BEAR USE OF CUTTHROAT TROUT SPAWNING STREAMS IN YELLOWSTONE NATIONAL PARK

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Abstract: Grizzly bears (*Ursus arctos*) and black bears (*U. americanus*) prey on spawning cutthroat trout (*Oncorhynchus clarki*, formerly known as *Salmo clarki*) in tributary streams of Yellowstone Lake. These tributary streams were surveyed from 1985 to 1987 to determine the presence and level of trout spawning activity and bear use. Indices were developed to enumerate spawner density and levels of bear use. Of 124 known tributaries of Yellowstone Lake, 48% had a spawning run. Of these spawning streams, 93% had associated bear activity, and 61% had associated evidence of bear fishing. Bears were apparently using more spawning streams and fish compared to 10 years earlier. Bear use of cutthroat trout spawning streams appeared to be largely a positive function of volumetric spawner density. We hypothesize that abundance and quality of stream-side vegetation relative to other foraging options influenced bear use. Intra- and interspecific avoidance among bears was suggested by patterns of spawning stream use. Less bear use of spawning streams than expected occurred within 1 km of park developments.

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Spawning and migrating salmonids are a major food of brown bears and black bears in coastal Alaska (Clark 1959, Frame 1974, Luque and Stokes 1976, Glenn and Miller 1980), British Columbia (Meehan 1961, Hamilton and Archibald 1985), and the Soviet Union (Bergman 1936, Bromlei 1965). In Yellowstone National Park, black and grizzly bears prey on spawning cutthroat trout in tributary streams of Yellowstone Lake (W.P. Hoskins, Yellowstone Lake Tributary Study, Interagency Grizzly Bear Study Team. Unpubl. rep., 1975; Mealey 1980). This has been evident from fish carcasses, vegetation matting, bear scats, tracks, and observations of bears along banks of spawning streams around Yellowstone Lake.

Bear use of spawning cutthroat trout in Yellowstone Park was studied in the early 1970's (W.P. Hoskins, Yellowstone Lake Tributary Study, Interagency Grizzly Bear Study Team. Unpubl. rep., 1975; Mealey 1980). Since 1975, changes in management of the cutthroat trout fishery have resulted in an increased proportion of older and larger fish in Yellowstone Lake (Gresswell and Varley 1988). This study was initiated by the Interagency Grizzly Bear Study Team (IGBST) in 1985 to further investigate bear use of spawning cutthroat trout in Yellowstone Park and to determine changes in levels of spawning stream use by bears since the early 1970's.

STUDY AREA

The study area included all 124 known tributary streams of Yellowstone Lake in east-central Yellowstone National Park, not including the Yellowstone River inlet and outlet (Fig. 1). Yellowstone Lake is a high elevation (2,358 m) oligotrophic lake. It has a surface area of 35,391 ha, mean depth of 42 m, basin capacity of 14 x 10^9 m^3, and watershed area of an estimated 261,590 ha (Benson 1961). Yellowstone Lake is typically frozen from December until late May or early June.

Landscape physiognomy of the Yellowstone Lake basin differs substantially between east and west shores of the lake. The east and southeast drainages are dominated by larger tributaries draining from high relief mountain topography, closed canopy mixed forest, and open subalpine slopes. The west and north drainages are characterized by smaller streams draining from low relief plateau topography, lodgepole pine (*Pinus contorta*) forest, and alluvial meadows.

