YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

ANNUAL REPORT OF THE
INTERAGENCY STUDY TEAM
1988

National Park Service
U.S. Forest Service
Montana Fish, Wildlife and Parks Department
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Idaho Fish and Game Department
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INTRODUCTION

The Interagency Grizzly Bear Study Team (IGBST) was initiated in 1973 and is a cooperative effort of the National Park Service, Forest Service, and since 1974 the States of Idaho, Montana, and Wyoming. The IGBST conducts research that provides information needed by various agencies for immediate and long-term management of grizzly bears (*Ursus arctos horribilis*) inhabiting the Yellowstone area. With increasing demands on most resources in the area, current quantitative data on grizzly bears are required for formulation of management decisions that will insure survival of the population.

Objectives of the study are to determine the status and trend of the grizzly bear population, the use of habitats and food items by the bears, and the effects of land management practices on the bear population. Earlier research on grizzlies within Yellowstone National Park provided data for the period 1959-67 (Craighead et al. 1974). However, changes in management operations by the National Park Service since 1967 - mainly the closing of open pit garbage dumps – have markedly changed some food habits (Knight et al. 1984), population parameters (Knight and Eberhardt 1985), and growth patterns (Blanchard 1987). Acting upon the recommendation of the Population Review Task Force, the Interagency Grizzly Bear Committee directed the IGBST to instrument and monitor 10 adult female grizzly bears for a 3-year period beginning in 1986. The females would be distributed throughout the various habitat conditions within the Yellowstone area.

Distribution of grizzly bears within the study area (Basile 1982, Blanchard in prep.), movement patterns (Knight et al. 1984, Blanchard and Knight in prep.), food habits (Mattson et al. in prep.), and habitat use (Knight et al. 1984) have been largely determined and are now being studied on a monitoring and updating level. Efforts are being concentrated on gathering population parameter data, determining behavior patterns, and assessing the effects of land use practices.

Movement data conclusively indicates that the existence of semi- autonomous population segments is unlikely and that the determination of population size will be difficult due to the average home range sizes of individual bears. Population trend indices appear to be more meaningful and measurable than a number estimate (Eberhardt et al. 1986). Research is ongoing in the attempt to document a sensitive and reliable trend index.

Data analyses and summaries presented in this report supersede all previously published data. Study methods are reported by Blanchard (1985).

RESULTS AND DISCUSSION

Monitoring/Population Trend

Marked Animals

Thirty-six individual grizzly bears were captured and marked during 1988 (Table 1), including 19 females (13 adult) and 17 males (14 adult). Six of these bears were recaptured a total of 8 times; 22 had not been marked previously. Twenty-three captures were a result of research efforts and all but 1 of those bears were released on-site, while 21 captures were a result of management actions and trapped animals were transported a total of 15 times to release sites throughout the study area.

A total of 46 grizzly bears were monitored for varying intervals during 1988, 43 of which were equipped with working radio transmitters. Twenty-two adult females were monitored, compared to 14 in each of the 2 previous years. The maximum number of adult females monitored at one time was 17 for the first week of October (Fig. 1), including females captured in both research and management efforts. The maximum number monitored through research efforts only was 12.

Unduplicated Females

Since 1983 the IGBST has attempted to develop a method for monitoring population trend in the Yellowstone ecosystem without trapping or marking bears. The most reliable system attempted appears to be counting the number of females with cubs-of-the-year (COY).

Procedures

All verified observations of female grizzly bears with COY reported by personnel of the participating agencies and by private citizens are considered. Reports include both aerial and ground observations. Bases for distinguishing different females with COY include both temporal and physical descriptions. Descriptions of family groups are compared with others previously reported in the general vicinity. Time of observation combined with distance between observations are used to distinguish whether look-alike observations are indeed different. Movement histories of radio-telemetered females during the study (1975-88) are used as a basis to make these decisions. Physical characteristics that have proved to be most reliable in distinguishing different family groups include, but are not limited to: number of cubs per litter, striking coloration (e.g., "white" face, "v" chest markings, extremely blond or black in direct sunlight), extremes in body size, and extreme aggressiveness by the female. Those that can be separated as individuals following these criteria are added to the unduplicated sample. Separations of family groups are usually easier using flight data compared to ground data since the same experienced personnel make most of the aerial observations.

Types of flights and patterns have varied during the course of the study reflecting annual research priorities. Different aerial monitoring techniques, specifically for observation purposes, have been attempted since 1983. Efforts were made to coordinate flights by different observers

Table 1. Grizzly bears captured during 1988.

Bear	Sex	Age	Date	Location[a]	Release site	Trapper
104	F	6	4/30	Pahaska/SNF	On-site	WY
144	F	2	4/30	Pahaska/SNF	On-site	WY
145	F	2	4/30	Pahaska/SNF	On-site	WY
146	M	8	5/6	Mormon Cr/SNF	On-site	WY
G42	M	Ad	5/15	Blackwater Cr/SNF	On-site	WY
134	F	6	5/17	Bridge Bay/YNP (mgt)	Turbid Lake/YNP	YNP
			5/23	Bridge Bay/YNP (mgt)	Basin Cr/YNP	YNP
110	M	5	5/21	Richards Pond/YNP	On-site	IGBST
			8/16	West Yellowstone/MT (mgt)	Management kill	MT
40	M	13	5/27	Mesa Pit Road/YNP	On-site	IGBST
147	M	9	5/27	Nez Perce Cr/YNP	On-site	IGBST
138	M	10	5/27	Lake/YNP (mgt)	Blacktail/YNP	YNP/IGBST
148	F	5	6/25	Gibbon Meadows/YNP	On-site	IGBST
149	F	Ad	7/8	Trout Cr/YNP	On-site	IGBST
150	M	5	7/14	Sunlight Cr/SNF (mgt)	On-site	WY/IGBST
151	M	8	7/15	Five Mile Cr/SNF	On-site	WY/IGBST
152	M	15	7/16	Five Mile Cr/SNF	On-site	WY/IGBST
153	M	8	7/20	Little Sunlight/SNF	On-site	WY/IGBST
154	F	2	7/21	Trail Cr/SNF	On-site	WY
			8/8	Sunlight G&F/SNF (mgt)	Sulphur Cr/SNF	WY
			9/26	Sunlight G&F/SNF (mgt)	Huff Gulch/SNF	WY/IGBST
			9/29	Sunlight G&F/SNF (mgt)	Thorofare/BTNF	WY/IGBST
117	F	5	7/24	Sunlight/SNF	On-site	WY
			7/28	Sunlight/SNF	On-site	WY
			9/25	Sunlight/SNF	On-site	WY
			9/28	Sunlight/SNF (mgt)	On-site	WY/IGBST
1	M	24	8/3	Sunlight/SNF	On-site	WY/IGBST
155	M	2	8/9	Bitch Cr/TNF	On-site	IGBST
156	F	6	8/10	Bitch Cr/TNF	On-site	IGBST
118	F	5	8/13	Pahaska/SNF (mgt)	On-site	IGBST/WY
157	F	Ad	8/30	Little Tr Cr/MT (mgt)	Turbid Lake/YNP	MT
158	M	SAd	9/1	Almart Lodge/MT (mgt)	Turbid Lake/YNP	MT

Table 1. Continued

Bear	Sex	Age	Date	Location[a]	Release site	Trapper
139	M	9	9/2	Mack's Inn/ID (mgt)	Buffalo River/WY	ID
79	F	14	9/3	Gardiner dump/MT (mgt)	Arnica Cr/YNP	MT
159	M	Ad	9/4	Mid Fork Boone/TNF (mgt)	On-site	ID
G34	F	2	9/8	Gardiner dump/MT (mgt)	Arnica Cr/YNP	MT
160	M	5	9/13	S Fork Shoshone/SNF (mgt)	On-site	WY
161	F	15	9/19	Ishawooa/S Fork/SNF (mgt)	On-site	WY/IGBST
141	M	2	9/15	Canyon/YNP	Turbid Lake/YNP	IGBST
126	F	16	9/23	Gardiner/MT (mgt)	Turbid Lake/YNP	MT
162	F	14	9/24	Mikolich residence/MT (mgt)	Otter Cr/YNP	MT
G44	F	Cub	9/24	Mikolich residence/MT (mgt)	Otter Cr/YNP	MT
G45	F	Cub	9/28	CUT Ranch/MT (mgt)	Accidental death	MT
163	F	4	11/3	Eagle Cr/SNF	On-site	WY

	Females	Males
Subadult	6	3
Adult	13	14

	Females		Males		Retraps Females		Retraps Males	
	Ad	SAd	Ad	SAd	Ad	SAd	Ad	SAd
Research	7	3	9	2	1	1		
Management	6	3	5	1	1	3	1	1

New bears = 22 (5 SAd F, 6 Ad F, 2 SAd M, 9 Ad M)

Total individuals bears = 36

[a] BTNF = Bridger-Teton National Forest, SNF = Shoshone National Forest, TNF = Targhee National Forest, YNP = Yellowstone National Park.

