counter this situation, park rangers killed 859 black bears and 99 grizzlies in control measures (accidental deaths not included), or an average of 27 bears a year. During this period approximately 33 million visitors entered the park, an annual average of about 938,000.

Theoretically, an increase in either numbers of bears or number of people should increase the opportunity of contact between the two. Many factors affect the probability of contact, and some of these can be manipulated for management purposes. A reduction in bear numbers is the easiest and most direct way of reducing contact, but is essentially an expedient approach to an action program.

Figure 1 shows the annual fluctuation in control kill between 1931 and 1965. Figure 3 illustrates the control kill over five-year periods and the annual average for each period. There appears to be no pattern governing the size of the annual control kill or the five-year totals until those figures are compared with the incidence of personal injuries (Figure 4). In general, the heavy control kills have either coincided with or immediately followed years when personal injuries were high. Following

Table 6

Summary of Yellowstone Bear Incidents, 1931-1965

Period	Personal Injuries	Property Damage	Black Bears Killed for Control		Grizzlies Killed for Control	All Bears Killed for Control	Black Bear Accidental Deaths	Park Visitation	Annual Ave. Park Visitation	Ratio of Black Bears Killed to No. of Visitors	Ratio of Grizzlies Killed to No. of Visitors
1931-35	195	985	179		3	182		1,100,000	220,000	1:6,100	1:366,600
1936-40	373	363	132	311	14	146		2,411,000	482,000	1:18,300	1:172,200
1941-45	128	283	106		31	137		1,101,000	220,000	1:10,400	1:35,500
1946-50	189	130	48		11	59		5,004,000	1,000,000	1:104,300	1:454,900
1951-55	239	461	82		16	98		6,541,000	1,308,000	1:79,800	1:408,800
1956-60	349	972	169	312	13	182	94	7,327,000	1,465,000	1:43,400	1:563,600
1961-65	205	1,150	143		11	154	50	9,338,000	1,868,000	1:65,300	1:848,900
1931-65	1,678	4,347	859		99	958	144	32,822,000	938,000	1:38,200	1:331,500

Grand Total, Black Bears - 965

Grand Total, All Bears - 1,102

Figure 3

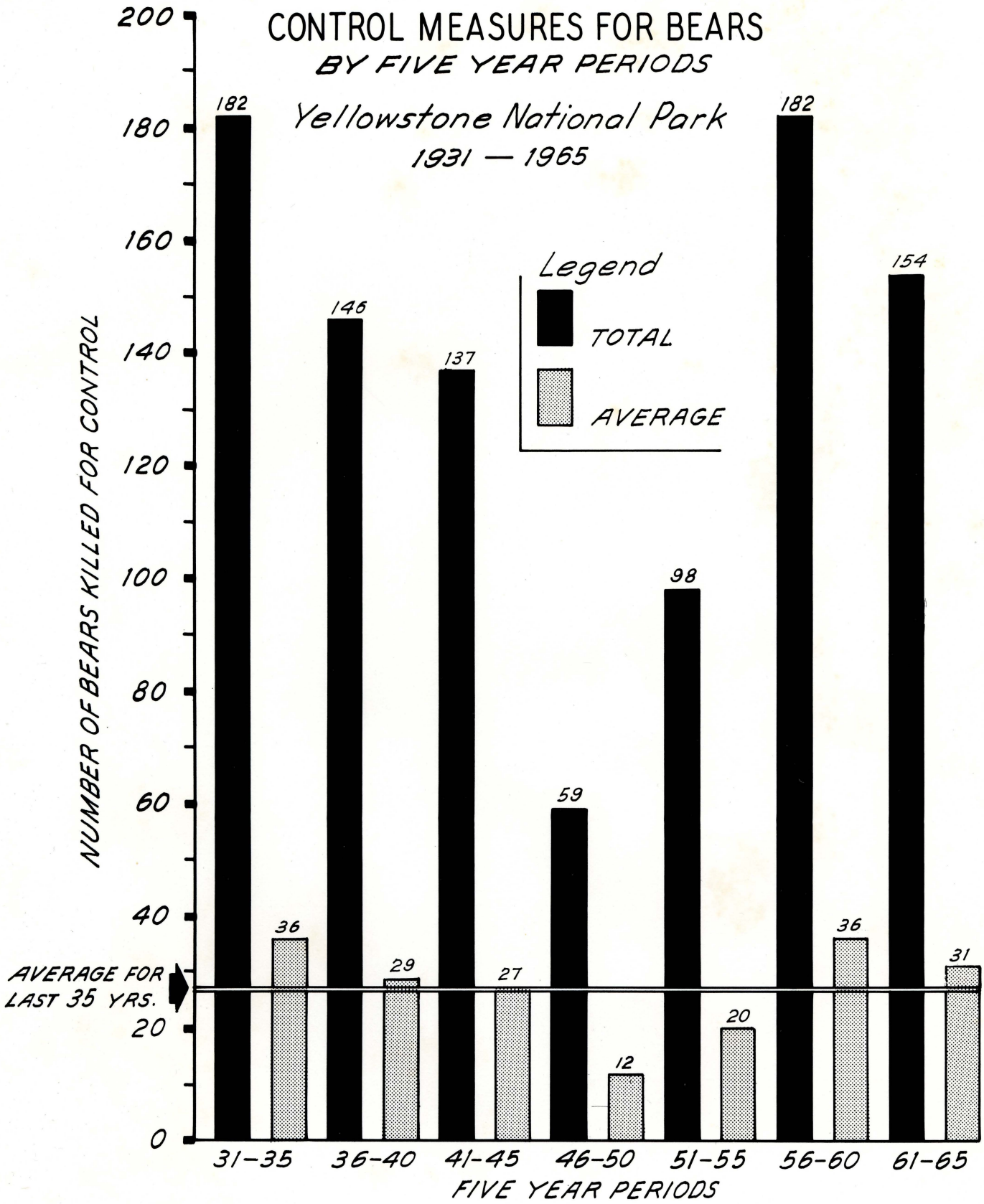
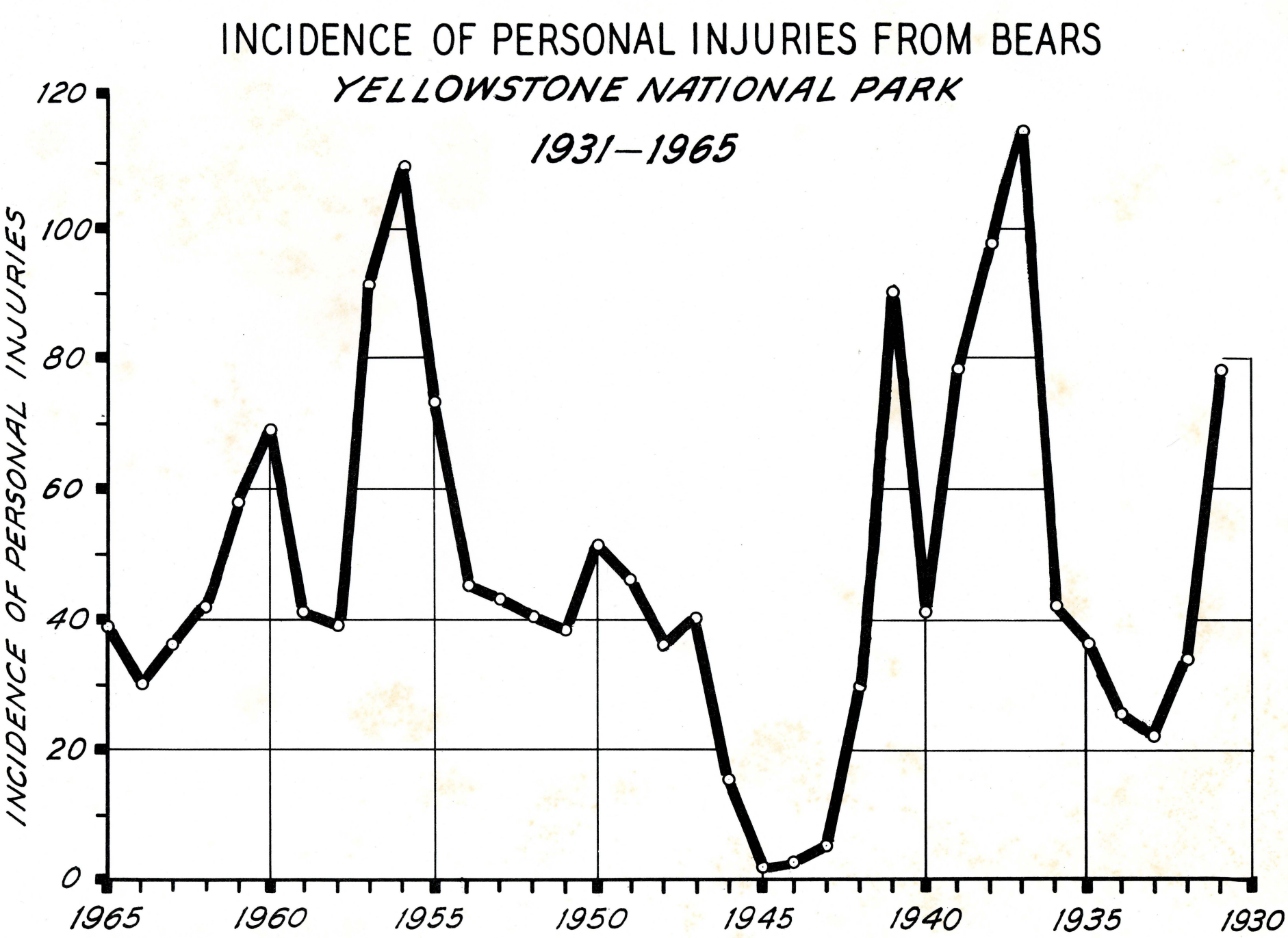

CONTROL MEASURES FOR BEARS
BY FIVE YEAR PERIODS
Yellowstone National Park
1931 — 1965
Legend
TOTAL
AVERAGE
NUMBER OF BEARS KILLED FOR CONTROL
200
180
160
140
120
100
80
60
40
20
0
AVERAGE FOR LAST 35 YRS.
182
36
146
29
137
27
59
12
98
20
182
36
154
31
31-35
36-40
41-45
46-50
51-55
56-60
61-65
FIVE YEAR PERIODS

Figure 4

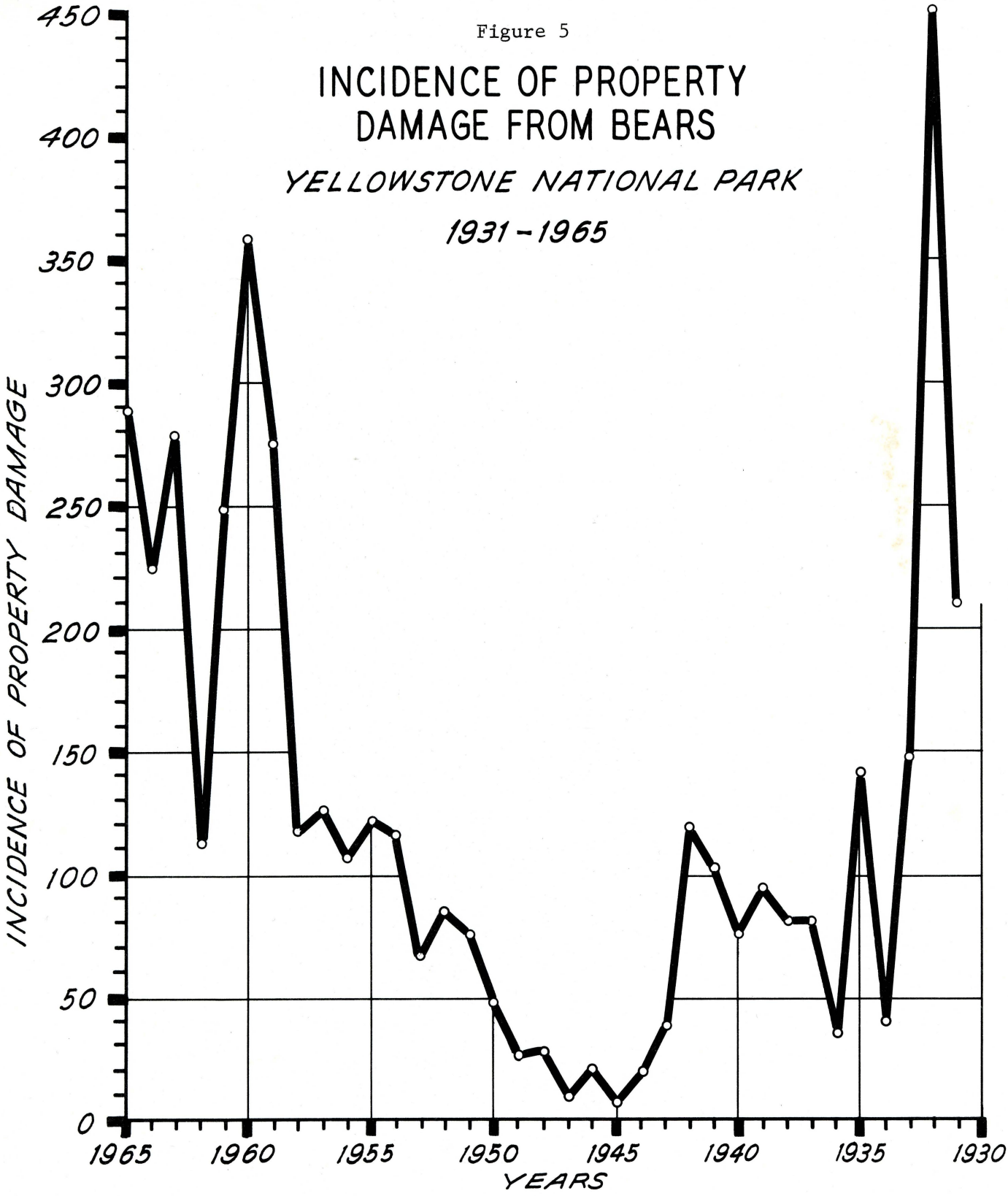

INCIDENCE OF PERSONAL INJURIES FROM BEARS
YELLOWSTONE NATIONAL PARK
1931—1965
INCIDENCE OF PERSONAL INJURIES
120
100
80
60
40
20
0
1965
1960
1955
1950
1945
1940
1935
1930

the heavy control kills, the incidence of personal injuries has dropped and so have the control measures. Exceptions to this general trend occurred when the low incidence of personal injury in 1933 and 1934 was followed by a heavy control kill in 1935 and when the high incidence of personal injury in 1955, 1956, and 1957 elicited only very light control until 1960, when a record number of 85 black bears was destroyed (102, if accidental deaths are included). The relationship between control kill and incidence of property damage (Figure 5) is not as consistent as that between control kill and personal injury, but a general pattern of increased control following increased damage is evident.

The great fluctuations in the annual control kills (Figure 1) show that no management guidelines exist to determine the level of these kills from year to year. High incidence of personal injury and property damage has been the catalyst initiating bear control; thus variation in the amplitude of the kill from year to year reflects administrative apprehension following visitor complaints. This type of control, based on direct response to public pressure, is too erratic to constitute a management program: bear control could and should be stabilized on the basis of systematically gathered knowledge.

Personal injuries have not increased importantly over the years. There were 195 during the five-year period from 1931 to 1935, and 205 during a similar period 25 years later (1961-1965). The maximum for a five-year interval was 349 between 1956 and 1960 (Table 6). Incidence of property damage has fluctuated widely; there were 985 recorded incidents in the first five years during which records were kept, and 1,150 during the last five (Figure 5). A trend correlated with the annual increase in

Figure 5


INCIDENCE OF PROPERTY DAMAGE FROM BEARS
YELLOWSTONE NATIONAL PARK
1931-1965
INCIDENCE OF PROPERTY DAMAGE
450
400
350
300
250
200
150
100
50
0
1965
1960
1955
1950
1945
1940
1935
1930
YEARS

visitor use is thus not apparent, although park visitation has risen steadily with the exception of the 1941-1945 period that coincided with World War II (Table 6).