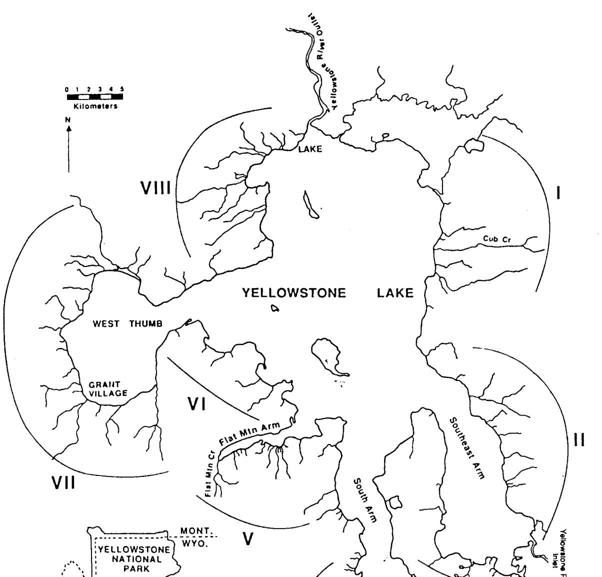

Fig. 1. Map of Yellowstone Lake and tributary streams. Study area streams are grouped as follows: east shore - groups I and II; south arms - groups III and IV; west shore - groups V and VI; front-country - groups VII and VIII. Front-country streams are proximal to park roads and developments.

METHODS

Field Methods

Field work was conducted during the cutthroat trout spawning runs, from May through August 1985, 1986, and 1987. Tributary streams within the study area were surveyed at approximately 1- to 2-week intervals. The 1985 study area included backcountry streams away from roads and developments along the east shore, south arms, and west shore (groups I through VI, Fig. 1). The 1986 study area consisted of front-country streams characterized by their nearness to park roads and developments (groups VII and VIII, Fig. 1). Selected backcountry streams (groups I and V) were also surveyed in 1986. In 1987, all study area streams were surveyed.

The presence and level of cutthroat trout spawning runs, bear activity, and bear fishing were determined from data collected for each visit and 100-m stream section. These data were: stream physical parameters including mean width, depth, and water temperatures; fish numbers and upstream extent of the spawning run, by counting spawners while walking upstream from the mouth (Frame 1974); bear activity and fishing, by counting and collecting all bear scats, counting fish carcasses, classifying bear trail use, and measuring all bear tracks found along streams.

Analysis Methods

Indices were developed to enumerate the relative density of spawning cutthroat trout and level of bear activity and bear fishing for each stream visit. Volumetric fish density (F_i) was expressed as the mean number of fish per m^3 of stream and was calculated by dividing the mean number of fish observed per 100-m section (F_n) by the mean volume of a 100-m stream section (S_v):

$$F_i = F_n / S_v$$

Two variables and 1 constant were used to calculate a relative index of bear activity (B_i). The mean number of scats found along 100-m sections of stream (B_s) and estimated level of bear trailing (B_t), expressed by a 5-part code (none = 0, light = 0.5, moderate = 1.0, heavy = 1.5, very heavy = 2.0) (cf. Reinhart and Mattson 1987), were added and multiplied by 0.25:

$$B_i = (B_s + B_t) \times 0.25$$

Bear fishing index (B_f) was calculated in a similar manner using 2 variables and 2 constants. Mean number of fish parts equivalent to 1 fish carcass, per 100-m stream section, (B_p) and mean percent volume of fish in bear scats, multiplied by 0.02 (B_{sf}), were added and multiplied by 0.25:

$$B_f = (B_p + B_{sf}) \times 0.25$$

Values of B_i and B_f were scaled with constants so as to range from 0 to 1. These indices were plotted for key streams to display temporal changes in spawner density, bear use, and bear fishing (Fig. 2). The extent and duration of spawning runs and bear activity were accounted for on each stream by summing F_i, B_i, and B_f across all stream visits. The result indexed total fish density and bear use for each stream, each year.

The relationship between volumetric fish density and bear activity (the dependent variable) was evaluated by simple linear regression analysis. Regression equations were developed for each year and major stream area (Table 1). Analysis of covariance was used to test for differences of regression coefficients and intercepts for significant regressions, among major stream areas for a given year. We tested for difference of slope and intercept between the west shore and front-country regressions for 1986, even though P was >0.05 for the west shore regression; we used the west shore as a standard of comparison for evaluating human impacts in the front-country area. Differences in track proportions among stream groups were tested using the Chi-square and Z statistics. The Tukey test was used to test between pairs when there was an overall significant difference among regression coefficients and elevations or bear track proportions (Zar 1984).