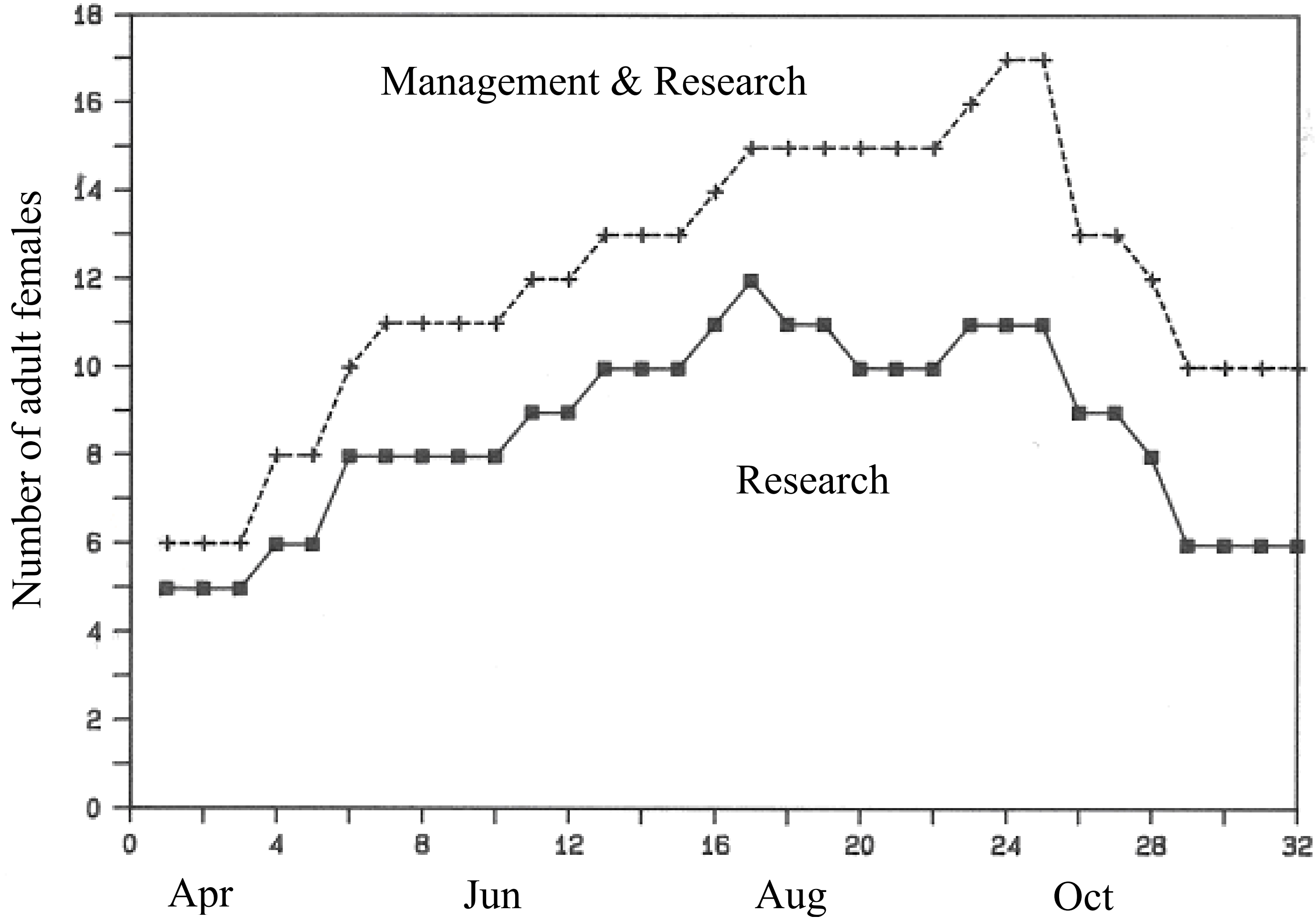


Fig. 1. Number of adult female grizzly bears radio-monitored during 1988 by 2-week intervals.

on the same day and in a predetermined random sequence. Variable weather patterns within the study area made this impractical. Beginning in 1986, segments were flown when possible and sequence was determined by weather conditions. Experience dictated 2 hours as the optimum time period for aerial observation based on observer fatigue. Experience also indicated flights over timbered terrain were not cost effective. During the course of the study, females with COY were most frequently observed from the air during June-August, with some allowance made for annual variance in observability due to weather, primarily amount of precipitation.

During 1986 the study area was divided into 11 areas that could be flown during a 2-hour observation period (Fig. 2). Flight areas varied in size depending upon topography and proportion of nontimbered area. Observation flights were concentrated over open terrain, specifically open/timber edges. Each flight segment was flown when opportune, beginning 1 June and continuing through August. The same procedure was followed during 1988. Several flight areas could not be effectively searched within the optimum 2-hour observing period. Adjustments to area boundaries were made prior to the 1988 flights. All areas were flown only once in 1988 due to dense smoke and aircraft restrictions resulting from wildfires in the Yellowstone ecosystem that summer and fall.

Results

Nineteen unduplicated females with 40 COY were observed in 1988. The current running 6-year average (1983-88) was 16 unduplicated females with an average litter size of 1.93 COY (Table 2).

A strong correlation was evident between annual number of unduplicated females with COY seen on observation flights and numbers seen by other methods ($r = 0.90$, $P < 0.05$) from 1983-88. During that period, an average of 35% of the unduplicated females was recorded on IGBST observation flights, ranging from 22-41%; during the last 3 years when methodology was similar, observation flights accounted for 37%. An average of 22 observation flights were made each year, each flight lasting approximately 2.5 hours. Unduplicated observations not recorded on observation flights included an average of 4% recorded incidentally on observation flights made by other researchers over the study area, 43% from ground sightings not duplicated on any type of observation flights, and 18% from IGBST trapping efforts and radio-tracking flights only.

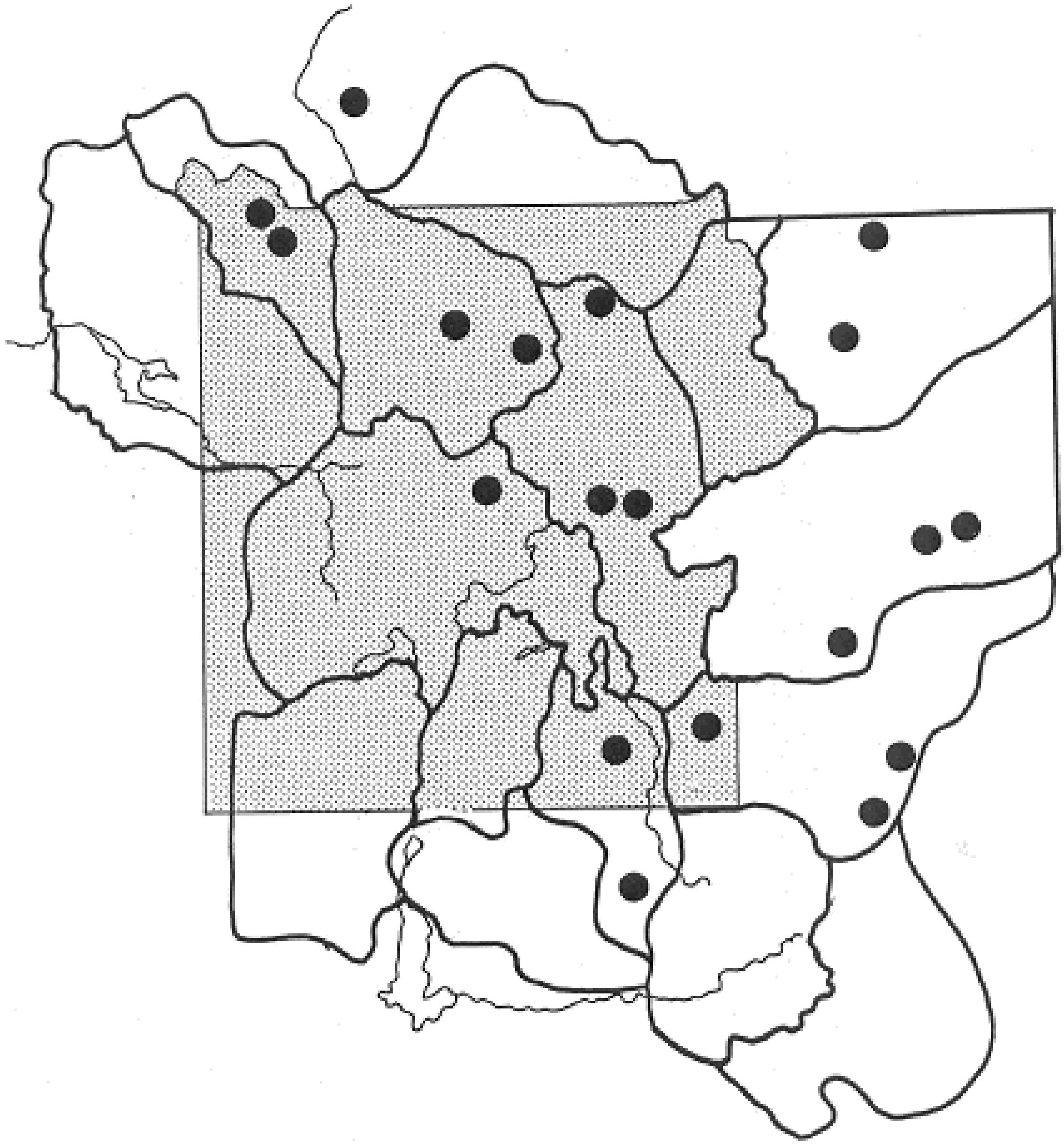


Fig. 2. Observation flight area boundaries and locations of first observation of unduplicated females with cubs-of-the-year during 1988.

Table 2. Unduplicated female grizzly bears with cubs-of-the-year, 1973-1988.

Year	Females	Cubs	Mean litter size	Adult female deaths (known and probable)
1973	14	26	1.86	4
1974	15	26	1.73	4
1975	4	6	1.50	1
1976	16	30	1.88	1
1977	13	25	1.92	6
1978	9	18	2.00	1
1979	13	29	2.23	2
1980	12	23	1.92	1
1981	13	24	1.85	5
1982	11	20	1.82	4
1983	13	22	1.69	2
1984	17	30	1.76	2
1985	9	16	1.78	2
1986	25	48	1.92	2
1987	13	29	2.23	2
1988	19	40	2.11	2
Total	216	412	1.91	41
Mean	13.50	25.75	1.91	2.56

Population Parameters

Sex and Age Structure

The sex structure of this population has apparently changed from strong male dominance during the first third of the study to more nearly 50-50 or slight female dominance (Table 3). This trend was apparent in not only capture data, but also litter sex ratios and mortality data. Capture data after 1985 was biased by greater efforts to capture females while mortality data should have been biased by greater efforts to keep females in the population beginning in 1983. However, a greater portion of the deaths was females in the latest third of the study (1985-88).

Table 3. Sex ratios (M:F) of captured grizzly bears, cub-of-the-year litters, and dead bears, 1975-88.

	Capture data (*n*)		Litters (*n*)		Mortality data (*n*)		% Subadult females Capture data (*n*)		% Subadult females Mortality data (*n*)	
1975-79	62:38	(78)	73:27	(15)	65:35	(34)	9.0	(7)	5.9	(2)
1980-84	52:48	(147)	45:55	(20)	60:40	(52)	25.2	(37)	13.5	(7)
1985-88	40:60	(97)	33:67	(18)	46:54	(28)	21.7	(21)	21.4	(6)
Total	51:49	(322)	49:51	(53)	58:42	(114)	20.1	(65)	13.3	(15)

The key to this change in sex structure appears to be an increase in percent of subadult females in the population. This increase is indicated by both capture and mortality data. A higher proportion of female cubs in litters and increased survivorship of subadult females in recent years could account for the change in sex structure of the population. Greater chances of surviving to reproductive age have been a direct result of greater diligence by management agencies to avoid deaths of female grizzly bears of all ages. Reasons for change in the sex ratio of litters are unknown.

The population sex structure for the entire study period is close to 50:50 for both capture data and litter sex ratio. Mortalities were male dominated (60:40). Mortality rates for male bears are usually greater, mainly because their larger home range sizes and greater rates of movements increase their odds of encountering high risk situations.

Production

Reproductive rates were calculated using data from marked females only. Complete cycles were recorded for 13 bears for which COY litter size was known (Table 4). Average litter size was 2.69 cubs for the completed cycles, and mean cycle length was 2.59 years for those 13 marked females; however, when the barren years for Bears 13 and 26 were included, the mean cycle length was a minimum of 3.05 years. Reproductive rate for the 15 females was 0.660.

Table 4. Completed reproductive cycles of adult females for which complete cub litter size was known.