The ratio of black bears killed to the increase in number of annual visitors does not show a direct correlation (Table 6). It is probable that the annual average control kill of 25 black bears has kept the roadside population at a level that currently varies little from the 1931 level. Unfortunately, there are no accurate censuses to prove or disprove this supposition.

As park visitation has increased, the jamming of vehicles to permit viewing of roadside bears may have imposed a limit on bear-visitor contacts by restricting the number of viewers and the amount of time spent in observing bears. This may have functioned as an unplanned means of zoning black bears and visitors, so that in spite of the enormous increase in visitors, there has not been a corresponding increase in annual visitor-bear incidents.

The 35-year personal-injury and property-damage levels indicate that the Park Service can expect an annual average of 48 personal injuries and 124 cases of property damage in Yellowstone unless more effective management techniques are devised (Table 4). In general, the problem of managing black bears in terms of human contact has intensified over the years, but the grizzly presents little more of a problem in this regard today than in the early 1900s. This can be attributed to the grizzly's habits of avoiding man and of concentrating at and near the refuse-disposal areas, as well as to the administrative zoning of these areas to prevent public access.

Management of both black and grizzly bears in Yellowstone has suffered from a lack of scientific information on vital population statistics. For example, the relative distribution of black bears along the roads and in the back country is not currectly known, nor has the size or structure of the population been determined. The effect of heavy control of roadside and campground bears on the ability of the population to reproduce is only speculative. As mentioned previously, management has been based on the assumption that two black-bear populations exist - roadside-campground and back country - and that the nuisance black bears killed in control measures will be replaced by back-country bears. Only scientific evidence can prove or disprove this assumption, and only such information can place black-bear control measures on a firm scientific basis. A study to verify or refute the existence of separate black-bear populations was outlined by the authors in 1963 and subsequently initiated by the Park Service.

In 1959, even less was known about the population biology of the grizzly bear. The basic management problem is how to preserve this species, and the problem can only be solved by a management program developed from population statistics. Our research has therefore been concentrated on obtaining these vital data for the grizzly.

Section III

POPULATION DYNAMICS OF GRIZZLIES

To understand the biological changes occurring in the Yellowstone grizzly-bear population, it has been necessary to procure factual data that would reveal the inherent ability of the grizzly to populate its environment. A population is in a continuous state of change, the character and extent of which depend upon biological functions of the species and upon its relation to the external environment. To determine the population status of the grizzly in Yellowstone we must concern ourselves with birth and death, because these functions increase and decrease the size of a population as well as change its age structure.

When the birth rate increases, the population consists of a preponderance of young animals; such a population is growing. If the birth-rate decreases, the population consists of a preponderance of older animals; such a population is declining. When birth and death rates are equal, the population is stable. A birth-rate decrease combined with a death-rate increase causes a steady decline that can result in extermination. Determination of these conditions in a population is fundamental to population analysis and to population management. In a long-lived species with a low reproductive rate such as the grizzly it takes many years for these changes to occur and to be observed and recorded.

Models of animal populations can be constructed using hypothetical situations and generalized information on birth and death rates and breeding physiology. These models are useful to the population ecologist but are of little help to the wildlife manager responsible for managing a specific population unit. During an eight-year investigation

we have obtained much of the information necessary to express the actual dynamic processes of the grizzly-bear population in Yellowstone.

This information reveals:

1. The size and structure of the population.
2. The reproductive capacity:
    a. Age at sexual maturity.
    b. Length of reproductive life.
    c. Number of cubs produced.
3. Mortality within the population.

We are still in the process of collecting data in these categories, and much data already obtained are not yet fully analyzed. However, enough information is available to define the population units, determine the growth trend of the grizzly population, identify major mortality factors, and express mortality rates.

The statistics and averages given here are based on either seven or eight years of data, and represent these periods of time unless otherwise stated. In this report we will not attempt to explain methods, to provide complete quantitative evidence, or to analyze all supporting data; such material will be presented in separate scientific papers. *The objective of the current analysis is to offer and interpret key information representative of the Yellowstone grizzly population so that the status of this population can be determined and management suggestions made.* We have purposely avoided giving details that do not directly contribute to this objective.

Size and Structure of the Population

Because the Yellowstone grizzly population is relatively small, and because a large proportion of it visits the earth-filled refuse dumps during the course of a year, it has been possible to make accurate censuses at these locations. In order that individual bears could be recognized, 216 were individually color-marked over the eight-year period from 1959 through 1966. The numbers marked each year were: 30, 47, 45, 19, 24, 34, 13, and 4. Observation and enumeration of these animals provided data on grizzly numbers, age structure, sex ratio, productivity, and survival. The counts of marked and unmarked animals are near totals for each population unit and for the park population as a whole. These censuses, combined with death statistics, provide the basis for management.

We made periodic censuses of each population unit throughout the eight years (Table 7, Figure 6). There were 324 censuses totaling 11,340 hours, with the average census period lasting approximately three and a half hours. Because the Trout Creek population unit is more than three times the size of the next largest unit, it was the most extensively censused and studied. Each unit will be referred to by name, and the parkwide population will be designated the Yellowstone population or the grizzly population. We will use population numbers as well as ratios to show population dynamics.

Population units: The Yellowstone population consists of four major and two minor units (Table 7, Map 3). Each unit tends to be self-contained but some exchange exists between them. Population coalescence occurs in the summering areas by a gradual build-up during June, July, and August. Members of each unit roam between their respective

summer and fall ranges, with migration movements of 15 to 75 airline miles or more.

Figure 7 shows the seasonal build-up for the Trout Creek unit during the years 1964-1966. The curves are based on the recognition of marked as well as unmarked but recognizable bears when they arrived in the Trout Creek area each summer. A list of these bears and the means by which they were identified in 1966 are given in Table 8. (A similar record was made for each of the other seven years.) The 1966 Trout Creek build-up progressed from 20 individual bears recorded on June 7 to a total of 128 by August 24. All 128 bears were not in the area simultaneously but all did visit Trout Creek and remained for varying lengths of time. The largest number of grizzlies observed on any one census during 1966 was 88 (Figure 6).

Dispersal from the summer concentration sites to fall foraging areas and winter dens usually begins in early September. This movement is abrupt compared to the steady increment of animals at the sites throughout the summer.

Population size: Within each year, the size of a grizzly population varies. A rapid increase during the relatively short period of birth (late January and early February) is followed by a gradual decline as deaths occur throughout the rest of the year.

The Yellowstone grizzly population was censused each year after the period of population increment. Females with cubs were first recorded at the census areas as early as June 1; in some years the last female with cubs appeared as late as August 30.



Plate 4

A female grizzly alerted by the approach of a male.
Thirty-six percent of the adult females produce cubs each year.



Plate 5

Male approaching a female in oestrus.
The male grizzly is sexually mature at four years of age but the young males are not active breeders.



Plate 6

A troop of grizzlies.
These bears frequently travel in groups.

Table 7

Census of Grizzly Bears by Areas, 1959-1966

Site	59	60	61	62	63	64	65	66	Ave.
Trout Creek	96	98	98	98	116	128	132	128	112
Rabbit Creek	22	40	31	29	31	31	27	48	32
West Yellowstone	27	16	19	7	13	12	12	13	15
Gardiner	9	9	10	11	10	7	13	8	10
Thumb	-	4	4	8	5	5	3	5	5
Pelican Creek	-	2	4	2	2	2	-	-	2
Totals -	154	169	166	155	177	185	187	202	174

- No census made

Figure 6

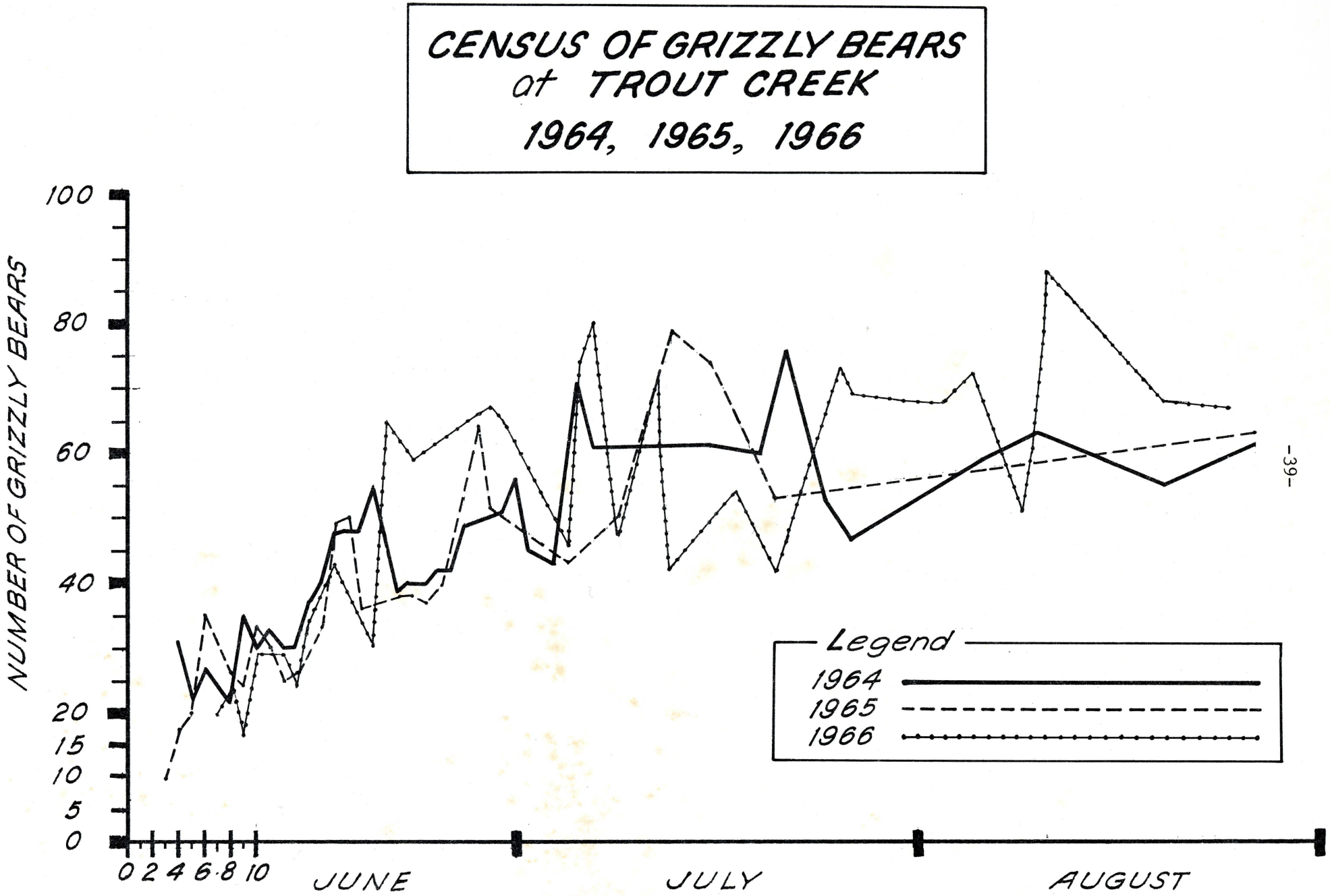

CENSUS OF GRIZZLY BEARS
at TROUT CREEK
1964, 1965, 1966
NUMBER OF GRIZZLY BEARS
100
80
60
40
20
15
10
5
0
0 2 4 6 8 10
JUNE
JULY
AUGUST
Legend
1964
1965
1966

Figure 7

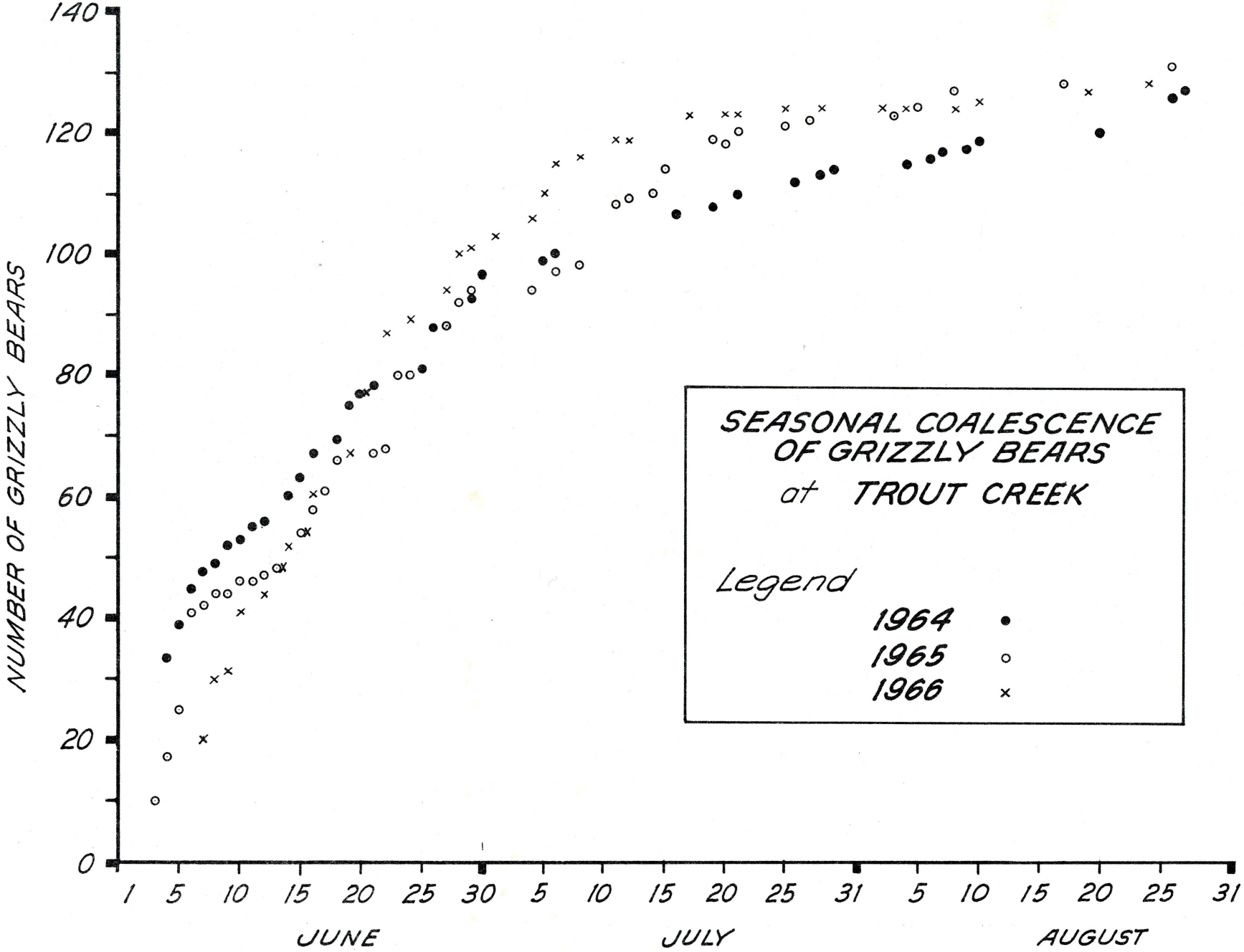

NUMBER OF GRIZZLY BEARS
140
120
100
80
60
40
20
0
1 5 10 15 20 25 30 5 10 15 20 25 31 5 10 15 20 25 31
JUNE
JULY
AUGUST
SEASONAL COALESCENCE
OF GRIZZLY BEARS
at TROUT CREEK
Legend
1964
1965
1966

Table 8

List of Individual Bears Visiting Trout Creek Dump in 1966

CUBS	TWO-YEAR OLDS	FOUR-YEAR OLDS	ADULTS	
			MALES	FEMALES
2 of #40 (#216; 1 unmarked)	#183	#135	#12	#15
	#188	#147	#41	#39
1 of #101	#208	#173	#76	#40
1 of #15	#209	#200	#88	#81
2 of #7	#202	#132	#14	#120
2 of #108	#184	#144	#20	#125
1 of #172	1 Unmarked Blonde	#142	#210	#10
4 of #96		#137	#206	#112
2 of #10	3 Unmarked	#141	Whitefang	#7
2 of Unmarked sow	Total - 10	Ring-eye	Scar-Shoulder	#140
Total - 17		Unmarked	Little brown boar	#150
		Total - 11		#101
			Short-eared boar	#175
				#34
			New brown boar	#44
ONE-YEAR OLDS	THREE-YEAR OLDS	FIVE-YEAR OLDS		#128
			Ivan II	#160
			Big brown boar	#96
2 of #81	#178	#166		#42
3 of #140 (211; 2 unmarked	#190	#109	Black boar	#108
	#201	#130	Little grizzled boar	#180
	#199	White-collar bear		#144
2 of #125	#181		Total - 17	#172
2 of #120	#204	Total - 4		#5
2 of #44	#187			Eyebrow sow
1 of #175	#165			White-sided sow
2 of #180	#207			Unmarked dark sow
2 of #5	#191			One-eye sow
3 of White-sided sow	#192			Blue sow
	#177			Total - 29
2 of Eye-brow sow	#158			
	#185			
Dogface	Unmarked Female		Total - 46	
2 Weaned yearlings (Unmarked)	Total - 15			
1 Blonde Yearling (Unmarked)				
Total - 25				

TOTAL GRIZZLIES TALLIED - 128

Note: Numbered grizzlies are those individually color marked. Named grizzlies are those with natural markings, scars or a uniqueness that permitted individual identification year after year.