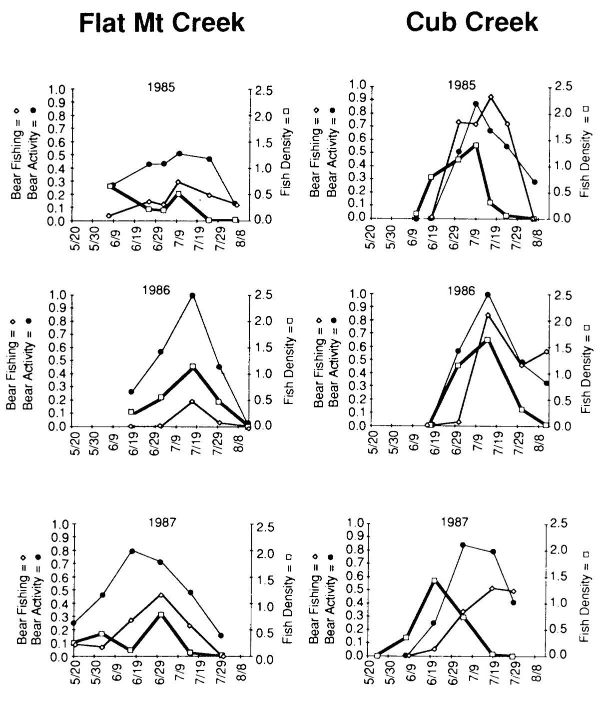

Fig. 2. Indices of bear fishing, bear activity, and fish density by date for Flat Mountain Creek (west shore) and Cub Creek (east shore) in 1985, 1986, and 1987.

Table 1. Regression equation parameters ($B_i = a \times b(F_i)$) for the relationship between fish density (F_i) and bear activity (B_i) for individual study years and areas around Yellowstone Lake. Areas are designated: WS - west shore; SA - south arms; ES - east shore; FC - front country. Front-country streams were divided into those >1 km from developments and <1 km from developments.

Year	Area	*n*	*a* (intercept)	*b* (slope)	r^2	*P*
1985	WS	8	0.482 A[a]	1.291 A	0.681	0.012
	SA	8	0.246 A	0.952 A	0.581	0.028
	ES	6	-0.312 B	0.742 A	0.873	0.006
1986	WS	6	0.734 A	0.448 A	0.500	0.116
	ES	6	0.689	0.498	0.456	0.325
	FC	17	-0.128 B	0.349 A	0.562	0.001
	>1 km	11	0.010	0.439	0.827	0.000
	<1 km	6	0.019	0.014	0.074	0.603
1987	WS	9	0.713	1.190 A	0.858	0.000
	SA	8	0.964	0.808	0.053	0.584
	ES	6	0.907	0.264	0.464	0.136
	FC	17	0.290	0.116 B	0.548	0.000
	>1 km	11	0.288	0.157	0.846	0.000
	<1 km	6	0.408	0.015	0.032	0.735

[a] Slopes and intercepts with unlike letters are significantly different ($P < 0.05$) within years. Only significant equations ($P < 0.05$) were tested, with the exception of WS 1986 ($P = 0.116$), and intercepts were not tested if slopes differed significantly (Zar 1984).

Tracks were used to estimate the number, species and size class of bears using spawning streams. Only tracks of autonomous bears were used for tallies and analysis. Interchange of bears among streams within each group was assumed. All track measurements for each stream group were plotted for each stream visit. The number of individuals was estimated by track size for each visit and year based on clustering of track measurements. Rear and front track widths were both used to discriminate individuals. Concurrence of larger and substantially smaller tracks was the basis for inferring presence of family groups.

Estimated track sizes for individuals were then compared across time periods within each stream group, and among adjacent stream groups. Tracks of equal or overlapping size from different time periods were considered to be of the same individual. When a clear pattern of track size clusters was not evident, a range of usually 1-2 bears was given. With this technique, the total number of bears estimated to have used a group of streams during a summer was usually less than the sum of individuals across stream groups and time periods. Track frequencies were tabulated by species, size class, and association with tracks of dependent young for each stream group and year. We assumed that track frequencies were correlated with the level of stream use by corresponding bear classes.