Bear	Number cubs/litter	Cycle length (years)	Number cubs dying before weaned	Bear	Number cubs/litter	Cycle length (years)	Number cubs dying before weaned
6	1	1	1	43	2	3	0
8	1	2	0	50	2	3	1
	3	3	0				
	2	2	0	59	2	2	2
10	2	3	?	106	3	4	2
	2	2	0				
				116	3	3	1
12	2	3	0				
	1	1	1	G36	2	3	?
16	2	3	1	13[a]	1 (min)	9	-
21	2	3	0	26[b]	1 (min)	5	-
38	3	3	0				

[a] Female producing no cubs for 3 years following weaning of previous litter and prior to next cub production, but litters seen only as yearlings, not cubs.
[b] Female producing no cubs for 3 years following weaning of litter; died before producing next litter.

Mean litter size for 67 litters of 44 marked females since 1973 was 2.12 cubs. First litters were smaller than subsequent litters (t = -1.561, P = 0.063), and were composed of a greater percentage of male cubs (Table 5). Females produced their first litters at the mean age of 5.70 years. The youngest producing females were 4 years (n = 5), while the oldest was 25 years (n = 1). The average age of the 44 females at litter production was 9.81 years.

Table 5. Litter characteristics.

	Mean age of female (n)	Mean litter size (n)	Proportion of male cubs (n)
First litters	5.70 (23)	1.88 (17)	0.67 (12)
Second+ litters	12.97 (37)	2.14 (35)	0.41 (34)
Unknown sequence	6.57 (7)	2.57 (7)	0.57 (7)
Dump litters[a]	9.70 (10)	2.11 (9)	0.57 (14)
Total	9.81 (67)	2.12 (59)	0.49 (53)

[a] Litters produced by females known to forage at dumps.

Mortalities

Categories of grizzly bear mortalities included known, probable, and possible deaths. A mortality involving a retrieved carcass, parts of a carcass, or adequate radio-telemetry evidence was a known mortality. Reports of a death by a reliable source (as determined by the Team Leader) with no physical evidence retrieved or suspicious radio- telemetry evidence were counted as probable mortalities. Persistent and repeated rumors of a death were recorded as possible mortalities. A single report by an unverified source was not included. Grizzly bear mortality rates were probably underestimated due to the difficulty involved in obtaining volunteer information concerning illegal deaths of a Federally "protected" species. Mortalities were frequently not reported until several years after the death occurred.

Seven known and 6 probable grizzly bear deaths occurred during 1988, 5 of which were human-caused, 7 by natural causes, and 1 from unknown causes (Table 6). Total known and probable mortalities since 1973 are illustrated in Figure 3 (see also Craighead et al. 1988).

Table 6. Grizzly bear mortalities during 1988.

Date	Bear	Sex	Age	Category	Cause	Locationa	Comments
Spring	Unm.	?	1	Probable	Natural	Table Mtn ara, SNF	Cub of #135; lost between 3/31 and 7/9
Spring	Unm.	?	1	Probable	Natural	Same as above	Same as above
7/15	150	M	SAd	Known	Mgt kill	Little Sunlight, SNF	Property damage, into garbage, killed livestock
August	109	F	7	Probable	Natural	Crandall area, SNF	Died in wildfire
August	Unm	?	Cub	Probable	Natural	Crandall area, SNF	Died in wildfire
August	Unm.	?	Cub	Probable	Natural	Crandall area, SNF	Died in wildfire
August	148	F	5	Probable	Natural	Carnelian Cr, YNP	Died in wildfire
8/16	110	M	5	Known	Mgt kill	West Yellowstone, MT	In garbage; 5th mgt trap
9/1	Unm.	F	Cub	Known	Roadkill	Grayling Cr, GNF	On deer carcass
9/24	Unm.	M	Ad	Known	Natural	Yellowstone Lake inlet, YNP	Killed by another bear
9/28	G45	F	Cub	Known	Handling	CUT Ranch, MT	Accidental death due to penetration of dart
10/11	160	M	Ad	Known	Illegal	Thorofare, BTNF	Hunter
Fall	145	F	2	Known	Unknown	Cody Peak, YNP	Carcass/collar found Spring 1989; no cause of death evident

[a] BTNF = Bridger-Teton National Forest, GNF = Gallatin National Forest, SNF = Shoshone National Forest, YNP = Yellowstone National Park.

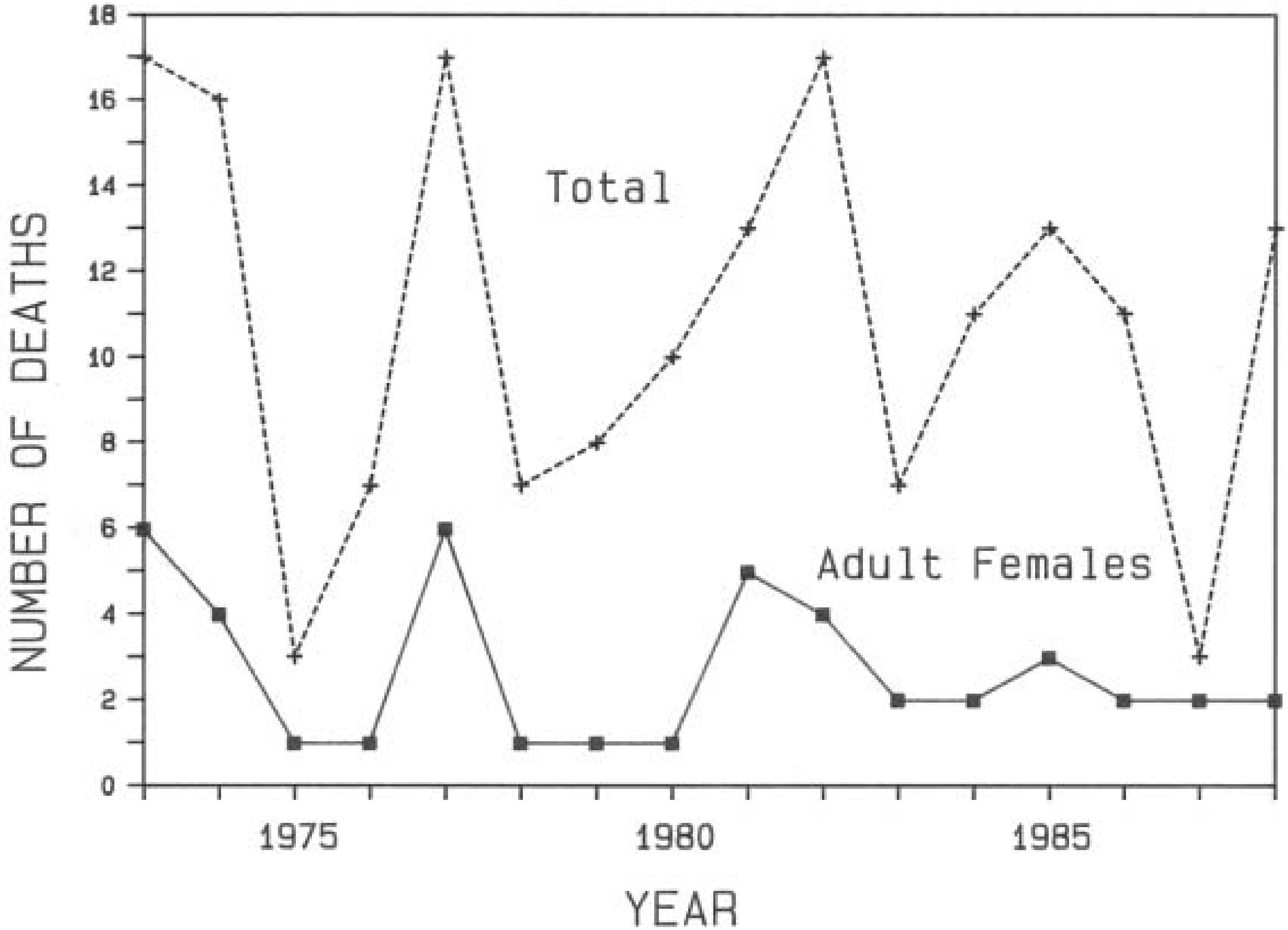


Fig. 3. Known and probable grizzly bear mortalities since 1973.

Food Habits

Procedures

Yellowstone grizzly bear food habits were determined from scat analysis and ground investigation of feeding sites. Scats were collected whenever encountered during investigation of aerial and ground radio locations of instrumented bears, and during conduct of other field work.

All bear scats collected and classified as grizzly and species unknown were included in the analysis. Dried scats were soaked in water to soften them and washed through 2 screens. Coarse material was retained in the large screen (holes 0.125 in) and fine material, including seeds, was collected in the small screen (holes 0.0328 in). All items were identified to species when possible, and the percent volume of each item was visually estimated.

Procedures used in the ground investigation of feeding sites are described by Blanchard (1985). Because feeding activities produce evidence of varying observability and longevity, site examinations were not used alone to determine food habits. Site examinations provide data on habitat use and preference; these examinations also provide data on feeding behavior that produces long lasting sign. Easily digestible food items that are rarely revealed through scat analysis (such as mushrooms) are evident at the feeding site. The more digestible items are probably under-represented in scat contents and, therefore, in the food habits analysis.

Whitebark pine (*Pinus albicaulis*) cone production was monitored to determine annual variation in the amount of pine nuts available to bears. Nine 90-m transects were established in whitebark pine stands in the study area during 1980 (Fig. 4). During 1987, 8 additional transects of 10 trees each were established to assess production in areas and habitat previously unmonitored; 2 more transects were initiated in 1988. Ten whitebark pine trees were selected along each transect and marked with a blaze and an aluminum identification tag. The crown of selected trees could be viewed from the ground from at least 2 angles. Cones were usually counted in July and early August when they had reached mature size, but few had been harvested by red squirrels (*Tamiasciurus hudsonicus*).

Results

Scat Analysis.--Food habits presented here represent results of fecal analysis. These data often do not accurately reflect relative proportions of ingested diet items primarily because different diet item types are subject to different digestibilities. For this reason, more easily digested items such as meat and berries are especially under- represented in scats relative to the vegetal grazing resource.