Annual census figures derived from direct counts and presented in Table 7 show the fluctuations in each of the six units and in the population as a whole. The Trout Creek unit has shown a gradual increase from a low of 96 in 1959 to a high of 132 in 1965, with maximum additions in 1963 and 1964. A temporary exchange of animals occurs between the Trout Creek and Rabbit Creek units and between the Rabbit Creek and West Yellowstone units. These short-term visits cannot be interpreted as actual increases or decreases in the size of the units. In general, all units have either increased slightly or remained essentially static, with the exception of the West Yellowstone unit. The apparent decline here may be due to the difficulty of making accurate censuses in an area where the animals are disturbed. All things considered, the average size of each unit (Table 7) probably represents the unit's actual size.

In order to determine if a grizzly population other than the six described units exists, numerous back-country censuses were made in July and August when the maximum number of grizzlies were recorded for Trout Creek (Figure 6) and for the other five population units. These censuses showed that few grizzlies confine their activities to remote areas of the park. Because almost all Yellowstone grizzlies visit the refuse dumps, we believe that almost all have been seen and counted from 1959 to 1966.

Table 7 shows that the total number of grizzlies constituting the six population units has grown from 154 in 1959 to 202 in 1966, with an eight-year average of 174 animals. We believe this increase of 48 grizzlies is real, although improved census techniques over the years probably have enabled us to identify and count more animals as the study

progressed. Since the data have not yet been analyzed statistically, we will use the eight-year average of 174 animals as a minimum population figure for the park. This figure is sufficiently accurate for population analysis and for management purposes.

Age structure: Although the thesis of animal population analysis rightly assumes that a static condition never exists, we must describe dynamic processes in a series of static conditions representing periods of time in the life of the population. We will assume, then, that the size and age structure of the Yellowstone grizzly population, constructed on the basis of eight consecutive years of data (Table 9 and Figure 8), are static and that they are a valid basis for analysis of the dynamics of this population. The age structure for this population has been obtained by averaging the classification counts (Table 9, Figure 8). These data are essentially life equations depicting changes within the population. They show that the mean population level of 174 grizzlies consists of: 19.1 percent cubs, 13.1 percent yearlings (1 1/2 years), 10.1 percent two-year-olds (2 1/2 years), 13.1 percent subadults (three to 4 1/2 years), and 44.7 percent adults (five years and older). In addition, over half the population is composed of subadult bears between the ages of six months (cubs) and four years. This preponderance of young animals, with the age class at birth representing 19 percent of the total population, indicates a relatively young-age bear population.

Mortality is highest in the early years of life as indicated by the drop in size of age classes from cub through two-year-olds. We will discuss mortality in a later section. Forty-five percent of the population consists of mature bears physiologically capable of reproducing, and 55

Table 9

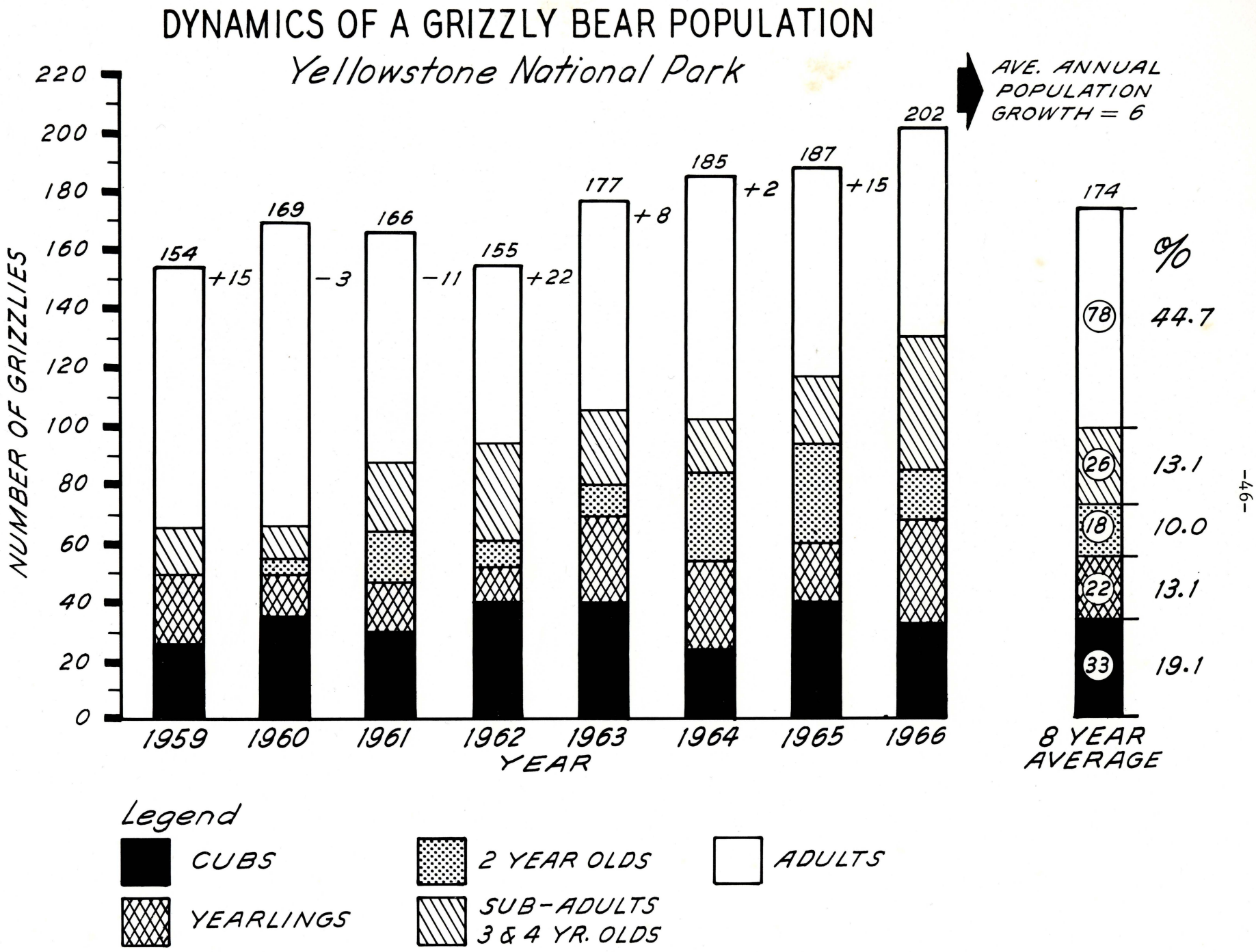
Age Structure of the Population Throughout
Yellowstone National Park, 1959-1966

Age	1959		1960		1961		1962		1963		1964		1965		1966		Average Percent for 8-year Period*
	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	No. of Indiv.	% of Total	
Cubs	26	16.9	35	20.8	30	18.1	39	25.2	40	22.1	24	13.0	40	21.4	32	15.8	19.1
Yearlings	23	14.9	15	8.9	17	10.2	13	8.4	29	16.5	30	16.2	20	10.7	36	17.8	13.1
Two-year-olds	17	11.0	5	2.9	17	10.2	9	5.8	11	6.3	30	16.2	34	18.2	17	8.4	10.0
Subadults**	--	---	12	7.2	23	13.9	35	22.6	25	14.2	19	10.3	23	12.3	45	22.3	13.1
Adults	88	57.2	102	60.3	79	47.6	59	38.0	72	40.9	82	44.3	70	37.4	72	35.7	44.7
Total	154	100.0	169	100.0	166	100.0	155	100.0	177	100.0	185	100.0	187	100.0	202	100.0	100.0

*Computed from eight-year average total population of 174.

**Subadults = three- and four-year-olds.

Figure 8


DYNAMICS OF A GRIZZLY BEAR POPULATION
Yellowstone National Park
AVE. ANNUAL POPULATION GROWTH = 6
NUMBER OF GRIZZLIES
220
200
180
160
140
120
100
80
60
40
20
0
154
+15
169
-3
166
-11
155
+22
177
+8
185
+2
187
+15
202
1959
1960
1961
1962
1963
1964
1965
1966
YEAR
174
%
78
44.7
26
13.1
18
10.0
22
13.1
33
19.1
8 YEAR AVERAGE
Legend
CUBS
YEARLINGS
2 YEAR OLDS
SUB-ADULTS 3 & 4 YR. OLDS
ADULTS

percent constitutes an essentially nonproductive segment of subadults. In future years, any marked increase in the percentage of mature bears to subadults could be interpreted as a sign of population decline: conversely, an increase in the percentage of subadults would indicate a population increase.

Sex ratios: Sex ratios were determined from 211 grizzly bears captured over a seven-year period (Table 10). The ratio among cubs is biased in favor of the male (100 females to 188 males) and remains biased until grizzly bears are three or four years of age, at which time the number of females equals the number of males. This differential mortality continues with age so that among adults the sex ratio becomes biased in favor of the female (100 females to 85 males). Figure 9 shows the proportion of five age classes among the sexes. The two halves of the figure total 100 percent, and the sum of the halves represents the sex ratio of a sample of 211 captured bears.

The sex ratio of adults cannot now be subdivided into finer age classes. Such information will be obtained, however. The age graph will then assume the shape of a pyramid to conform with the age structure. The present adult sex ratio of 100 females to 85 males should have survival value in a promiscuous species where relatively few males are necessary for breeding.

Reproductive Capacity

The capacity of a population to reproduce depends on the age at which males and females reach sexual maturity, the length of reproductive life, and productivity, or the size of the adult female segment

Table 10

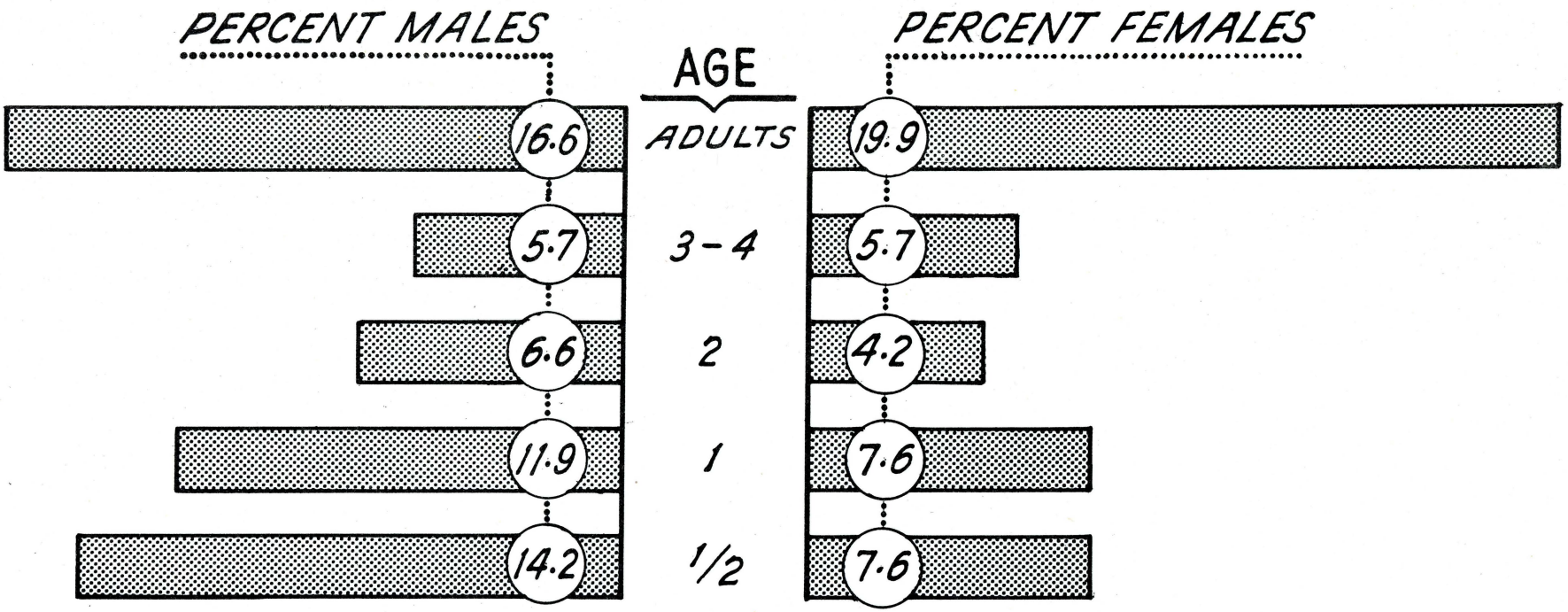
Sex Ratios of Marked Bears, 1959-1965

Age Class	Males	Females	Total	Sex Ratios (Females:Males)	Percent Females
Cubs	30	16	46	100:188	34.8
Yearlings	25	16	41	100:156	39.0
Two Years	14	10	24	100:140	41.7
Three and four years	12	12	24	100:100	50.0
Adults	35	41	76	100:85	53.9
Totals	116	95	211		55.0
Sex ratio of total marked population				100:123	

Figure 9

AGE GRAPH CONSTRUCTED FROM GRIZZLY BEARS CAPTURED AND MARKED

1959 – 1965



of the population and the rate at which this segment produces offspring.

Age at sexual maturity: The male grizzly is sexually mature at four years of age and the female at five, as evidenced by mature testis tubules with active spermatogenesis in the male and by mature ovaries with Graffian follicles in different stages of maturation in the female. Young males are not active breeders, however, because the older, larger males claim the females in estrus and drive the younger males away. Forty-six percent of the adult males breed, and 10 percent of these account for 50 percent of all successful copulations observed. The linear dominance hierarchy existing among the older adult males in areas where they concentrate (Hornocker, 1962) tends to limit the breeding to the dominant male and those immediately subdominant to him.