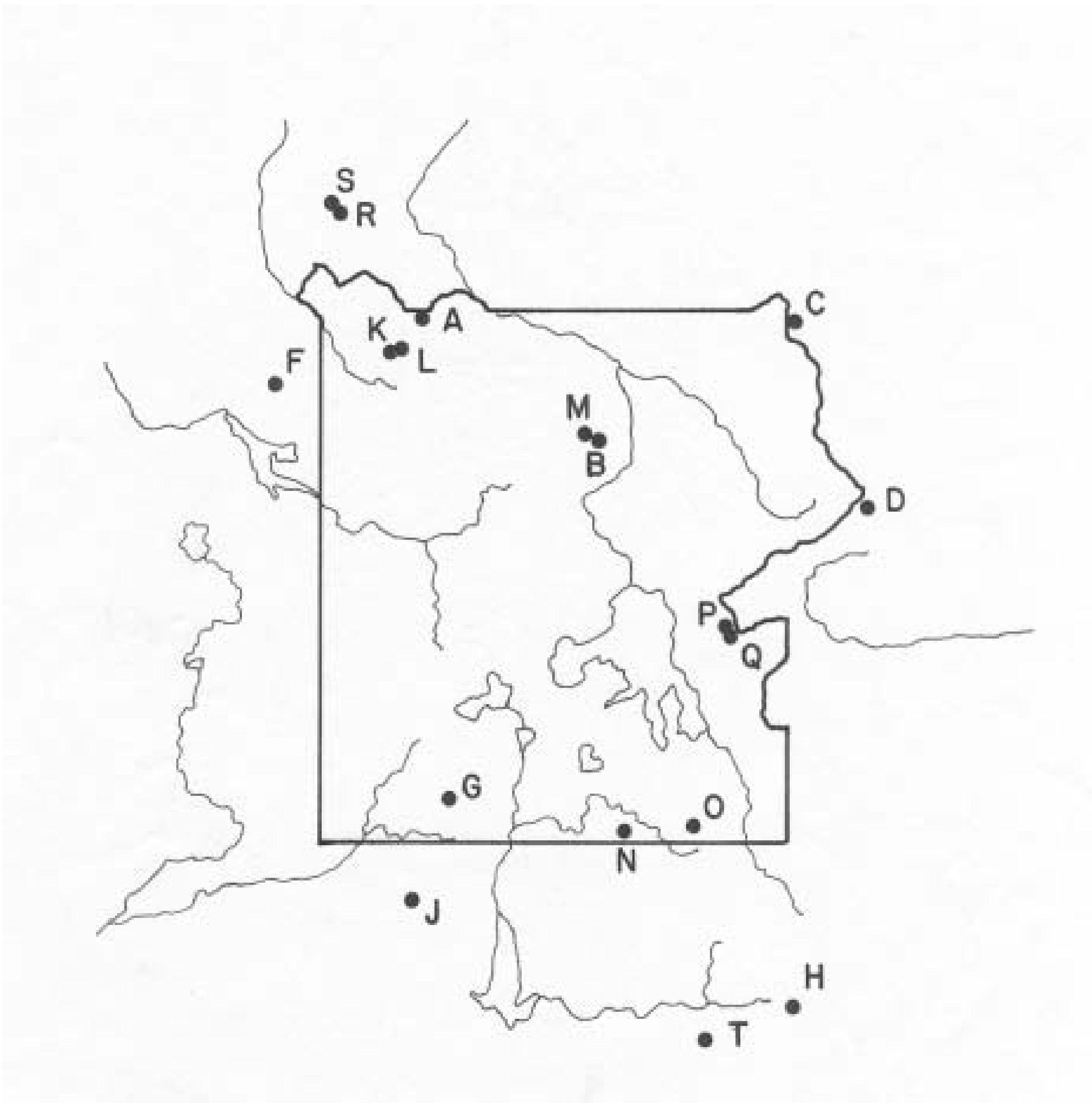


Fig. 4. Locations of whitebark pine cone production transects.

During 1988, 363 scats were collected and analyzed for content, including 55 deposited in spring, 238 in summer, 65 in fall, and 5 of unknown age (Table 7). Twenty-six black bear scats were analyzed, but contents are not reported here due to the small sample size.

Food habits in 1988 were influenced by both the drought and the Yellowstone wildfires. Notable variations from the 9-year average scat contents of 1979-87 included greater volumes of ungulates and wasps, and lesser volumes of whitebark pine nuts. Wasps experienced population booms possibly due to abundant food sources, such as spruce budworm, and dry weather conditions conducive to high larvae survival and emergence success. Grizzly bears exploited this food source, excavating nests in both logs and underground and consuming adult wasps. Greater than average volumes of ungulates in scat contents were a direct result of the wildfires. Grizzly bears were attracted into burned areas after the fires had passed in search of ungulate carcasses (Blanchard and Knight, in prep.). The average volume of ungulates in scats collected from 1979-87 was 3-8% during fall compared to 20% in 1988.

Virtually no whitebark pine nuts were found in scats during 1988. This year was characterized by low cone production throughout most of the study area (see Whitebark Pine Cone Production, below).

<u>Whitebark Pine Cone Production</u>.--The fall of 1988 was characterized by overall low whitebark pine cone production, similar to that during the last 2 years, 1986 and 1987 (Table 8). The only areas with appreciable numbers of cones were south of Yellowstone Lake (Transects N and H), and to a lesser degree east of the Lake (Transects P and Q) (Fig. 4). As expected, by August grizzly bears began seeking alternate foods, often associated with human activity. Significantly, no such activity occurred in areas of at least moderate cone production. Eighteen management actions involving grizzly bears occurred between 1 August and 1 October. Only 1 such action occurred after 1 October 1988. By that time bears had been drawn into burned areas where ungulate carcasses were available.

<u>Feed Sites</u>.--Ground investigation at 226 aerial locations of instrumented bears from April-October revealed evidence of feeding activity at 135 of those sites. Evidence of activity other than feeding was recorded at 25 of those sites and no evidence of bear activity was observed at the remaining 67 sites. Feeding activity was also recorded at 219 sites not associated with an aerial location of an instrumented bear. Activity at all 354 grizzly bear feeding sites is summarized in Table 9. An average 1.24 different feeding activities were recorded at each site.

The most frequently recorded feeding activities were searching for insects (0.45), digging for small mammals and their food caches (0.20), grazing (0.19), and digging for roots (0.17) (Table 10). The most frequently recorded food items in scat contents were foliage (0.69), insects (0.30), large mammals (0.26), and roots (0.10). One feeding activity observed at feed sites but not detected in scat content analysis was stripping bark for cambium. This activity was recorded at 3 feed sites during June and July. Food items identified in scats that were not apparent at feed sites included garbage and unidentified birds. Species identification within general food item categories was more often possible with scat content analysis as opposed to feed site examination.

Table 7. Seasonal grizzly bear scat contents for 1988.

	Spring[a] (*n* = 55)		Summber[b] (*n* = 238)		Fall[c] (*n* = 65)	
	% Freq.	% Vol.	% Freq.	% Vol	% Freq.	% Vol.
Pine nuts			1.68	1.68		
Berries			7.14	7.14	18.46	14.92
Vaccinium					7.70	2.93
Sporophytes	1.82	0.18	0.84	0.42		
Equisetum	1.82	0.18	6.30	2.56		
Foliage:						
Graminoids	56.36	37.73	41.18	22.90	29.23	21.23
Forbs	7.28	1.73	35.30	25.96	13.84	4.85
Cirsium	1.82	0.91	13.03	6.93		
Taraxacum			11.76	6.18	1.54	1.54
Trifolium	5.45	0.82	9.66	4.41		
Roots:	21.82	10.63	5.88	2.59	15.39	11.84
Lomatium			3.36	1.87		
Melica	12.73	7.27			6.15	4.85
Perideridia					3.08	2.85
Mammals	61.82	32.91	18.49	7.39	33.85	19.92
Elk	27.27	14.55	6.30	2.73	18.46	11.92
Bison	25.45	14.36	6.30	2.04	9.23	5.08
Cutthroat trout			6.30	3.38		
Birds			0.84	0.04		
Insects	9.09	0.73	34.45	15.02	29.23	15.23
Ants	9.09	0.73	19.33	3.76	9.23	3.46
Bees			3.78	1.09	13.85	6.38
Moths			11.76	9.64	6.15	5.38
Garbage			0.84	0.46		
Debris	61.82	16.09	31.93	11.18	43.08	9.08

[a] March, April, May.
[b] June, July, August.
[c] September, October.

Table 8. Mean annual whitebark pine cone production on study transects.

Year	Total cones	Total trees	Total transects	Mean cones per tree	Cones/transect/year			
					Mean	SD	Min.	Max.
1980	2,312	90	9	25.69	256.89	122.99	139	562
1981	1,191	90	9	13.23	132.33	148.69	8	489
1982	1,443	85	9	16.98	160.33	154.18	0	463
1983	1,531	88	9	17.40	170.11	88.78	78	372
1984	360	56	6	6.43	60.00	41.41	14	124
1985	2,312	85	9	27.20	256.89	192.27	17	625
1986	103	75	8	1.37	12.88	13.18	0	38
1987	394	155	16	2.54	24.63	37.49	0	118
1988	406	169	17	2.40	23.88	44.32	0	148

Table 9. Activities recorded at grizzly bear feeding sites, April-October 1988.

Month	No. of feed sites	Types of feeding activities											
		Large mammals	Grazing	Ants	Roots	Small mammals	Whitebark pine nuts	Fish	Wasps	Moths	Cambium	Berries	Unknown dig
Apr	21	6	2	3	1	10							1
May	55	8	15	4	5	22	1	1					3
Jun	38	8	4	5	10	5	3	1			1		3
Jul	133	5	36	63	28	18	1	2	2	9	2	5	3
Aug	43	1	4	28	3	2			15			2	3
Sep	50	9	6	16	10	14			9	1			4
Oct	14	3		6	2				4				2
Total	354	40	67	125	59	71	5	4	30	10	3	7	19

Table 10. Percent frequency of feeding activities at 354 feed site examinations during 1988.

Feeding activity	Spring[a] (n = 76)	Summer[b] (n = 214)	Fall[c] (n = 64)	Total (n = 354)
Digging pine nuts	1.32	1.87	0	1.41
Grazing berries	0	3.27	0	1.98
Grazing graminoids and forbs	22.37	65.67	9.38	18.93
Digging roots	7.90	19.16	18.75	16.67
Digging small mammals	42.11	11.68	21.88	20.06
Scavenging/preying large mammals	18.42	6.54	18.75	11.30
Fishing	1.32	1.87	0	1.41
Searching insects	10.53	54.21	54.69	44.92
Miscellaneous	5.26	5.61	9.38	6.22

[a] April, May.
[b] June, July, August.
[c] September, October.
[d] Stripping bark for cambium and unknown diggings.

Digging for small mammals and their food caches was more frequently recorded at feed sites than in scat contents. This feeding activity had a low success rate compared to other activities. In contrast, consumption of berries was more evident through scat analysis than at feed sites.

DYNAMICS OF UNGULATE CARCASS AVAILABILITY AND USE BY BEARS ON THE NORTHERN WINTER RANGE AND FIREHOLE AND GIBBON DRAINAGES

1988 Progress Report

by
Gerald I. Green

INTRODUCTION

During years of severe winter and spring weather, substantial amounts of carrion, consisting mostly of elk (*Cervus elaphus nelsoni*) carcasses, are available to scavengers in Yellowstone National Park (Houston 1978, 1982). After emergence from their winter dens in March and April, Yellowstone grizzly bears (*Ursus arctos horribilis*) use carrion and weakened ungulates as a primary food source (Knight et al. 1984). Reproductive success of female grizzlies is at least partly dependent on availability of carrion on spring ranges (Mealey 1975, Picton 1978). A positive relationship between spring habitat productivity and adult female density has been indicated (unpublished IGBST data). Because adult females are key to viability of the Yellowstone grizzly bear population (Knight and Eberhardt 1985), availability of ungulates on spring bear range may be crucial to Yellowstone's grizzlies.