Females, though physiologically mature at five years, frequently do not produce a litter until they are a year or two older. However, for the purpose of defining the adult female segment of the population we have considered all females five years and older as adults.

Length of reproductive life: The reproductive life of both male and female grizzlies extends into old age; for example, a 20-to-27-year-old male showed active spermatogenesis and a 15-to-21-year-old female had a litter of three cubs. In the Yellowstone population generally, both males and females 15 years and older are active breeders. A female estimated to be 15 to 17 years old in 1966 produced three litters in eight years, and another of similar age produced three litters in five years. Reproductive histories recorded over an eight-year period indicate that some females may produce a litter every second year. It is therefore physiologically possible for a female with a life span of 25 years to

produce 10 litters.

Productivity: This function of a population is frequently expressed in terms of the number of offspring annually produced and surviving to some specified time in the life cycle of the species. In the Yellowstone grizzly study, we have used the number of cubs counted during June through August as a measure of net productivity (Table 11). For such counts to have meaning, they must be related to the size of the female segment of the population and to the percentage of this segment that each year produces offspring. As shown in Table 12, the average number of adult bears in the population of 174 animals is 78; the adult sex ratio of 54-percent females and 46-percent males enable us to compute 42 as the average number of adult females in the population.

Accurate counts of cubs (Table 11) were possible because individual females with their litters could be identified each year by color-coded markers. Table 11 shows that 266 cubs were produced during the eight-year period. The maximum cub crop was 40, the minimum 26, with an eight-year average of 33.3. This average annual increment represents 19.1 percent of the base population of 174 animals (Table 9, Figure 8).

The adult female is bred in late May or June, gives birth to cubs in late January or early February, and emerges from her winter den with cubs about one year from the time of conception. Some females wean their offspring as yearlings the following spring, while others care for them for another full year and wean them as two-year-olds. The breeding cycle is thus either two or three years; in rare instances it may be only one year or longer than three years. The observed average

for the population is three years.

In Table 12 we have expressed the number of females with cubs as a percent of the total adult female population. This statistic is shown for each of eight years and also averaged. These computations reveal that an average of only 15 of 42 females annually produced cubs, representing 36.2 percent of the adult females, or a little over one third.

Table 13 shows that 16.8 percent of the adult female population annually is engaged in caring for yearlings. This is less than half the number of females annually producing cubs (Table 12). The percentages of females with either cubs or yearlings are shown in Table 13. Fifty-three percent of the adult female population is annually engaged in caring for young and does not breed, and 47 percent, or 20 females, are potential breeders each year. However, as shown in Table 12, an average of only 15 produces litters each year; thus five females, (12 percent of the average adult female population) are unproductive--that is, they neither care for young nor will they produce a litter the following year.

Ratios of adult females to offspring are helpful in visualizing productivity. For example:

The ratio of cubs to adult females is 33:42. The average cub crop represents 78.6 percent of the number of adult females. The ratio of cubs to productive females only is 33:15, or 220 percent. The ratio of yearlings to adult females is 23:42, or 54.8 percent. The ratio of both cubs and yearlings to adult females is 56:42.

Table 11

Cub Counts Throughout
Yellowstone National Park, 1959-1966

	1959	1960	1961	1962	1963	1964	1965	1966	Totals	8-Year Average
Cubs	26	35	30	39	40	24	40	32	266	33.3

Table 12

Number of Females with Cubs Expressed as Percent of Total Adult Female Population, Yellowstone National Park, 1959-1966

	Total Adult Population	Computed Adult Female Pop.*	Number Females With Cubs	Percent of Adult Female Pop. With Cubs
1959	88	48	14	29.2
1960	102	55	17	30.9
1961	79	43	13	30.2
1962	59	32	17	53.1
1963	72	39	16	41.0
1964	82	44	11	25.0
1965	70	38	19	50.0
1966	72	39	15	38.5
Average	78	42.3	15.3	36.2

*Only the adult grizzly population was used in computing these figures, which are based on a sex ratio of 100 females:85 males or 54 percent females and 46 percent males. Although a few four-year-old females may produce cubs, their numbers are insignificant, and the error introduced by not including this age class is considered negligible.

Table 13

Number of Females with Yearlings Expressed as Percent of Total Adult Female Population, Yellowstone National Park, 1959-1966

	Total Adult Population	Computed Adult Female Pop.*	No. Females with Yearlings	Percent of Adult Female Pop. with Yearlings	Percent of Adult Female Pop. with Cubs and/or Yearlings
1959	88	48	7	14.6	43.8
1960	102	55	6	10.9	41.8
1961	79	43	5	11.6	41.9
1962	59	32	5	15.6	68.8
1963	72	39	7	17.9	59.0
1964	82	44	7	15.9	40.9
1965	70	38	6	15.8	65.8
1966	72	39	14	35.9	74.4
Average	78	42.3	7.1	16.8	53.0

*Only the adult grizzly population was used in computing these figures which are based on a sex ratio of 100 females:85 males or 54-percent females and 46-percent males. Although a few four-year-old females may produce cubs, their numbers are insignificant, and the error introduced by not including this age class is considered negligible.

Note: Females that had weaned yearlings were not included in this table.

We can conclude that the ability of the Yellowstone grizzlies to reproduce themselves is not a factor limiting population growth. However, this population shows only a very slow rate of growth, as evidenced by the age structure. Examination and analysis of mortality factors should therefore indicate why the population is not growing more rapidly and where the mortality occurs.

Mortality

Mortality and survival are complementary functions in a population. Mortality can be measured by recording the dead; survival by counting the living. In a population of long-lived animals, this must be done frequently and over a long period of time to obtain accurate death statistics.

When aging techniques can be applied, mortality and survival data specific to age and sex can be obtained for the population. Life tables constructed from such data reveal the population turnover - age-specific mortality rates, longevity, and the period of time required for one or more generations to live and die.

Various techniques have been used to determine mortality among the Yellowstone grizzly bears during a seven-year period (1959 through 1965).

These are:

1. Maintaining death records of both marked and unmarked grizzlies of all ages.
2. Determining survival by censusing marked bears and recording those missing from the population.

3. Maintaining death records of generations of known- or established - age grizzlies.

4. Counting cubs and yearlings to obtain first-year mortality and survival statistics.

Data obtained from these varied approaches should yield, in time, precise knowledge of grizzly mortality, survival, and age structure of the adult segment of the population. Death statistics obtained to date are incomplete but are adequate for use as a basis for management suggestions.

Causes of mortality: Causes of mortality during the years 1959 through 1965 of 108 grizzly bears of all ages are shown in Table 14: 55 of these bears were marked and 53 were unmarked. Shooting of grizzlies outside the boundaries of Yellowstone accounted for 42.7 percent of the deaths. Control measures of all types within the park were responsible for 27.8 percent, and all other causes amounted to 29.5 percent.

Ten grizzlies were inadvertently killed by the injection of drugs. Three of these occurred during the first year of the study and were the result of developing and improving the immobilization technique. The other seven were all bears that for one reason or another were unusually susceptible to the immobilizing drug or were purposely drugged heavily to prevent accidents in congested campgrounds where these bears had become troublesome. Mortality induced by the research project averaged 1.4 grizzlies per year, or one animal for every 40 that were handled.

Miscellaneous deaths included grizzlies struck by motor vehicles, shot by poachers or visitors, cubs killed by large boars, and deaths from unknown causes.

Average annual mortality: We have established the fact that the grizzly-bear population increased from 154 animals in 1959 to 202 animals in 1966 and that the average size of the population during that period was 174 animals (Table 7). We have also shown that an average of 33 cubs is produced each year and that these cubs comprise 19.1 percent of the average population (Table 9, Figure 8). The population increase over the eight-year period averaged six bears per year. Thus the average annual increment of 33 cubs produced an average annual population growth of only six animals. If we assume that the difference between the average annual recruitment and the average annual population growth is mortality, then we have an average annual mortality of 27 animals, or 15.5 percent of the base population of 174 (Figure 8).

Some of this mortality has been established by tangible evidence of death and can be expressed as a percentage of the population level for any given year or as a percentage of an average level for a number of years. For example, mortality records between 1959 and 1965 of the 108 marked and unmarked grizzlies of all ages (Table 14) represent an average annual mortality of 9.1 percent of the average grizzly population during that period. Because tangible evidence of death is difficult to obtain, this percentage represents a minimum.

Two hundred and twelve grizzlies of all ages were marked over the seven-year period. Fifty-five marked grizzlies were recovered and causes of death directly established; the death of 70 others was

Table 14

Known Grizzly-Bear Mortality Related
to Causes and Year of Death, 1959-1965

Year	Hunters Outside Yellowstone		Park Service Control Measures: Direct Control		Park Service Control Measures: Zoos		Drug Overdose		Killed for Biological Study		Misc. Causes		Total	Percent of Total Population Respective Years
	M*	UM*	M	UM	M	UM	M	UM	M	UM	M	UM		
1959	1	3	2	2	-	1	3	-	-	-	-	-	12	7.8
1960	2	10	4	2	-	-	0	1	-	-	1	-	20	11.8
1961	5	3	1	1	2	-	1	-	3	-	0	4	20	12.0
1962	2	3	1	4	-	-	1	-	-	-	3	1	15	9.7
1963	2	4	2	-	1	3	1	-	-	-	1	1	15	8.5
1964	4	0	1	1	-	-	1	-	1	-	1	3	12	6.5
1965	4	3	2	-	-	-	2	-	-	-	-	3	14	7.5
Sub-totals	20	26	13	10	3	4	9	1	4	0	6	12	108	9.1 (Average)
Totals	46		23		7		10		4		18			
Grand Totals	46		30				10		4		18			

* M - Marked

** UM - Unmarked

indirectly established by annual censuses*. The mortality among this marked population representing an average annual mortality of 8.4 percent.

Among 122 grizzlies of all ages marked during the first three years of study (1959-1961) 19, or 70.5 percent, were recorded as dead by the end of 1965. This represents an average death toll of 10.1 percent per year over a three-year period.

During the nine years from 1957 through 1965, 83 percent of 77 marked bears of known and established age, representing five generations, were recorded dead, representing an average annual mortality of 9.23 percent (Table 16).

The similarity between these expressions of average annual mortality based on marked and unmarked grizzlies of all ages, marked grizzlies only, and known-and established-age grizzlies representing five generations, can be interpreted to mean that the death percentages are probably accurate. They show that each year the recorded mortality ranged between eight and 11 percent.

Mortality by generations: The ages at death among five generations of grizzlies (Table 16) have ranged from cub to eight years. Death statistics for the 1957 generation, or cohort, represent eight years, with one year less for each succeeding cohort (1958 through 1961). Thus the death records for the youngest cohort (1961) encompass only four years. Table 16 shows the size of each generation, the number and percent of the bears that have died in each cohort. The death

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*Marked bears not observed for two or more consecutive years are considered dead. To date, only three marked grizzlies unobserved for two or more years have been reobserved.

percentages range from 50 to 100 in the cohorts. Among the 77 marked bears representing five generations, the mortality averaged 83 percent.

The 1959 cohort of 19 animals has experienced a mortality of 94.7 percent in six years; the 1960 cohort of 14 animals has had 100-percent mortality in five years. Only a small percent of any generation survives to reproduce. The females that do survive, however, have a long reproductive life and constitute the vital productive segment of the population: a relatively few long-lived productive females are apparently sufficient to maintain the population level. This dependence upon a small productive nucleus could jeopardize the population should the death rate increase.

In view of these findings, grizzly-bear management should be directed toward increasing the survival of females to breeding age and providing greater security for those that have attained this age. This would increase the size of the productive female segment of the population and help to insure survival of the species.

Age-specific mortality: Age-specific mortality can be derived from a dynamic life table that follows the fate of a generation of animals all born at the same time. It can also be derived from a composite life table showing the ages of death regardless of year of birth or year of death of the animals involved. Eventually our data will enable us to construct both types of table for the Yellowstone grizzly bear. At present the composite life table recording length of life is more nearly complete and thus subject to more precise interpretation. Table 17 records the death of 78 marked and unmarked grizzly bears during a seven-year period.

Table 15

Summary of Mortality of Marked Grizzlies, 1959-1965

	Number	Percent of Marked Grizzlies	Percent of Total Mortality
Total number of marked grizzlies	212		
Grizzlies still in the population in 1965	87	41.0	
Total mortality	125	59.0	
Grizzlies known to be dead	55	26.0	44.0
Grizzlies established as dead*	70	33.0	56.0

* Grizzlies that have not been observed for two or more consecutive years.

Table 16

Mortality in Five Generations of Grizzly Bears, Yellowstone National Park, 1957 to 1966

Year of Birth	Size of Generation	Numbers of Bears Marked	Percent of Generation Marked	Marked Bears Dead	Percent of Marked Bears Dead
1957	33*	17	51.5	14	82.4
1958	33*	10	31.3	5	50.0
1959	26	19	73.1	18	94.7
1960	35	14	40.0	14	100.0
1961	30	17	56.7	13	76.5
Total		77		64	83.1

Average Annual Mortality Rate 9.23

*Size of the 1957 and 1958 generations is not known. An average size is used, computed from averaging the sizes of 1959 through 1965 generations.

Sixty-four of the 78 animals (1 1/2 through 6 1/2 years) were field-aged when captured and marked, or if unmarked were aged at the time of death. The 14 animals between seven and 23 years old were aged by tooth sectioning, using increments or annuli in the dental cementum as age criteria (Scheffer, 1950; Stoneberg and Jonkel, 1966).

Table 17 reveals that mortality is high during the first 1 1/2 years of life and remains high during the subadult period. About 39 percent of all deaths occur before the cub is 1 1/2 years old, 40 percent between 2 1/2 and 4 1/2, and a final 21 percent through 19 years of adult life to old age and death.

To visualize how these deaths are distributed, the information can be projected to a hypothetical population in order to express survival and death in terms of the number of deaths and the number of survivors per thousand. In constructing a life table, it is assumed that the data are based on a cohort of 1,000 animals that begin life together and die in the same proportion as described quantitatively by the mortality record.

Table 18 and Figure 10 show a life table constructed from these 78 mortality records. From the histogram (Figure 10) we read that the age-specific death rate for the 1 1/2-year-old bears is 38.5 percent. This shows that among a thousand grizzlies progressing from cub to 1 1/2 years of age, 385 die and 615 survive to enter the next age class. A hundred and fifteen die at 2 1/2, and 500 survive to enter the 3 1/2-year age class. The histogram also shows that death rates remain consistently high in the 1 1/2- through 4 1/2-year age age classes and level off during the middle years. The mortality rate

gradually increases among the older animals, and obviously the death rate in the oldest group is 100 percent.

Early-age mortality: This mortality has been determined from censuses of the number of young observed with females. The enumeration of cubs, yearlings, and two-year-olds appears in Table 9 and Figure 8.

Since the female grizzly keeps her offspring with her for at least one year, accurate counts of the yearlings are possible. Because these families could be identified at the concentration sites, differences between cub counts one year and yearling counts a year later could be readily detected. We have tentatively interpreted the differences as mortality between the ages of six months (cub) and 1 1/2 years (yearling).

Many of the females with yearlings as well as their offspring were color marked so that they could be individually recognized. The mortality represents entire families, including the female, entire litters, and members of litters only. In some cases an entire family was never reobserved; in other cases females were reobserved but not members of their litters; and in still other cases individual litter mates were missing and never reobserved.