In 1985 the Interagency Grizzly Bear Study Team (IGBST) initiated a study in the Firehole drainage to assess the effects of over-wintering ungulate mortality, spatial distribution of carcasses, and human (*Homo sapien*) and scavenger activities on use of carrion by grizzlies (Mattson and Henry 1987). In 1987 Norris Geyser Basin and Gibbon Meadows were included in the Firehole study and surveys of the Northern Elk Winter Range were initiated. The study was continued through the spring of 1988. This report provides a summary of the 1988 findings, with the Northern Range and Firehole-Gibbon data reported separately.

METHODS

Study areas and methods are described in detail by Green and Mattson (1988). Ungulate weights were derived from data in Houston (1978) and Hobbs et al. (1983) and adjusted for skeletal mass by algorithms given in Robbins (1983) and Berger and Peacock (1988).

THE NORTHERN RANGE

Study Area

The Northern Range study area lies wholly within Yellowstone National Park. This study area consists mainly of lower elevation valleys of the Yellowstone, Lamar, and Soda Butte drainages. It also includes lower portions of Specimen Ridge and the south-facing slopes of Mt. Norris.

Backcountry Survey Routes

The study area included 3 subunits: the Black Canyon, Lamar, and Soda Butte areas. Survey routes established in 1987 were traveled again in 1988. A total of 754.2 km were traveled between 16 March and 20 May 1988. All of the backcountry survey routes were located within 7 km, and 51% within 2 km of an active highway. The greatest percentage of the routes were on south- and southwest-facing aspects. A large part of routes were located on mid- and low slopes.

Ungulate Sightings

A total of 4,576 ungulates were sighted within 1 km of the survey routes. Ungulates were not sighted evenly throughout the 3 study area subunits. Ungulates were sighted in study area subunits at the rate of 11.6 ungulates/km in the Black Canyon, 25.4 ungulates/km in the Lamar, and 18.6 ungulates/km in the Soda Butte subunits.

Ungulate Carcasses

A total of 78 carcasses were investigated during the spring of 1988. Of these carcasses, 59 were elk, 7 were mule deer (*Odocoileus hemionus*), 5 were bison (*Bison bison*), 5 were bighorn sheep (*Ovis canadensis*), 1 was pronghorn (*Antilocapra americans*), and 1 was moose (Alces alces). Fifty-two of these carcasses were found on survey routes at an average rate of 1 carcass/14.5 km of survey route traveled. A majority of the carcasses were found on low slopes and in bottoms. However, when the percentage of carcasses was compared to the distances traveled in each of the topographic positions, the distributions were not significantly different ($G = 8.21$, $df = 5$, $p = 0.15$) (Fig. 5). A small sample size compromised the statistical test; it is likely that ungulates died more often than expected by chance in bottoms. Although a large number of the carcasses were found on south- and southwest- facing slopes, they were found proportionally to the distance traversed on each of the aspect classes (Fig. 6).

Peak ungulate die-off during spring 1988 occurred during the last half of March (Fig. 7). This coincided with peak die-off of elk >10 years old. All of these old elk were females and comprised the largest class percentage (29.4%) of total carcasses during this time period.

Among all time periods, 88% of adult elk carcasses found were females. Among age classes, the largest percentage of elk carcasses were short yearlings (52.8%). The majority of short yearlings died prior to March.

Several elk died on the Northern Range as a result of active predation during spring 1988. I found 1 verified predation by a grizzly on an adult female elk, 1 probable grizzly bear predation on an adult female elk, 2 verified lion kills, and 1 probable lion kill - all on backcountry survey routes. No verified coyote kills were recorded on the backcountry survey routes; however, 4 verified coyote kills and 1 probable kill were found along roadsides in the Lamar area.

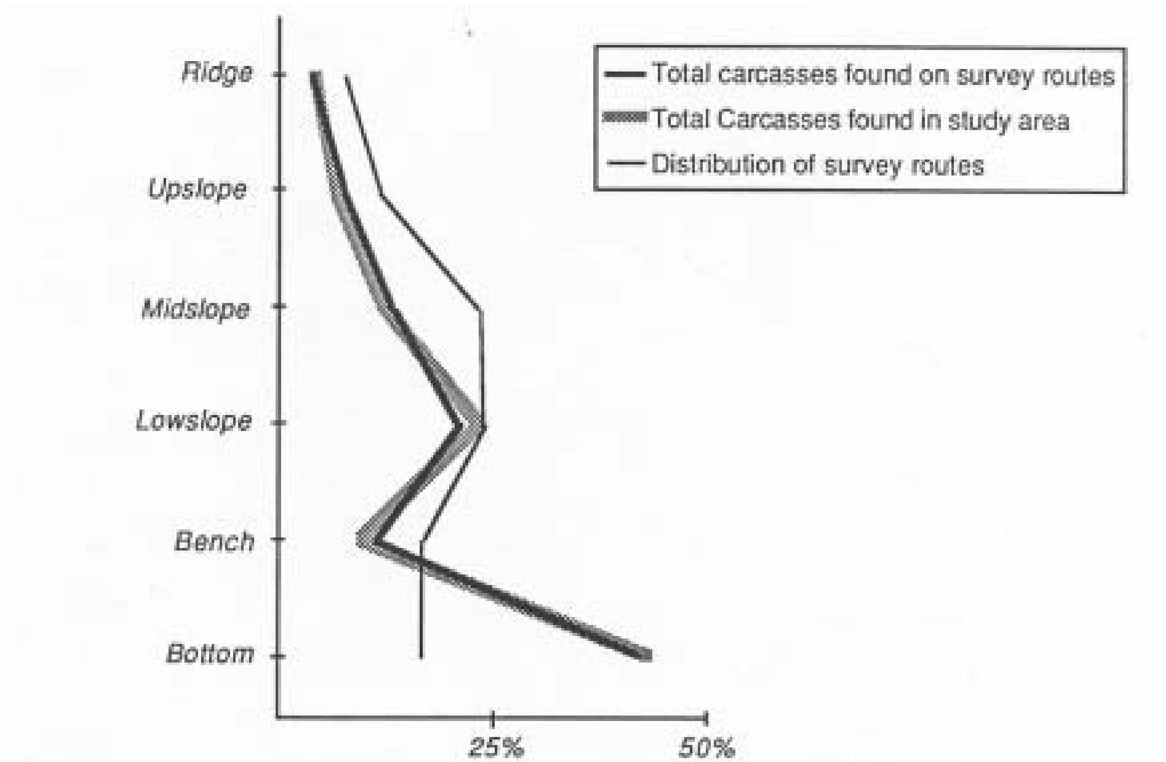


Fig. 5. Percent distribution of carcasses and survey routes among landforms.

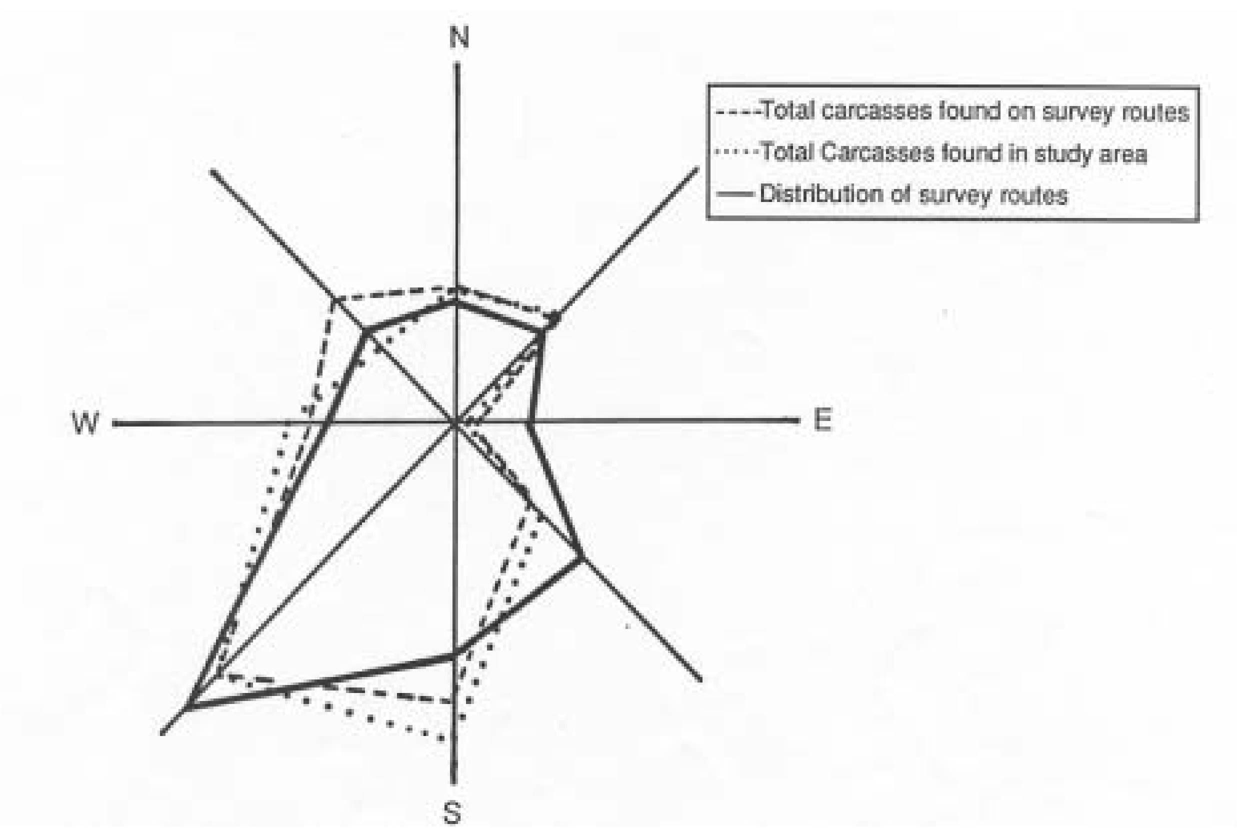


Fig. 6. Percent distribution of survey routes and carcasses by aspect.