The possibility that differences between cub and yearling counts could be caused by emigration as well as death has been considered and rejected. If dispersal rather than death were responsible for the differences, we could expect an increase in the two-, three-, and four-year-old classes as these bears gradually "drifted" back to establish their own patterns of visiting the refuse sites. To date,

the census records of individually marked bears give no evidence of this type of movement, and support a conclusion that the differential count is largely a result of mortality.

Existing data show that the yearing and two-year-old age classes combined (Figure 8) are only slightly larger than the cub class. Cubs comprise 19 percent of the population; one- and two-year-old bears, 23 percent; and three- and four-year-olds, 13 percent.

Table 19 shows the number of cubs born each year and the number of these that were counted the following year. An average of 65.8 percent of all cubs survives to the age of 1 1/2 years; 34.2 percent are mortalities. Deaths during this period are a result of injuries inflicted by older bears, lethal attacks by large boars, shooting of entire families, malnutrition, and other causes not yet conclusively determined.

Between 1959 and 1961, mortality during the first year and a half of life averaged 53 percent. It averaged 22 percent between 1962 and 1966 (Table 19). The increased survival in the latter years is not fully understood, but as information accumulates we will obtain more knowledge of this critical period in the life of grizzly bears.

The similarity between the percent mortality (34.2) recorded in the 1 1/2-year age group by census techniques (Table 19) and the percent mortality (38.5) recorded by death records (Table 17), and the percent mortality of marked cubs only (36.2) suggests that a mortality of approximately one third of this age class is sufficiently accurate for management purposes and should be used until a more refined mortality record is available.

Table 17

Deaths of Grizzly Bears Related to Age, 1959-1965

Age in Years	Number of Deaths	Percent Deaths	
1-1/2	30	38.5	39.0
2-1/2	9	11.5	
3-1/2	14	17.9	40.0
4-1/2	8	10.3	
5-1/2	1	1.3	
6-1/2	2	2.5	
7	1	1.3	
8	2	2.5	
9	1	1.3	
10	1	1.3	
11	0	0	
12	1	1.3	
13	1	1.3	
14	1	1.3	
15	2	2.5	21.0
16	0	0	
17	0	0	
18	1	1.3	
19	1	1.3	
20	1	1.3	
21	0	0	
22	0	0	
23	1	1.3	
Total	78	100.0	

Table 18

Composite Life Table

Age Class (x)	Number Dead in Age Class x (d'x)	Number of Deaths per Thousand (d_x)	Number of Survivors per Thousand (l_x)	Mortality Rate (q_x)
1-1/2	30	385	1000	385
2-1/2	9	115	615	187
3-1/2	14	179	500	358
4-1/2	8	103	321	321
5-1/2	1	13	218	60
6-1/2	2	25	205	122
7	1	13	180	72
8	2	25	167	150
9	1	13	142	92
10	1	13	129	101
11	0	0	116	---
12	1	13	116	112
13	1	13	103	126
14	1	13	90	144
15	2	25	77	325
16	0	0	52	---
17	0	0	52	---
18	1	13	52	250
19	1	13	39	333
20	1	13	26	500
21	0	0	13	---
22	0	0	13	---
23	1	13	13	1000
Total	78	1000	0	

Figure 10

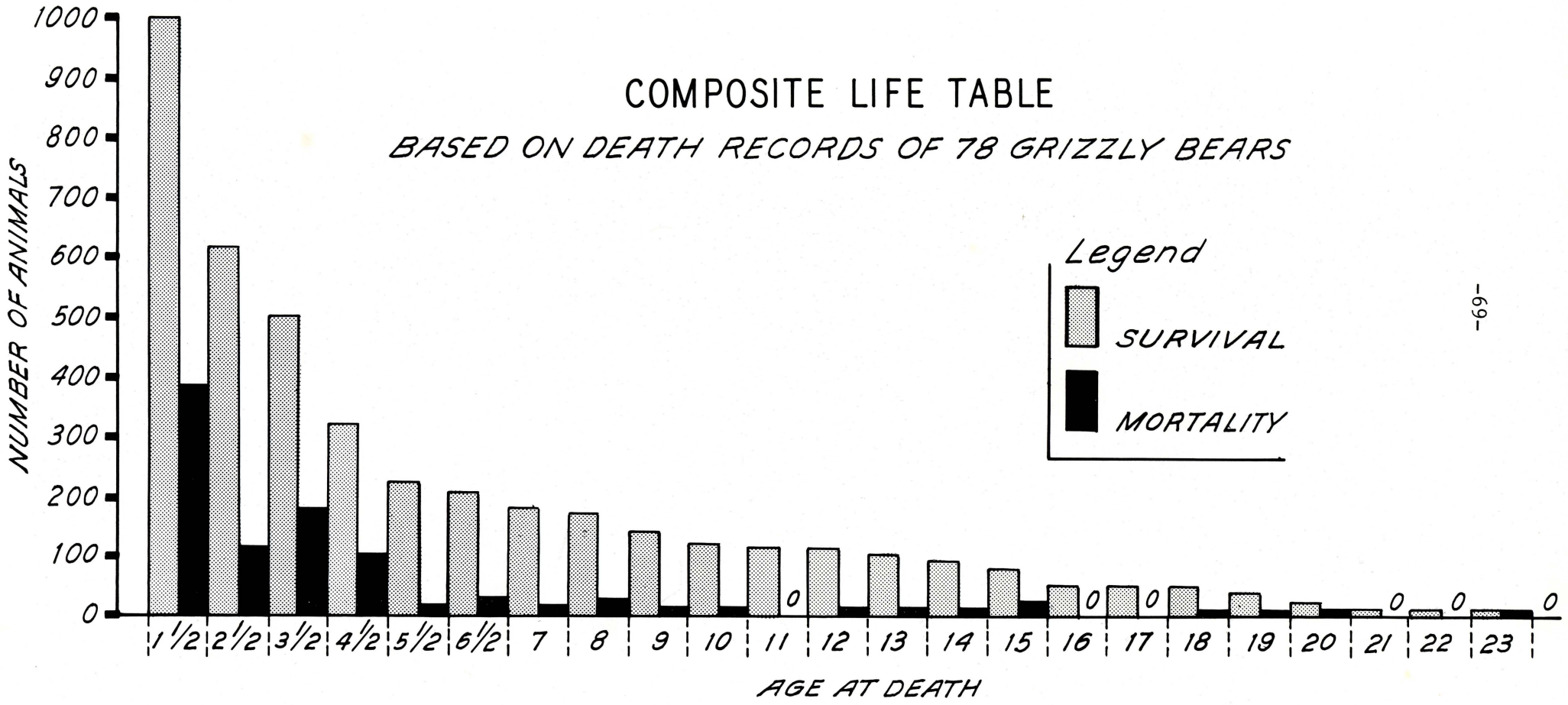

COMPOSITE LIFE TABLE
BASED ON DEATH RECORDS OF 78 GRIZZLY BEARS
NUMBER OF ANIMALS
1000
900
800
700
600
500
400
300
200
100
0
Legend
SURVIVAL
MORTALITY
1 1/2
2 1/2
3 1/2
4 1/2
5 1/2
6 1/2
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
AGE AT DEATH

Table 19

Number of Cubs Born Relative to Yearling Survival, 1959-1966

	1959	1960	1961	1962	1963	1964	1965	1966	Total
Cubs Born	26	35	30	39	40	24	40	32	266
Cubs Surviving to Following Year (Yearlings)	13	17	13	29	30	20	32	--	
Number of Yearlings Unaccounted For	13	18	17	10	10	4	8	--	
Percent Yearlings Unaccounted For	50.0	51.4	56.7	25.6	25.0	16.7	20.0	--	

An average of 65.8 percent of all cubs survive to the age of 1-1/2 years; 34.2 percent are unaccounted for, and all evidence indicates they are mortalities. The causes of mortality have not yet been fully established.

Sex-differentiated mortality: In a sample of 125 deaths at all ages, the sex ratio was 100 males to 76 females or 57-percent males to 43-percent females (Table 20). This differential mortality of 14 percent is probably caused in part by the greater movement exhibited by males, which in turn makes them more vulnerable to hunters. However, the fact that the sex ratio among cubs (Table 10) favors the male almost two to one suggests that the sex-differentiated mortality occurring among males may be biologically funtional. If so, the mortality is from natural causes. As pointed out earlier, the sex ratio of adult animals in the population is 46-percent males to 54-percent females.

A sex-specific life table will eventually be constructed. Such a table will provide a description of age classes by sex and enable us to identify more precisely the adult female group and to determine whether the sex-differentiated mortality is important to population maintenance.

Age structure from death records: A comparison of the percentage of deaths as related to age (Table 17) with the average age structure of the living population (Figure 8) shows that the age structure of the grizzly population cannot be constructed from present death statistics. The ages at death simulate the age structure of the population only in the 1 1/2-year age class. They greatly exaggerate the size of the subadult class (two-three-, and four-year-olds) and under-represent the size of the adult class.

Facts Applicable to Management

The data presented in this section have recorded the gains and losses in the Yellowstone grizzly-bear population. The life equations and life tables will be greatly refined as more information is accumulated, which will allow more precise interpretation in the future.

Certain facts, however, are evident:

1. Annual recruitment is only slightly in excess of annual mortality; therefore the growth of the population is very slow.
2. Females are not productive until at least five years of age.
3. The reproductive cycle of the adult female averages three years.
4. In any given year, only 36 percent of the adult females are productive.
5. Highest mortality occurs in the 1 1/2-year age class.
6. ~~High~~ Higher mortality occurs among young males than among young females.
7. Hunting is a major cause of death.
8. Maintenance of the population depends upon survival of a small nucleus of productive females.
9. Management should be directed toward increasing the survival of females to breeding age and providing greater security for those that have attained this age.

Table 20

Sex-differentiated Mortality of Marked Bears: Known Dead and Established Dead Grizzlies, 1959-1965

Sex	Number Known Dead	Sex Ratio (Known Dead)	Number Established Dead	Sex Ratio (Established Dead)	Total Number Dead	Sex Ratio (Total Dead)
Males	32	100 males:72 females or 100 females:139 males	39	100 males:79 females or 100 females:126 males	71	100 males:76 females or 100 females:131 males
Females	23		31		54	
	55		70		125	

* Expressed as percentages, males composed 58-percent and females 42-percent of the known marked bear mortalities; males composed 56-percent and females 44-percent of established dead marked bears. Among all bear mortalities, the percentage is 57-percent males to 43-percent females.

Sex ratio of adult animals in the population as determined by classification counts was 46-percent males and 54-percent females.

10. Continued enumeration of the Yellowstone population and the accumulation of more detailed death statistics are essential tools for future management.



Plate 7
Observing color-marked grizzlies
in Yellowstone back country.



Plate 8

Grizzlies were captured in culvert traps. Some were shot, free-roaming, with propulsive syringe darts containing immobilizing drugs.

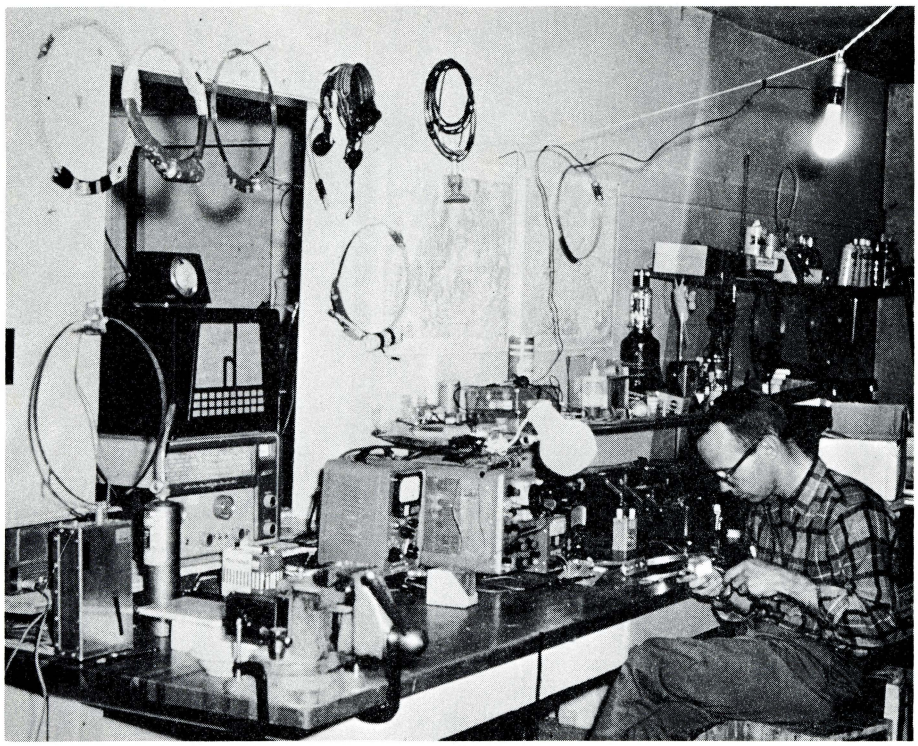


Plate 9

Yellowstone laboratory that served as a base for field operations; provided by Yellowstone Park Company.



Plate 10
Tatooing grizzly under forearm; this permanent mark supplemented numbered ear tags and color-coded markers.



Plate 11

Preparing to place a radio collar on an immobilized grizzly. Den sites, daily movements and size of home ranges were determined by radio-tracking.



Plate 12

Testing signal strength of transmitter before releasing instrumented grizzly.



Plate 13

A 900-pound male grizzly shot at night with propulsive syringe darts containing immobilizing drug. Animal has been fitted with a radio collar, and researchers are taking a blood sample.



Plate 14

Weighing a young adult male. Large males weighed between 800 and 1000 pounds.

Section IV

SUGGESTIONS FOR MANAGING THE GRIZZLY

The congressional act of 1916 creating the National Park Service specifies that one of the purposes of the national parks is to conserve the scenery, natural and historic features, and wildlife, and to provide ways for these to be enjoyed yet left unimpaired for future generations.

This congressional mandate became a paradox as our population and its demands upon national-park recreational resources increased. How to reconcile preservation and use has yet to be satisfactorily resolved. Although broad guidelines have been established for carrying out this complex task, factual data on which to base resource-management programs have been inadequate or nonexistent. Change from an early philosophy of "static" preservation to a modern concept of continuous scientific management of wildlife and habitat has gradually taken place within the Park Service, and was delineated in the report of the Advisory Board on Wildlife Management (Leopold et al., 1963). In Yellowstone National Park this transition was well under way in the late 1950's.

Now confronting the Park Service is the specialized task of acquiring specific information to implement the guidelines. Progress will largely depend upon encouraging a comprehensive research program to obtain vital biological and ecological information and upon getting the necessary financial support for both short- and long-range management activities. It is imperative that the National Park Service apply wildlife-management information just as rapidly as it is brought to light. The findings of research must serve as the basis of policy and as the tools of management.

Specific management programs must be developed or perfected for specific ecological situations within the total long-range planning. Although the black bear and the grizzly bear require distinct policy guidelines and management programs, the two species are nevertheless sufficiently

interrelated in Yellowstone and adjacent areas that a management plan for either species must consider both. To this extent only, the management of the black bear will be discussed in this section. Specific suggestions will be confined to the grizzly bear.

Management of the grizzly presents a unique problem. This carnivore is a large predator that under certain conditions does not hesitate to attack man or his livestock. As such it must be controlled. Yet it is an endangered species and, in addition, a trophy animal of high value. Thus the very nature of the grizzly has imposed restrictions on the extent to which it can be protected, but as a threatened species it must receive sufficient protection to insure its survival. This will require highly skillful management as well as the maintenance of wilderness habitat so essential to the bear's existence.

Yellowstone National Park serves as a refuge for a grizzly population of 170 to 200 animals, probably the largest in the contiguous United States. Some grizzlies live entirely within the park; others emigrate to areas outside its boundaries. Although protected within the park, grizzlies can be shot when they wander out. Thus management must be concerned first with how to protect the base population within the park and second with how and under what conditions to harvest the overflow.