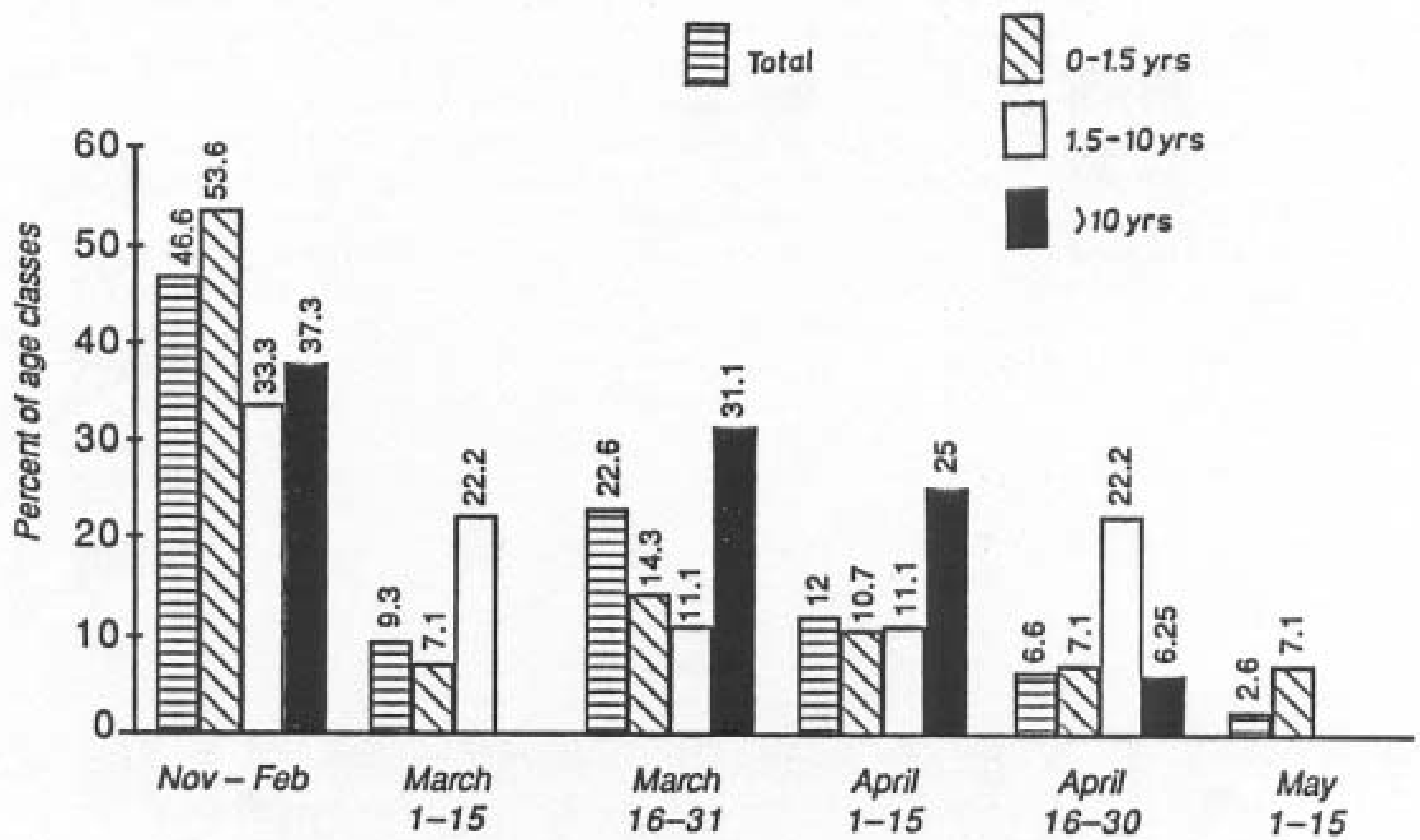


Fig. 7. Percent distribution of total carcasses and elk carcass age-classes among time periods.

Bear Sign

A minimum of 3-5 black bears (*Ursus americanus*) were estimated to be within the study area when track analysis and bear sightings were integrated (Green and Mattson 1988). The majority of black bear sign was found in the Black Canyon subunit (Fig. 8a), as in 1987 (Green and Mattson 1988). Only 1 black bear track set and 1 sighting by team members were recorded outside but closely adjacent to the Black Canyon subunit. These were on the south side of Little America Flats on the lower timbered slopes of Specimen Ridge, in the Soda Butte subunit.

Grizzly bear sign was more evenly distributed among study area subunits. A minimum of 2-3, 5-6, and 6-7 grizzlies were estimated to be present in the Black Canyon, Lamar, and Soda Butte subunits, respectively (Fig. 8b). Assuming free interchange of bears among subunits, I estimated a minimum of 10-12 grizzlies used the Northern Range in areas sampled on survey routes.

Bear avoidance of roads was suggested by an increased number of track sets per kilometer traveled as distance to the Cooke City highway increased (Fig. 9). This same pattern was evident during 1987 (Green and Mattson 1988).

Bear Use of Carcasses

The first bear sign found within the study area was dated 21 March. Eleven adult female elk, 1 bull elk, 1 short yearling elk, 1 adult bighorn, and 1 adult mule deer were estimated to have died after 20 March, making available an estimated 1,315 kg of biomass (wet weight) to bears.

I generally considered short yearlings to be unavailable to bears (Green and Mattson 1988); however 1 short yearling was included in my estimate of available carrion during 1988 because of a special circumstance. This short yearling had died of sickness and malnutrition near the Yellowstone River in the Black Canyon and was found shortly after by a black bear.

Remains of an adult bull bison and an adult cow elk which died early in the winter were preserved from consumption by other scavengers by submersion in a bog near the Lamar-Yellowstone confluence. These carcasses contributed an estimated additional 13 kg to available biomass. All available carrion in this bog was consumed by a grizzly.

Five of the 15 carcasses with dates of death after 20 March evidenced bear usage (Fig. 10). Of the estimated 1,315 kg of available biomass, black bears were estimated to have consumed 138 kg and grizzlies 136 kg. Grizzly bears were associated with only 2 fresh carcasses, 1 of which involved confirmed grizzly predation and the other a probable grizzly bear predation.

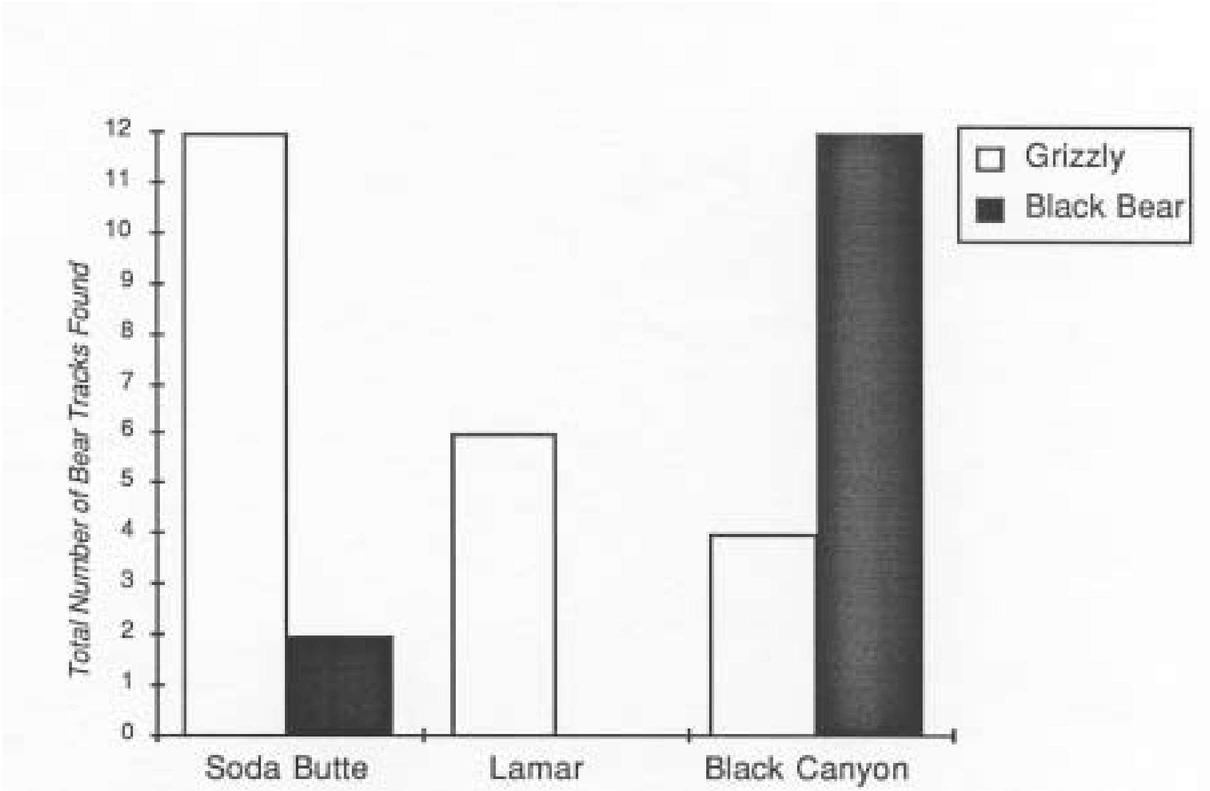


Fig. 8a. Number of track sets found among study area subunits.

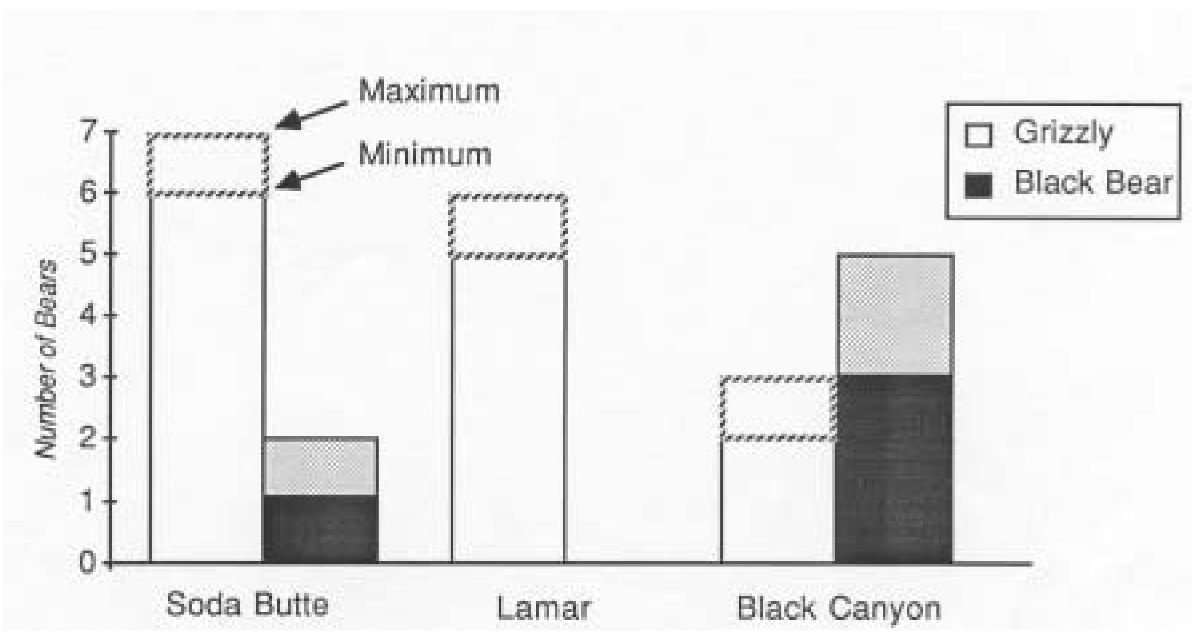


Fig 8b. Number of bears estimated among study area subunits.