No integrated plan exists for managing the grizzly throughout Yellowstone National Park and adjacent forest areas. The State of Montana has accorded the grizzly the status of a game animal to be legally hunted only during big-game seasons. Stock-killing bears can be killed as predators but the incident must be reported and the hide turned over to the state. In 1967 the Wyoming Game and Fish Commission banned hunting of the grizzly following its placement on the endangered species list. It had previously been listed as a game animal but was actually managed as a predator and could be killed at any time.



Plate 15

Hayden Valley, summer range of grizzly bears. Trout Creek refuse dump is located at upper right of photo. Three hundred and twenty four censuses were made at six grizzly bear concentration sites. These censuses represented 11,340 man hours of observation.



Plate 16

A young-adult male grizzly on an elk kill. After the first feeding, the carcass is generally covered. The large ungulates are important in the diet of Yellowstone grizzlies



Plate 17

A female grizzly may first breed at four years of age and continue producing cubs until she is 18 or 20



Plate 18

Grizzlies frequently stand when alerted or aroused.



Plate 19

Grizzlies feeding on a bison carcass. The number of grizzlies in six population units increased from 154 in 1959 to 202 in 1966 with an eight year average of 174 animals.



Plate 20

Most Yellowstone grizzlies visit a refuse dump at sometime during their lives.

Yellowstone National Park is not a self-regulatory ecological unit. Together with adjacent national-forest land, however, it does represent a near-complete unit. This vast, relatively unmodified land area lying in Wyoming, Idaho, and Montana should be cooperatively managed for the perpetuation of the grizzly. Although the grizzly can be managed and preserved strictly within the 3,412 square miles of the park, the margin of safety for the population and the latitude for population manipulation would be greatly enhanced in the larger area, which includes Yellowstone Park and contiguous portions of the Gallatin, Shoshone, Teton, and Targhee National Forests. A cooperative state and federal effort to manage the grizzly should be based on the two broad objectives noted previously:

1. Maintenance of the present population level within the park, with management practices designed to increase it in peripheral areas where there are no serious conflicts with other resource uses.
2. Harvesting of surplus animals in Wyoming and Montana under controlled hunts, subject to hunting regulations that recognize the grizzly as both an endangered species and a trophy animal.

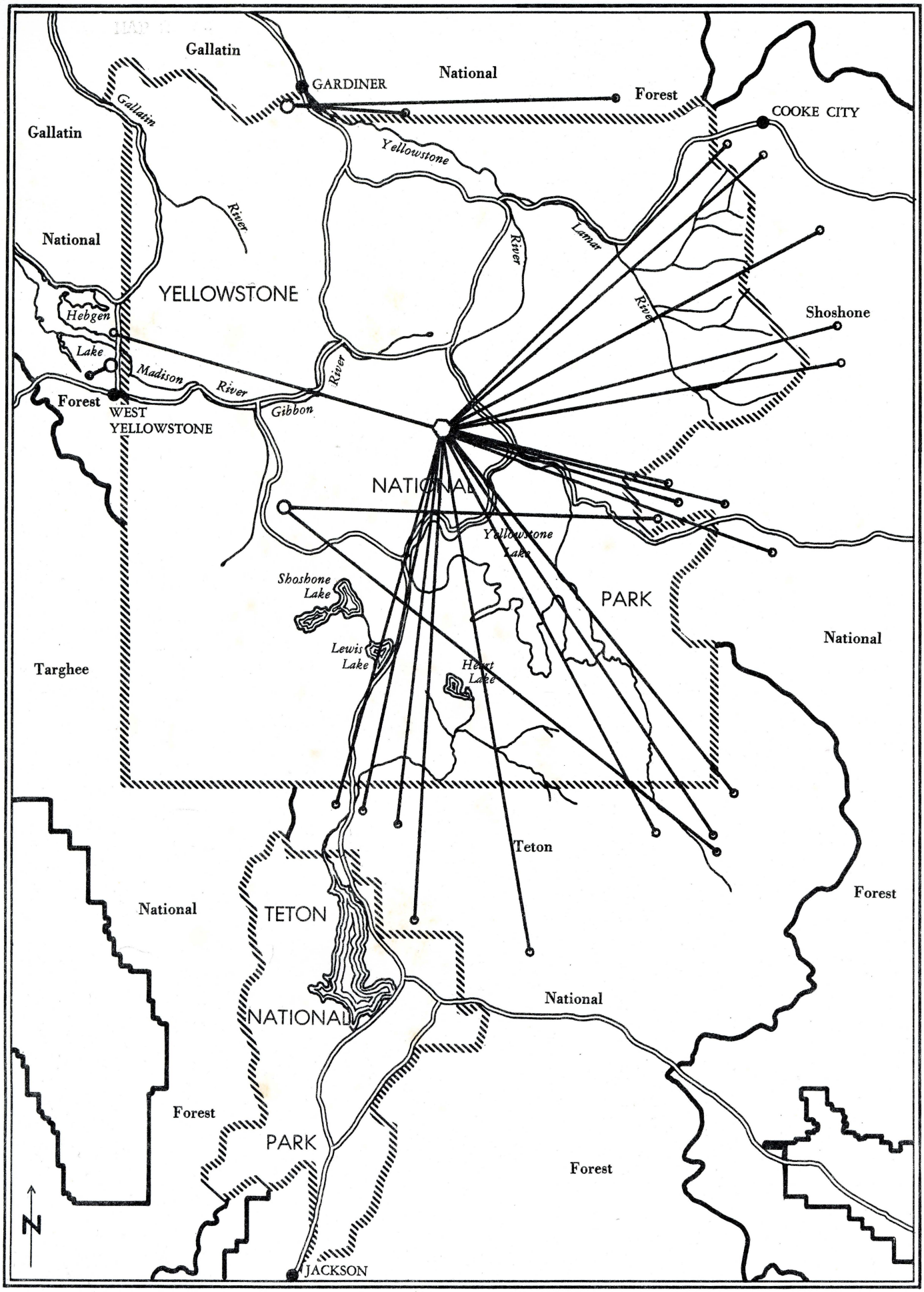
To realize these objectives, certain management steps may require state legislation. Some management procedures will pertain only to Yellowstone National Park and some to the four adjacent national forests, where management of habitat and game animals is respectively a responsibility of the U. S. Forest Service and the State Fish and Game Departments. Other procedures will involve the entire management area and every administrative organization concerned. All will require envisioning ecological and social conditions at least 50 years from now.

The area of about 5,400 square miles that includes Yellowstone Park and an adjacent 10-mile corridor of national-forest land supports

about one grizzly bear to every 27 to 32 square miles. Throughout most of the year (as discussed earlier) the animals are widely dispersed (Map 2), but during late spring and summer a high percentage are grouped at five concentration sites within the park (Map 3). Individual bears tend to congregate at the same sites year after year, with relatively little exchange between these sites. The dispersal pattern in autumn also shows that individuals habitually return to the same wintering areas or inhabit home ranges from which they seldom if ever depart. Earlier we have emphasized that by far the largest concentration of grizzlies occurs at Trout Creek in Hayden Valley, near the geographic center of the park. About two thirds of the Yellowstone population live in this high valley during the summer months, attracted by a refuse dump and an abundance of natural foods. The other third is distributed as indicated in Table 7 and Map 3, dispersing in Fall to all parts of the park and beyond (Map 2).

Yellowstone Park may now be supporting a near-stabilized population of grizzlies, but on the basis of biological information obtained in our investigation, we believe that a higher population could be maintained, and probably should be in order to afford maximum population security. To increase the size of the population will require a lowering of the mortality rate and an increase in grizzly habitat. This can be accomplished by:

1. Integrating the management of grizzlies with the management of all park resources.
2. Definitive and carefully regulated zoning within the park for management of animal populations.
3. More selective control over grizzlies destroyed within the park, and greater efforts to substitute alternatives to killing.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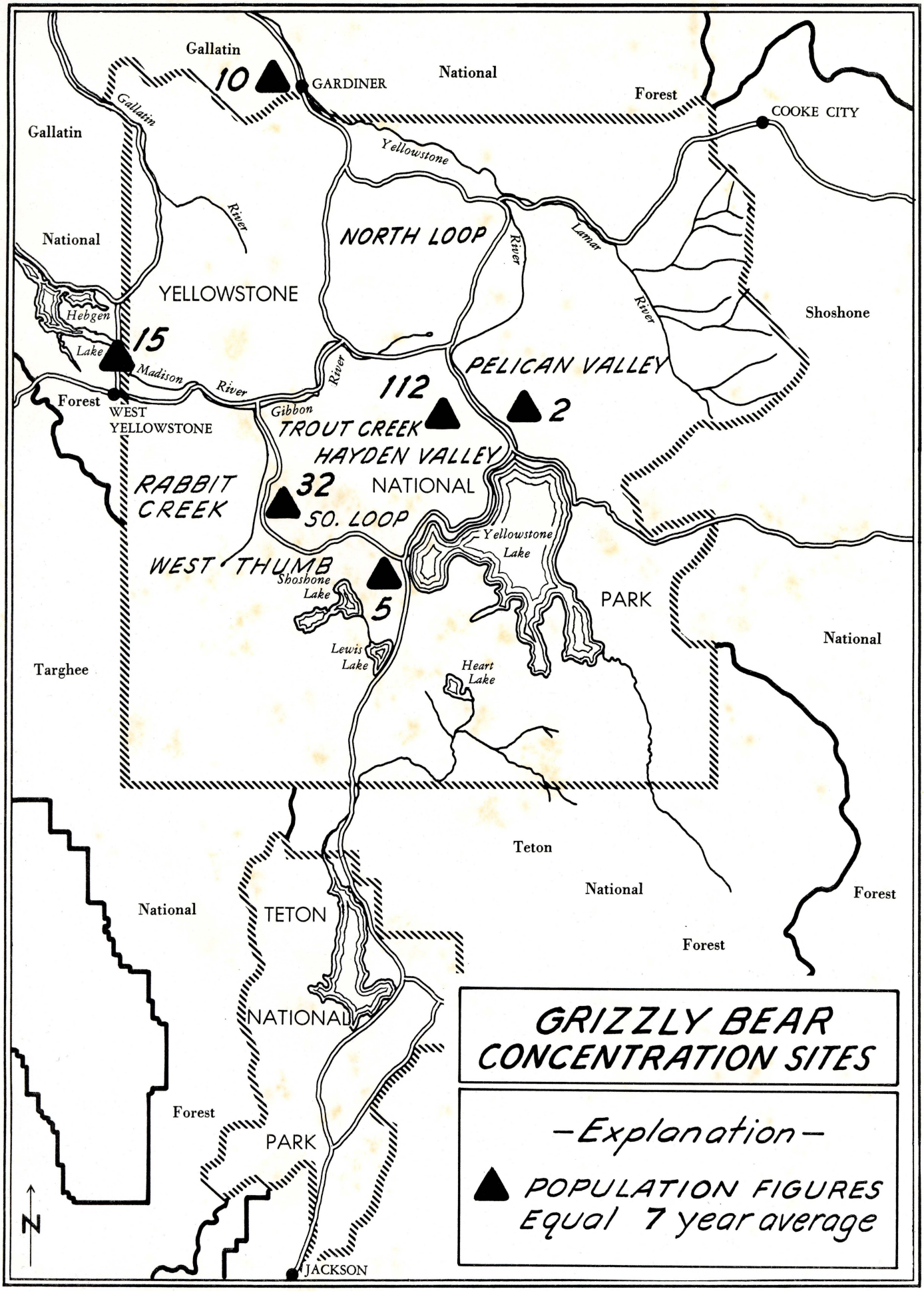
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Gibbon
TROUT CREEK
HAYDEN VALLEY
RABBIT
CREEK
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Targhee
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GRIZZLY BEAR
CONCENTRATION SITES
-Explanation-
POPULATION FIGURES
Equal 7 year average
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SCALE 5 4 3 2 1 0 5 10 MILES

4. Zoning to create a buffer zone, or protective corridor, around the park.
5. Improvement of hunting regulations in areas adjoining the park.
6. Improvement of control measures outside the park.

Integrated Management

Management of the grizzly must be part of a comprehensive program of park management. Policies for management of the various park resources cannot be effective if they are separately conceived and implemented, because any one species or resource interacts directly with others. For example, management of the grizzly must be viewed in relation to management of elk and bison, since reduction of these herbivores to protect the range affects the food habits and behavior of the grizzly. Similarly, increasing the grizzly population or altering its distribution could change the numbers and distribution of the black bear, which in turn could influence visitor-bear incidents. The location of additional facilities such as waste-disposal sites, campgrounds, and service roads will also alter the wildlife patterns of an area, as will forest-management practices such as pesticide spraying, Ribes control, and fire suppression.

In short, certain policies governing various park resources have been applied or are being considered that will affect the grizzly. This fact should be recognized and carefully considered in any future planning.

Zoning Within the Park

Zoning within the park has been an essential factor to date in preserving the grizzly population by reducing the bears' encounters with man. However, as described earlier, zoning has existed more by accident than by planning. Clearly defined and well-regulated zoning throughout

the park is a prerequisite for proper wildlife management. The following pages contain recommendations for zoning on various scales, from large to small in area, from broad to specific in purpose.

Detailed zoning plans for Yellowstone National Park should, of course, be developed simultaneously with review and classification of wilderness land within the park, which will constitute the broadest categorization of park areas. Under the National Wilderness Preservation Act of September 3, 1964, the Secretary of the Interior was directed to review every roadless area of 5,000 contiguous acres or more in the national parks, monuments, and other units of the national park system and to report recommendations of this review to the President within 10 years after the effective date of the act. The act defines wilerness as

> "An area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions...."

A large proportion of the 3,412 square miles of Yellowstone National Park meets wilderness standards and will no doubt be so classified for purposes of the act.

Wildlife-management areas: The very nature of wilderness and of the related administrative restrictions impose handicaps in managing the grizzly and other big-game species, whether these be threatened with extinction or are overabundant. The present intensive management program for elk and bison following years of inadequate management, with accompanying overpopulation and severe habitat damage, points up the need for a continuing program of animal control. Managing populations of elk, bison, black bear, and grizzly bear as well as other wildlife species within the park is a tremendous annual task, and one that cannot be accomplished in wilderness country under restrictive wilderness regulations. Lowering wilderness standards by permitting certain nonconforming administrative

practices is not desirable, however, because these can be abused or expanded. Therefore, consideration should be given to establishing wildlife-management areas or districts distinct from areas classified as wilderness. Such wildlife areas, essential for the management of certain species, could be designated and administered as semi-wilderness. The semi-wilderness areas would differ from wilderness in retention of existing administrative structures and access roads. Also, limited use of vehicles and aircraft would be permitted for animal control, enforcement of visitor zoning, and other specific administrative requirements.

The semi-wilderness designation should not imply that such areas would be more subject to future roading or development of physical facilities than would wilderness. On the contrary, semi-wilderness areas, because of their animal concentrations, should be carefully excluded from future development, with the exception of research installations, if necessary. Restriction of roading and development is particularly important in the South Loop of Yellowstone, where grizzlies summer, and in the Lamar Valley, where elk winter.

The significant distinction between wilderness and semi-wilderness designations should therefore be one of administrative practice: wilderness describes natural areas where man is a visitor, making no purposeful changes and exerting little or no purposeful control; semi-wilderness, as used here, describes natural areas where man can manipulate and control animal populations with optimum efficiency.