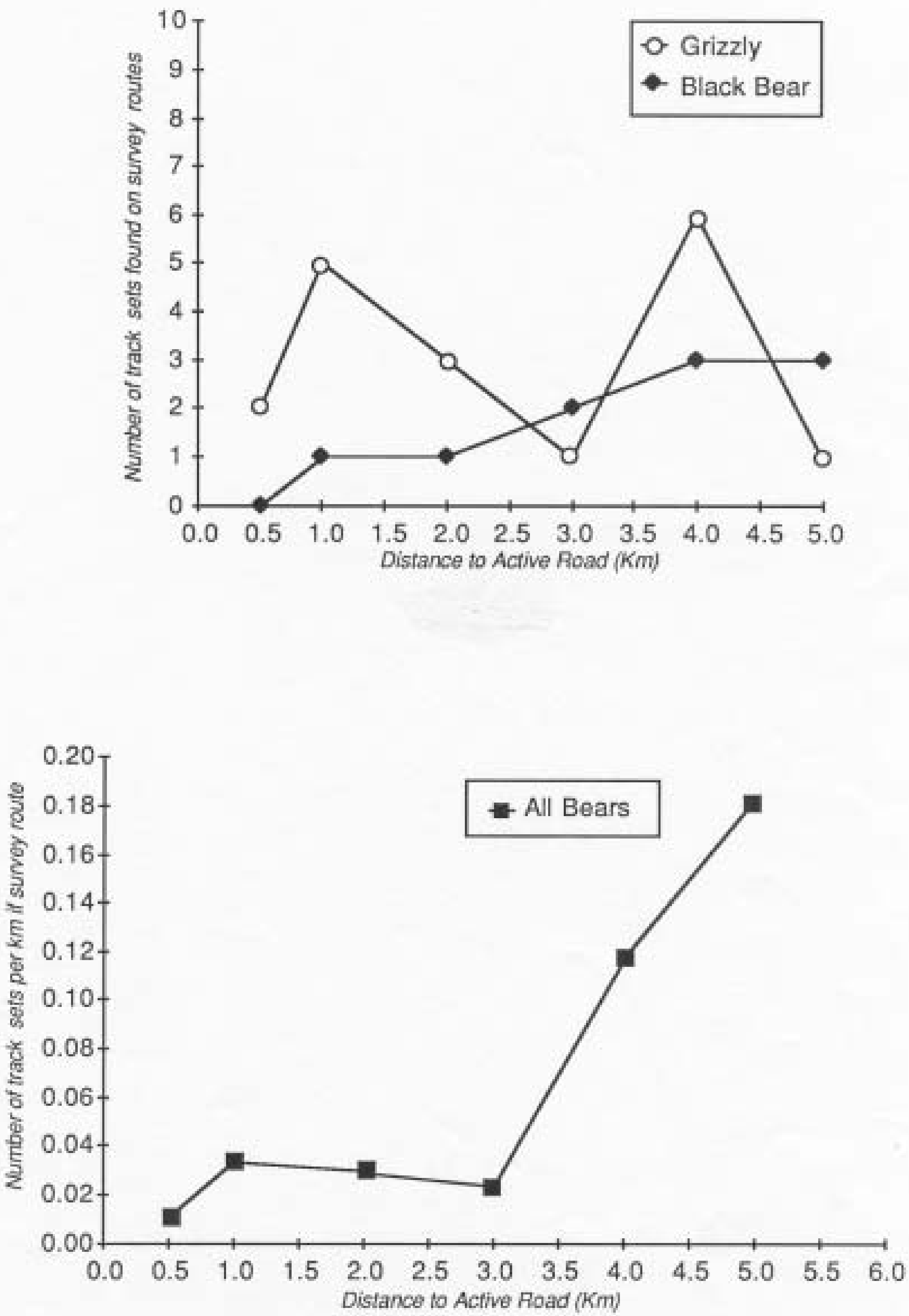


Fig. 9. Number of grizzly and black bear track sets found, total and per km, by distance to road.

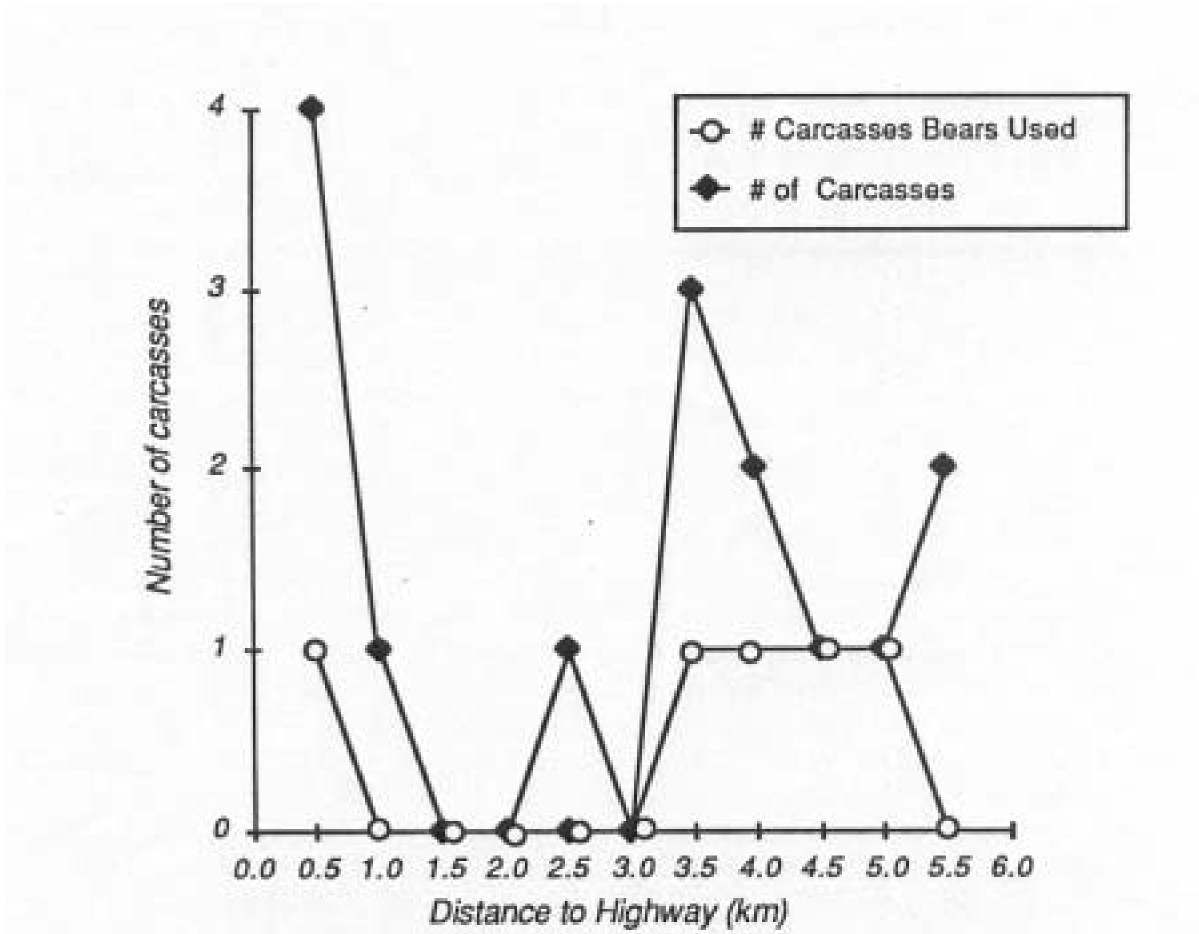


Fig. 10. Available carcasses and carcasses used by bears according to areas delineated by 500 meter zones away from Cooke City highway.

A smaller portion of available carrion was used within 3 km compared to beyond 3 km of the Cooke City highway. Of the 530 kg of biomass available within 3 km of an active highway, I estimated that 14.1% was used by bears. Bears used 35% of the available 797 kg of carrion beyond 3 km of the highway. Similar under-use of carrion along the Cooke City highway was also evident during spring of 1987 (Green and Mattson 1988).

THE FIREHOLE-GIBBON

Study Area

The study area extends from the southern edge of the Lone Star geyser basin northward and includes the lower geothermal portions of Nez Perce Creek drainage. The Gibbon study area consists of the meadow network along the Gibbon River from its mouth at Madison Junction upstream east and northward, including the Gibbon Meadows and Norris Geyser Basin.

Survey Routes

An estimated 357 km of survey routes were traveled in the Firehole and Gibbon drainages between 24 March and 13 May. Routes in the Firehole drainage were surveyed completely twice. Routes in and around the Norris Geyser Basin and Gibbon Meadows received a single cursory examination.

Ungulate Carcasses

A total of 53 carcasses were investigated, 27 of which were found on survey routes, at an average rate of 13.2 km/carcass. Of these carcasses, 21 were bison and 32 were elk. Among elk, 15 were adult females, 5 were adult males, and 12 were short yearlings. Bison carcasses consisted of 8 adult females, 5 adult males, 6 short yearlings, and 2 calves-of-the-year.

Data indicated no carcass association with specific aspect classes; the Firehole-Gibbon study area is characterized by low relief. However, geothermal influence appeared to be related to carcass location. The area immediately surrounding each carcass was characterized by degree of geothermal influence. Heavy geothermal influence was coded 3, moderate influence 2, light influence 1, and no geothermal influence 0. Carcasses were not randomly distributed among classes of geothermal influence ($C = 21.1$, $df = 3$, $p < 0.001$). Ungulates died more often than expected in areas of moderate geothermal influence (code 2) and less often than expected in areas of no geothermal influence (code 0).

Bear Sign

First bear sign was 24 March in the Firehole-Gibbon area. Peak bear sign was found during the last half of April. Twenty-nine track sets were measured in the Firehole area; a minimum of 4 to 7 grizzlies and 1 black bear were estimated to have been present. A minimum number of bears could not be determined for the Norris Geyser Basin-Gibbon Meadows area. Repeated sampling in this area was not accomplished, and none of the bear tracks recorded in the Norris area were found on survey routes.

Bear Use of Carcasses

Thirty ungulates in the Firehole-Gibbon study area were estimated to have died after 23 March and were thus considered available to bears. Short yearling elk and bison were included in this count due to the restricted nature of the geothermal areas and the absence of evidence indicating coyote predation on ungulates.

An estimated 5,832 kg of biomass (wet weight) was available to bears on survey routes in the Firehole-Gibbon study area. Four adult male bison carcasses accounted for a large portion (2,395 kg) of biomass estimated to be available to bears. Five female bison contributed to the second greatest amount (1,776 kg) of available biomass. Among elk, old females contributed the most (402 kg) to available biomass; short yearlings also contributed an estimated 397 kg to available biomass.

Nine of 30 carcasses available to bears evidenced bear use. Of the 9 carcasses used by bears, 3 were adult bison, 2 were adult elk, 1 was a short yearling bison, and 3 were short yearling elk.

Two of the elk found died as a result of grizzly bear predation. An adult bull elk was killed near Tanker Curve along the Gibbon River, and a short yearling elk was killed in Pocket Basin in the Firehole drainage.

Carcass use by bears was less than expected within 400 m of active highways. Nineteen of the 30 carcasses available to bears were located within 400 m of an active highway. Only 2 of these carcasses were used by bears. Seven of the 11 remaining carcasses beyond 400 m of an active highway were used by bears (Fig. 11).

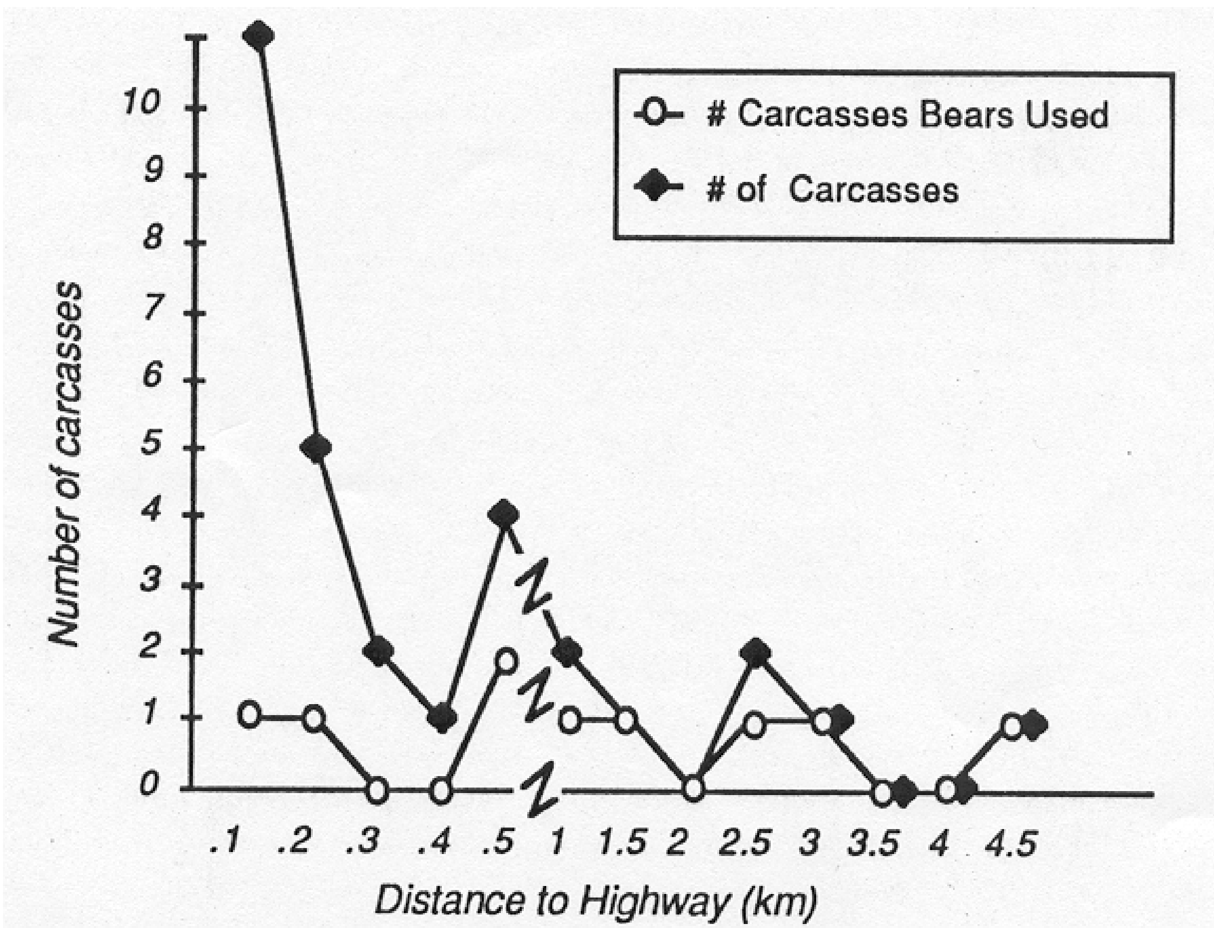


Fig. 11. Available carcasses and carcasses used by bears in the Firehole-Gibbon study area, by zones away from highways.

Human Activities

The level of human activity in the Old Faithful area was recorded by 2 methods. Traffic counters at Madison Junction and south of Biscuit Basin recorded traffic to and from Old Faithful between 26 April (Julian date 130) and 18 May (Julian date 138). The minimum number of recorded passes by vehicles between Madison Junction and Old Faithful was 237. Vehicular traffic increased from this low on 26 April to 2,478 on 18 May, the last date of our survey period. The number of individuals served meals in the Old Faithful TW Services cafeteria was also recorded, as was the number of contractors who had lunch at Old Faithful. The average minimum number of individuals who had lunch at Old Faithful from 4 April through 28 April was 31.

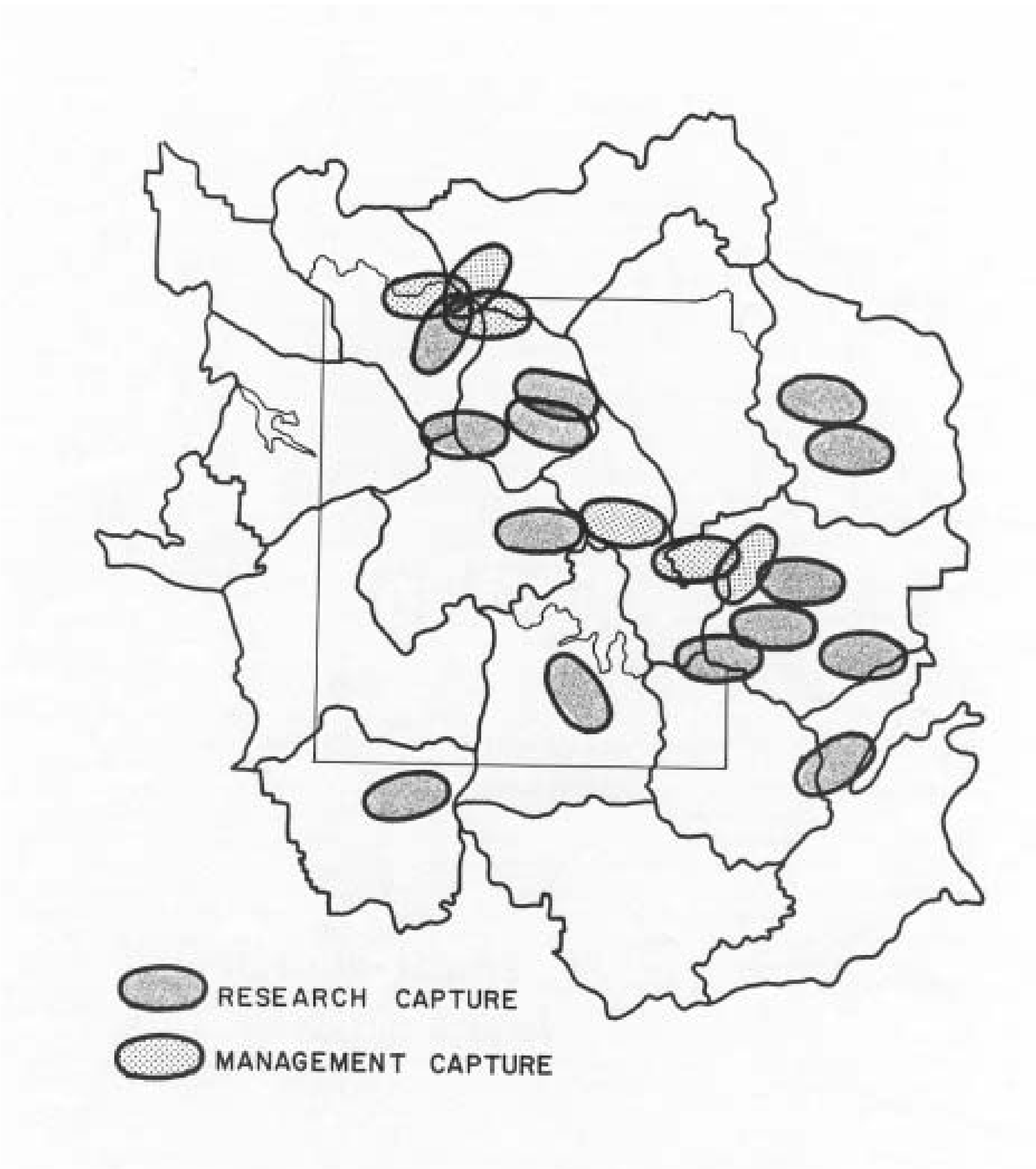
RESULTS AND DISCUSSION

Low precipitation in the fall and winter combined with mild fall and spring temperatures almost certainly explained my low frequency of encounters with ungulate carcasses during the spring of 1988. Moderate amounts of carrion were found in the Firehole drainage when compared to previous years (Henry and Mattson 1988). Fewer carcasses were found on the Northern Range than in 1987.

Carcasses within 400 m of an active highway in the Firehole-Gibbon study area were used less by bears than more distant carcasses. Carcasses within 3 km of an active road on the Northern Range were also used less by bears. In addition, a positive relationship was evident between number of bear tracks found per kilometer of survey route traveled and distance from the Cooke City highway. Although sample sizes were small, these findings corroborate the 1987 findings on the Northern Range and are comparable to previous years findings in the Firehole drainage. Pooling of carcass use and track data over a number of years will more clearly define bear avoidance of roads and human development.

I hypothesize that differences in bear avoidance of roads between Northern Range and Firehole-Gibbon study areas are the result of differences in cover availability. Areas immediately adjacent to highways on the Northern Range contain relatively little average forest cover (Green and Mattson 1988). In contrast, the Firehole-Gibbon study area is more densely forested. However, analysis of 1988 data indicates the 400-m zone of reduced bear involvement in the Firehole-Gibbon area encompasses a greater concentration of carcasses than the 3-km zone of influence indicated on the Northern Range.

The concentration of black bear sign found in and around the Black Canyon subunit in spring 1988 was similar to the findings of 1987, although considerably more grizzlies were estimated to be in our study area during 1988 than in 1987. The concentration of black bears to grizzly bears likely reflects black bear avoidance of grizzlies and niche differences between the 2 species. However, no well-founded hypotheses can be presented at this time to explain the difference in grizzly numbers on the Northern Range between 1987 and 1988.



Appendix A. Range locations of adult female grizzly bears radio-monitored during 1988, and bear management unit boundaries.

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