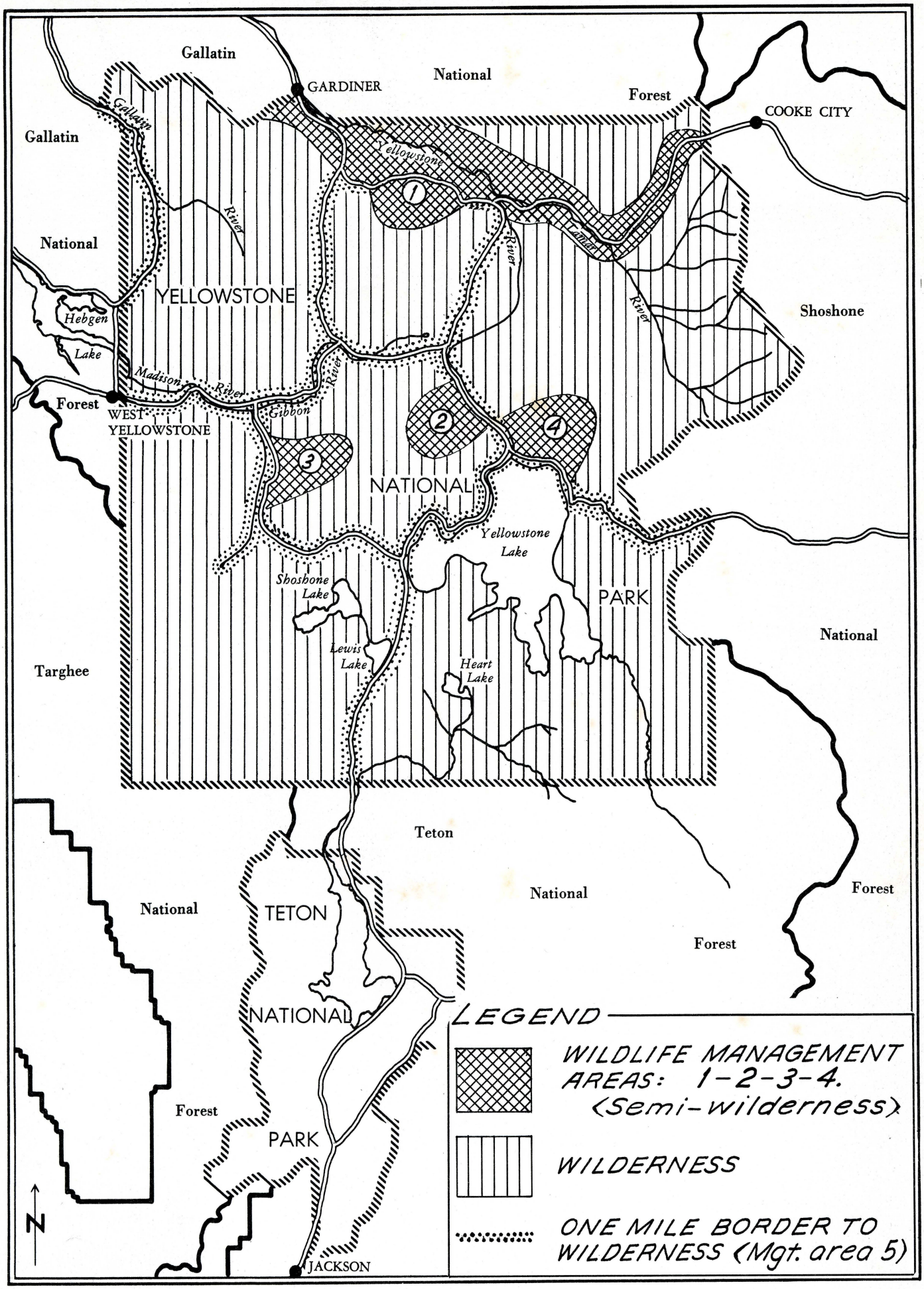
Map 4 shows areas within the park that we recommend for specific designation. Four of these, as indicated, should be allocated for intensive wildlife management. The map also shows areas that meet the wilderness criteria as defined by congress, as well as a mile-wide wilderness boundary strip that parallels the major roads and borders Lewis Lake and the nonwilderness portions of Yellowstone Lake. Wildlife management on

the four proposed districts (Area 1 for management of elk, Areas 2 and 4 for management of grizzly and bison, and Area 3 for management of bison) involve or will involve intensive use of aircraft and over-snow vehicles.

With regard to helicopters, over-snow vehicles, etc., we should emphasize here that the administrative use of such equipment, as opposed to horses, cars, and trucks, reduces environmental impact and ecological distruptions, and for this reason alone should be encouraged. Big-game management in Yellowstone has become a reality because of these mechanical aids, with savings in money and manpower. It is unrealistic to believe that they can be ruled out or that the use of even more proficient machines can long be delayed. Man on foot or on horseback is economically inefficient and physically inadequate for the task of managing wildlife over extensive wilderness areas where hunting is prohibited. Partly because the job appeared hopeless, a park philosophy of no management persisted long after it was outdated. The result of that philosophy is habitat damage that will take generations to rectify.

The one-mile zone on each side of the major roads and campgrounds (Map 4) serves as a buffer zone to all land designated as wilderness. This zone constitutes a fifth wildlife-management area. Within it, black bear and nonmigratory elk can be managed. The great majority of visitors confine their activities to this zone and will probably continue to do so. We believe that a buffer area of this sort is essential for the management of the grizzly as well as for control of ecological situations that otherwise get out of hand. We suggest that all the wildlife-managment areas be officially recognized and that criteria be developed for managing the wildlife within them.

Off-limit area: Congregating of grizzly bears within the geographic heart of the park should be encouraged by specific management practices. In working out the details of these practices, park administrators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Lewis Lake
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WILDLIFE MANAGEMENT AREAS: 1-2-3-4. (Semi-wilderness)
WILDERNESS
ONE MILE BORDER TO WILDERNESS (Mgt. area 5)
SCALE 5 4 3 2 1 0 5 10 MILES

should consider the fact that the grizzly population is now concentrated within the South Loop during the summer (Map 3) and that the bears disperse over the back-country and beyond the park borders for eight to nine months of the year (Map 2). The concentration of grizzlies in the South Loop and other relatively restricted areas during the heights of the tourist season has created a highly favorable situation for zoning. Because much of the land lying within the South Loop is the heart of the grizzly's summer range, portions or all of it should be off-limits to visitors except along the major roads or by special permission.

Elimination of refuse dumps: The unsightly and "unnatural" refuse dumps that have existed for so long in Yellowstone are not in keeping with national-park scenic standards or philosophy. Although the dumps where grizzlies feed are not often visited by the public, they are frequently viewed by dignitaries and scholars of our own and foreign countries who wish to obtain a first look at a grizzly bear. The experience of viewing a grizzly under such conditions, though interesting and even thrilling, does not enhance the image of either the Park Service or the grizzly.

However, concentration of grizzlies during the summer at refuse dumps has both advantages and disadvantages in the management of the species. Forty-three percent of all grizzly deaths occur when they move out of the park sanctuary (Map 2) and are shot by hunters. Since the refuse dumps within the park attract and hold grizzlies for extended periods of time, they reduce outward movement in summer and fall and by so doing lower the mortality.

Dumps outside the park, such as those at Gardiner and West Yellowstone (Map 3) have the opposite effect. Grizzlies move out of the park to feed at these areas, and although the bears are closely watched by Montana game wardens, illegal shootings do occur.

For years the Park Service has considered replacing the earth-filled refuse dumps with incinerators. To do so will, of course, eliminate the garbage as a food source, and the initial effect of this on the grizzlies will greatly complicate management. Presence of food at the dumps during June, July, and August directly influences grizzly distribution, as well as patterns of daily movement, location of bedding sites, social behavior, and the size of the spring and summer home areas.

With grizzlies concentrated at the Trout Creek and Rabbit Creek sites during summer, it has been feasible to place these areas off limits to tourists and rangers alike, thus greatly reducing the possibility of personal injuries. Zoning of this sort will become more difficult and less effective when the open-pit dumps are replaced by incinerators and the grizzlies, with less food to hold them, disperse more widely during the summer months.

The older bears will require some time to adjust to a summer diet of natural food only. Natural food is more difficult to obtain than garbage, and the bears show a preference for the latter. Also, as management reduces the size of the elk and bison populations, carrion and live meat will become less available. A high proportion of all big-game animals dying in the park are consumed by grizzlies. The large herbivores are an important, perhaps an essential, part of the grizzlies' diet, especially in late fall and early spring. Although food obtained at the dumps does not appear to be necessary to the grizzlies' welfare or to maintaining the present population level, young bears learn the habit of feeding at the dumps from their mothers, and the habit becomes ingrained. The younger bears in turn pass this learned behavior on to their offspring. It will require a number of years and several generations to break this well-established habit.

Figure 7 (Section III) illustrates the gradual increment of bears at Trout Creek dump during the summer and the similarity of this pattern from year to year. An eight-year record of grizzly concentrations at this dump show that some individuals are almost nightly visitors. Others come less frequently, and some very rarely. Almost all park grizzlies visit one or more of the six major refuse-disposal areas at some time within a year. Some of the older females have established home ranges that include a dump, and have maintained these ranges for many years. Such ranges are small, eight to 15 square miles, and their size and stability seems to be related to the ease with which the females and their offspring can satisfy their nutritional requirements.

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 still be available but where adequate protection will not. The net result could be tragic personal injury, costly damages, and a drastic reduction in number of grizzlies.

Therefore, in replacing the refuse pits with incinerators we recommend that:

1. A cautious phasing-out program be enacted, with an

incinerator installed at Trout Creek, where an experimental situation can prevail.

2. For several years a portion (perhaps half) of the Trout Creek refuse be incinerated and the remainder dumped in a pit where it would be available to the grizzlies. Thereafter, a graduated program of incineration would be carried out. If the elimination of the Trout Creek refuse dump does not adversely affect the grizzly population, then similar graduated programs of incineration should be adopted for all refuse disposal within the park.

3. Research be continued during the phasing-out period in order to determine precise effects on bear numbers, movements, behavior, productivity, and mortality.

4. All grizzly-man contacts and property damage incidents throughout the period be recorded and compared with earlier records.

As we have already stressed, it is important in the future management of the grizzly bear in Yellowstone to keep the base population concentrated within the park. Since removal of garbage as a food source will disperse the bears, this must be countered by other means. One practical solution may be the utilization of surplus elk and bison as supplementary food for the grizzlies until they have adjusted to the change. Some of the elk and bison now annually trapped for transplanting could be butchered, frozen, and stored. These carcasses, properly distributed during the spring and summer, would hold the grizzlies in the Hayden Valley Area and prevent wide dispersal during the phasing-out period.

Another approach would be to have surplus elk and bison periodically shot by park personnel from early spring through summer, a few at a

time. These carcasses would be left as food for grizzlies. Public sentiment would probably be in opposition to such measures at first, but if the park is to fulfill its mandate, the public must be educated to the need for integrating a program of reducing overabundant species with a program of preserving one that is threatened. Surplus elk would provide a more natural food for grizzlies than garbage, and the practice of shooting elk for this purpose would be no more aritificial than present methods used to reduce them. The grizzly feeds substantially on elk and buffalo carcasses during the critical period after leaving the winter dens. As mentioned before, this food source appears to be important in maintaining grizzly population levels.

Some elk carcasses could be placed periodically at strategic spots in Hayden Valley east of the Yellowstone River. Grizzlies attracted to the food could be viewed by the public at a safe distance, and with the bears in a natural environment. However, providing a wildlife display of grizzly bears for the public should be secondary to the objective of holding the base population of grizzlies within the confines of the park.

Any program for public viewing of grizzlies can easily create problems, as it has in the past, and thus should be initiated with caution. We do not endorse a public viewing program of the grizzly, believing that national-park policy should be to minimize grizzly-visitor contacts, not encourage them. We do point out, however, that if surplus elk and bison were selectively distributed on the summer range during the phasing out of the dumps, the opportunity for the public to see grizzlies would be enhanced.

Retention of refuse dumps: Grizzly bears have been feeding at refuse dumps in Yellowstone Park since the late 1800s. We have been unable to detect any adverse biological effect on the bears from this habit,

unless it be a higher rate of infection from the round worm. Thus the wisdome of removing the open-pit dumps without substituting another method of attracting and holding grizzlies within the park must certainly be questioned.

If a program of providing carcasses of surplus elk and bison cannot be worked out or proves to be ineffective, we suggest that an open-pit dump be maintained at Trout Creek and that other dumps be relocated to places where it would be most desirable to maintain grizzly concentrations. In order to improve the aesthetics of the situation, we strongly urge that food be sorted from the other refuse. The edible garbage could be dumped for the bears and the trash incinerated. Such a plan would eliminate the present eyesores and yet provide the grizzlies with enough food to hold them within the park, thereby assuring that present numbers will be maintained.

We recognize the artificiality of this as a management technique. However, any purposeful management of wildlife populations or their habitats can be considered "unnatural". Moreover, within Yellowstone some of the natural population regulating processes have been so altered since the establishement of the park that these are not now effective. Since there is no possibility of these being wholly restored, and since management must do the job, artificiality becomes inevitable. Maintenance or re-establishment of the natural situation although a commendable ideal to work towards in national parks, and we fully endorse this concept, does nevertheless, have limitations that must be recognized.

Location and operation of refuse dumps has been an administrative function. We suggest that this function should be part of the wildlife-management program, with consideration given to placement of pits, to the type and amount of refuse left for the bears, and to sanitary inspection, with requirements of the grizzly paramount. Several pits at

such widely dispersed points as Trout Creek, Pelican Valley, and Upper Nez Perce Valley -- far from roads, visitor centers, or campgrounds -- might effectively hold grizzlies within the park and at the same time distribute them so as to avoid visitor-bear incidents.

Any program to alter the present waste-disposal situation, whether by eliminating or retaining refuse dumps, will be costly. Funds for this purpose should be appropriated as a part of the wildlife-management budget.

Selective Control

Because encounters with grizzlies are dangerous to visitors, it is necessary to capture and remove nuisance bears. Twenty-eight percent of all grizzly deaths result from control efforts in the park. Therefore, refinement of certain control procedures would reduce the unnecessary death rate from this cause without increasing the probability of bear incidents.

Because food demands are high prior to and after "hibernation," grizzlies of both sexes and all ages are on the move in early spring and late fall. They can become particularly troublesome as they pass through and forage in campgrounds. Fortunately, the immediate pre- and post-denning periods are brief, and the bears captured at these times and transported to remote parts of the park normally will not return to give further trouble.

The frequency of campground use by grizzlies was determined in our study by a program of capture, marking, release and by radiotracking. Among 212 individuals captured throughout the park from 1959 through 1965, 48 (22.6 percent) were taken in or near campgrounds. Grizzlies that visited a campground once tended to repeat. Forty-four percent of those captured at a campground the first time were later recaptured at a campground, and 38 percent of these were killed because they were considered a danger to campers. Forty-three percent of the grizzlies captured in campgrounds and then released are still alive and do not constitute a

control problem. This indicates, we believe, that many of the grizzlies visiting campgrounds do not become habitual offenders and that a lenient policy of control is justified.

On rare occasions, a female with small cubs becomes a "nuisance" bear. Since relatively few females constitute the reproductive base of the Yellowstone population, such animals should not be killed in control measures unless no alternative exists. Capturing and releasing at a remote site will frequently solve the problem, but if it does not, the offspring should be captured and sent to a zoo and the adult freed. Relieved of her filial responsibility, the female may be agitated for a day or two, but normally will either travel to one of the open-pit dumps or retreat to the back country. The current practice of shipping both females and cubs to zoos solves the immediate problem but reduces the reproductive capacity of the population.

Weaned yearlings, two-year-olds, and other subadult bears are more prone to visit campgrounds than adults. Since such animals are not part of the productive segment, a more liberal control effort can be exercised. Some of these young grizzlies become frequent campground visitors for a short time and then move on; therefore a rigidly enforced policy requiring three captures before instigating control measures would tend to favor the infrequent offender. The habitual offender and those that have caused personal injury must, of course, be eliminated. Except in emergency situations, the decision to kill a grizzly should be made by the superintendent and his advisory staff, not deligated to district or subdistrict rangers.

Personnel and administrative problems: Control measures for both black and grizzly bears as well as for other wildlife species are carried out by the ranger staff under the general supervision of the

management biologist and the chief ranger. Authorization to destroy a bear rests with the superintendent but in practice is delegated to the subdistrict ranger. The bear-management programs in Yellowstone Park have suffered generally from divided authority, inadequate financing, and lack of information and supervision. Management of bears has been considered a minor ranger activity, with few planned objectives and with no specific operating budget.

Some rangers engaged in bear control do not understand population biology and have retained an outmoded philosophy of complete protection. Others consider bear control as extra duty, and reason that the best bear is a dead bear; in such cases, bear-ranger conflict as well as bear-visitor conflict is considered sufficient cause for control action, sometimes to the point of killing the offender without consideration of alternatives. The result of these attitudes is a laxity of control in some districts and overcontrol in others. The majority of rangers, however, understand the problem and require only more supervision and adequate financing to do a more efficient job.

Cooperative effort between districts to capture bears or to release one- and two-time offenders in remote areas, could be greatly improved. Although release of black bears far from the place of capture is not generally effective, this procedure does frequently disrupt the behavior pattern of a nuisance grizzly. District rangers are reluctant, however, to release grizzlies in their districts, fearing that this may only transfer the problem from another district to their own. A policy of distant release should be mandatory, with a pooling of resources and manpower to cope with a grizzly should it become troublesome in the release area.

The administrative aspects of handling nuisance bears in Yellowstone could be improved by:

1. Encouraging greater interdistrict cooperation.
2. Appointing permanent rangers to bear-management duties. These rangers should be given a training course in bear-handling techniques and basic concepts of population ecology.
3. Increasing the bear-capture, bear-handling capability with more equipment and manpower.
4. Rigidly enforcing all regulations pertaining to bear-visitor interactions.
5. Providing an annual operating budget specifically for the management of black and grizzly bears. The budget should be realistic in terms of equipment and manpower requirements.
6. Developing a more comprehensive program of visitor education, through the interpretive service, with regard to bear-management problems.
7. Encouraging and fostering among park personnel a philosophy that recognizes the grizzly as a rare and endangered species that requires maximum protection and should only be controlled under special conditions.

Zoning Outside the Park

Yellowstone National Park is bordered on all sides by national forests; much of this land is or will be in wilderness status. A major difference between national-forest wilderness and national-park wilderness is that hunting is permitted in the former. We mentioned earlier that 43 percent of all grizzly mortalities occur on the forestlands adjacent to the park. Zoning of all or part of this area could provide protection ranging from complete closure to enforcement of restrictive hunting regulations. The purpose of such zoning should be to establish a larger sanctuary for a larger base population of grizzlies and to provide more

huntable animals - the overflow of an enlarged population.

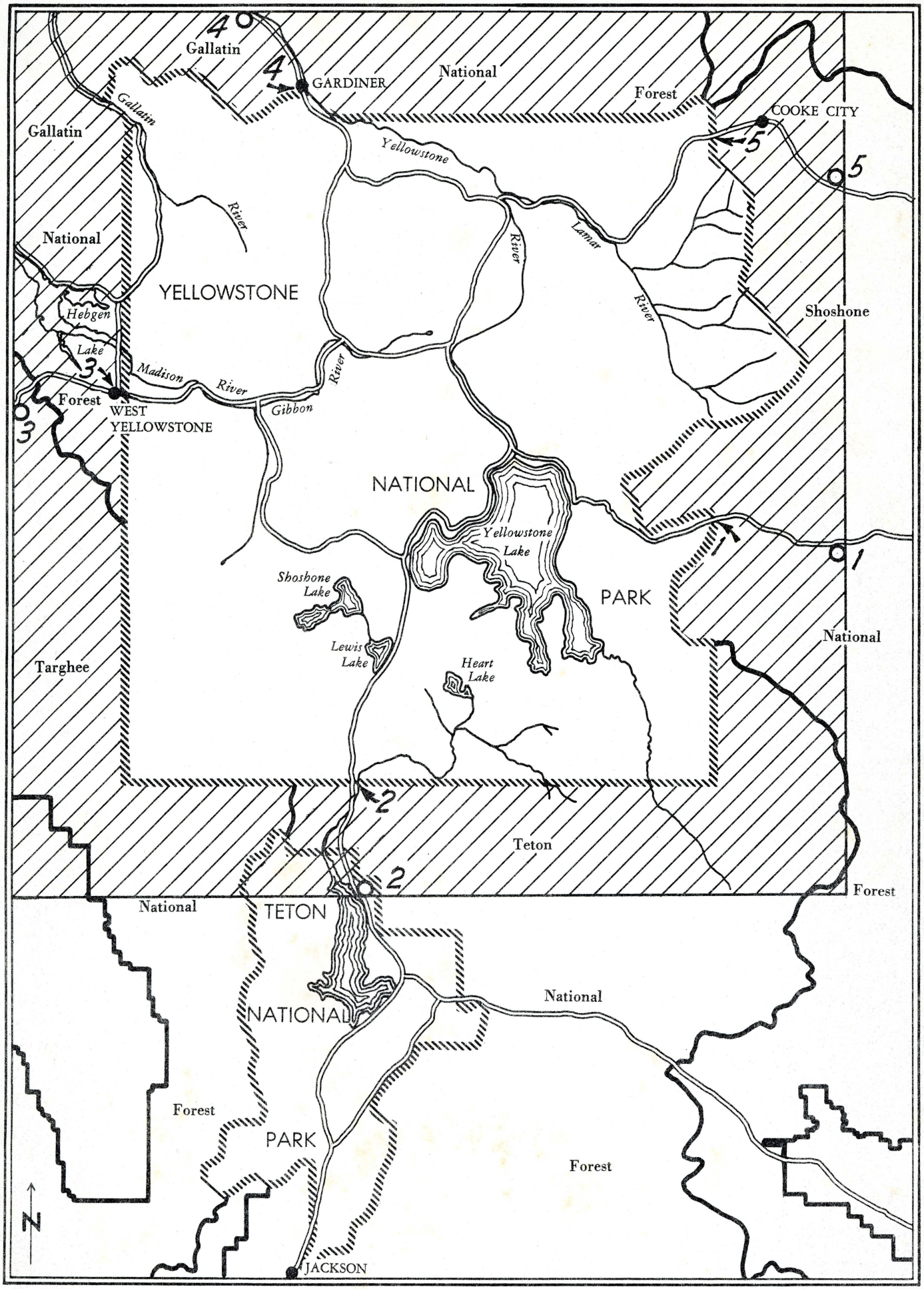
To accomplish these objectives it is suggested that national forestlands surrounding the park be managed for protection of the grizzly. We believe that a 10-mile-wide corridor, consisting of approximately 2,000 square miles (Map 5), would constitute a minimum protective zone. The corridor should not be considered a permanent refuge but an area closed to the hunting of grizzly bears during the transition period of "phasing out" Park Service refuse dumps. Provision should be made to open or close this zone to grizzly-bear hunting whenever population data indicate the need.

During open seasons, hunting regulations could be enforced by establishing checking stations on five major highways 10 miles beyond the five entrances to Yellowstone Park (Map 5) and by mandatory reporting of kills of all outfitters and guides with hunting camps in and adjacent to the zone.

The grizzly bear should not be given complete protection outside the park except in this zone and under the conditions outlined above. A policy of complete protection in a broader area would invite countermeasures by the livestock industry and by private landowners, and would result in greater danger to the grizzly than at present.

A protective zone bordering Yellowstone will encompass deeded land in the vicinity of Gardiner, Cooke City, and West Yellowstone. If it becomes necessary in these areas to capture a marauding bear or one that has caused personal injury, it should be carried out by federal or state authorities on request of the landowner.

Our data indicate that many of the animals concentrated within the park in summer will constitute a steady flow into and out of the unprotected areas during spring and autumn. They can and should be hunted in these unprotected areas. A moratorium on the grizzly is not supported


Gallatin
GARDINER
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Forest
COOKE CITY
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Yellowstone
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YELLOWSTONE
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WEST
YELLOWSTONE
Gibbon
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Lamar
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Shoshone
NATIONAL
Yellowstone
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SCALE 5 4 3 2 1 0 5 10
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PARK ENTRANCES AND ENFORCEMENT SITES ARE NUMBERED

by the facts of our study: the grizzly must be hunted and harvested outside of the sanctuaries or, like other species, it will in time overpopulate its habitat, move into intensive land-use areas, and recreate the very problems that brought about its decline.

Hunting Regulations

Enlightened hunting regulations should go hand in hand with the foregoing recommendations for managing the grizzly.

We offer the following suggestions:

1. That the grizzly bear be declared a trophy animal in the states of Wyoming, Montana, and Idaho and hunted on a limited-permit basis during a specially designated season. This hunting season should coincide with the regular big-game seasons, and a biological questionnaire should accompany each permit.

2. That hunting be limited to mature males and to females without offspring. No member of a recognizable family unit should be a legal trophy.

3. That no grizzly be killed without a permit except in defense of life or property. That animals taken in this manner, as well as those killed illegally, be turned over to state fish and game authorities, who should tag hides and skulls and record biological data.

4. That because an important segment of the total grizzly population resides in and adjacent to Yellowstone National Park, and because the habitat of this population in the West is largely confined to Wyoming, Montana, and Idaho, similar hunting and protective regulations should be enacted for these three states.

Furthermore, management regulations and the annual harvest for this tristate area should be jointly determined by agreement of state and federal authorities through a cooperative tristate council, which would meet annually.

Control of Grizzlies Outside the Park

Grizzlies that move outside the border of Yellowstone occasionally prey on livestock. Approximately half a dozen situations develop each year. Personnel of the Division of Wildlife Services of the Bureau of Sport Fisheries and Wildlife normally trap the offenders and kill them. The development of immobilizing, handling, and transport techniques now makes it feasible to remove rather than kill offending grizzlies. Therefore, to further protect this endangered species we recommend that:

1. Marauding grizzlies be livetrapped by state and federal authorities and immobilized for distant release.
2. By agreement between state and federal agencies they be marked and then released at Trout Creek near the geographic center of Yellowstone.
3. Two-time offenders be killed.
4. State and federal personnel charged with the task of capturing predators be trained in the use of immobilizing techniques.
5. A close working relationship be maintained between park rangers, state law enforcement officers and government trappers in trapping and transplanting activities.
6. The livestock industry be informed of the objectives and limitations of a grizzly-bear capture-release program.

Suggestions for Future Management of the Black Bear

In Yellowstone National Park, management of black bears over the past 35 years has primarily consisted of direct control of offending animals. In spite of continuous and at times severe control measures, the problem of reducing black-bear incidents has not been solved. The number of incidents can probably be kept within tolerable limits by present

methods; however, the mutual affinity of black bears and tourists on the roads and in the campgrounds of the park insures that wherever there are black bears and visitors and food, bear and man are certain to meet. Management should strive to reduce bear-man contacts without drastically reducing the black-bear population or the opportunity of visitors to view the animals. The black bear is the most popular wildlife display in Yellowstone. The expectation of seeing one is a major tourist attraction.

Present black-bear management can be improved by:

1. A control program designed to stabilize the annual kill.
2. A system of more effectively zoning bears and visitors.
3. Solution of the refuse-disposal problem in campgrounds.
4. Visitor education regarding the bear problem, and rigid enforcement of bear-feeding regulations.

All these methods are currently in effect, but require refinement and must be practiced with knowledge of black-bear numbers, distribution, and age structure. A long-range population study to furnish such information is needed. ~~The objectives of black-bear numbers, distribution, and age structure. A long-range population study to furnish such information is needed.~~ The objectives of black-bear management should be a more precise operation based on bear biology as well as bear incidents.

A program designed to maintain the annual control-kill of black bears at a figure closely approaching the 35-year average of 28 would prevent the drastic fluctuation in numbers of bears that occurs under the present system of a highly erratic kill. Such management would provide more consistent visitor viewing without increasing visitor hazards.

Summary of Recommendations for Management of the Grizzly Bear

Grizzly-bear management has been accomplished almost entirely by zoning. Some of this has been a conscious effort by park administrators and some has resulted inadvertently from the visitor-use pattern that has evolved. Because of its endangered status and its aggressive behavior when

disturbed, the grizzly presents a basically different management problem than does the black bear.

Present grizzly-bear management can be improved by:

1. More effective zoning within the park to maintain grizzly habitat, encourage grizzlies to remain in the center of the park, and reduce or prevent visitor-grizzly incidents. This program would include phasing out of open-pit refuse dumps or more refined methods of operating the dumps.
2. More selective control of grizzlies within the park.
3. Creation of a protective corridor around the park.
4. Revision of hunting regulations in areas adjoining the park.
5. Translocating maurading grizzlies captured outside the park.
6. Continued research and evaluation of management.

In the case of the grizzly, a basic problem is how to provide maximum protection and habitat for a threatened species yet maintain it as a game animal outside its sanctuaries. This problem requires inovations in certain management practices both within and outside the park and cooperative planning and action by state and federal authorities.

Grizzly-man contacts have not been numerous in Yellowstone Park over the years. However, when contact does occur it can be serious, and for this reason park policy should be direct toward minimizing such incidents. Management practices should be tailored to augment the grizzly population and to maintain it at an optimum level. To accomplish this goal, the distribution and number of visitors should be manipulated to minimize contact with grizzlies wherever possible, rather than the number of grizzlies reduced.

Whereas the black bear should be managed to provide maximum

visitor viewing with a minimum of incidents, the grizzly should be managed to provide maximum protection for the animal with a minimum of viewing. The grizzly should not be exploited as a tourist attraction.

Implementation of Findings and Continued Research

Management of bears in Yellowstone will require broad ecological understanding and a continuous flow of specific knowledge regarding changes in habitat, population size and structure, behavior patterns, movement, and effect of management practices themselves. Such knowledge comes from research conducted in the field year in and year out. It is essential that the National Park Service recognize the importance of research, provide for it, and encourage it as an integral part of park management. Whether supported by the Park Service or by independent sources, research activity should not be terminated when only partial knowledge is obtained, nor should it be turned on and off in response to administrative pressures. The conduct of research cannot be guided by apprehension resulting from adverse public reaction, which in turn is frequently the result of inadequate interpretive media. The solution to public misunderstanding of resource-management issues is more and better public education, not curtailment of the fact-finding process.

We can offer no more concise statement on the problems of research and management than that of the Advisory Committee to the National Park Service on Research. This committee, in its report to the Park Service (1963) stated:

> "An examination of natural history research in the National Park Service shows that it has been only incipient, consisting of many reports, numerous recommendations, vacillations of policy, and little action.
>
> "Research by the National Park Service has lacked continuity, coordination, and depth. It has been marked by expediency rather than by long-term considerations. It has in general lacked direction, has been fragmented between divisions

> and branches, has been applied piecemeal, has suffered because of a failure to recognize the distinction between research and administrative decision-making, and has failed to insure the implementation of the results of research in operational management."

We recognize that the situation described above is being corrected. As part of this process, we urge that the findings of this long-term research study on the grizzly bear, a threatened species, be incorporated into a highly motivated action program. To manage both the black and the grizzly within Yellowstone National Park will require a realistic wildlife-management budget, specialized personnel, and cooperative effort by administrators, management biologists, and researchers.

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