RESULTS

Bear Use of Spawning Streams

Of 124 known tributaries of Yellowstone Lake, 59 (48%) had a cutthroat trout spawning run. Of these streams, 55 (93%) had associated bear activity, and 36 (61%) had conclusive evidence of bear fishing. In a similar study, W.P. Hoskins (Yellowstone Lake Tributary Study, Interagency Grizzly Bear Study Team. Unpubl. rep., 1975) found the same number of streams with spawning runs. However, only 17 (29%) of these streams were known to be used and 11 (19%) fished by bears in 1974 and 1975.

Variation in the occurrence and timing of spawning runs and bear activity was evident among study years and lake areas. Sixty-one percent of backcountry spawning streams were fished by bears all 2 or 3 study years, whereas only 24% of front-country streams were fished both years they were surveyed. The beginning, peak, and end of spawning runs and associated bear use in 1986 were 1-2 weeks later than in 1985, and 2-4 weeks later than in 1987 (Fig. 2). Onset and peak of spawning stream use by bears was consistently 1-3 weeks later on the east shore compared to other areas around the lake. Highest levels of bear fishing and streamside use occurred within 1-2 weeks after peak number of spawners (Fig. 2).

Fish Density and Bear Activity

There was an overall positive relationship between volumetric fish density and bear activity on backcountry spawning streams (Table 1). More specific patterns were evident when streams were stratified by major areas around Yellowstone Lake and study years. Steep slopes and high r^2 values characterized the regression of bear activity on fish density for the west shore in 1985 and 1987, and the east shore and south arms in 1985. A moderate slope and lower r^2 value were evident for the west shore 1986 regression. Weak or not significant relationships were evident on the south arms in 1987 and east shore in 1986 and 1987. Intercepts were lowest for the regression between bear activity and fish density on all stream groups during 1985. Intercepts of significant regressions were highest on the west shore.

Moderate slopes and r^2 values characterized the regression between fish density and bear activity for all front-country streams in 1986 and 1987 (Table 1). The relationship between bear activity and spawner density was much stronger for spawning streams >1 km from tourist facilities and campgrounds compared to streams <1 km from developments. Intercepts for front-country regressions were consistently low. In 1986, indices of bear activity were 90% less on streams <1 km from developments than expected by the relationship between fish density and bear activity on streams >1 km from developments. Overall this translated into 46% less use of front-country spawning streams than expected. In 1987, observed bear use on streams <1 km was 30% less than expected, and overall use of front-country streams 13% less than expected.

Track Measurements

We estimated a minimum of 44 autonomous bears on spawning streams around Yellowstone Lake during 1987. Each of these bears was associated with ≥5 sets of track measurements. Mean difference between the largest and smallest measurement for an individual was 5.6 mm (SD = 1.9 mm).

Differences in number of autonomous bears and representation of bear species and classes were evident among stream groups (Table 2). Streams <1 km from human developments (group VIII) received comparatively little bear use during either 1986 or 1987. The largest number of bears was estimated to use streams in groups I, IV, V, and VII. Tracks of autonomous small bears were proportionately most common on streams in groups III-VII. Conversely, with the exception of group VIII, tracks of large lone bears were proportionately least common in groups III-V. Family groups and their tracks were concentrated in groups I and V. Proportionate representation of black bear tracks in 1987 progressively increased around the lake from groups I and II to a maximum in groups VI and VII.

A tendency towards spacing among bear classes and family groups was evident on the 3 major backcountry spawning streams. An average of 1.4 and range of 1-2 family groups were present on a given stream on 13 visits where at least 1 family group was present, even in areas where 7 to 8 family groups were known to be in the area. An average of 1.4 and range of 1 to 4 large lone bears were also present on a given stream on 25 visits where at least 1 large lone bear was known to be present. A family group was present only 1 of 7 instances where 2 or more large lone bears were present on a stream, and 6 of 17 instances where tracks of 1 large lone bear were observed. Family groups were also present on 6 of 11 visits when no tracks of lone large bears were observed. On 1 of the streams, where large lone bears were present 13 out of 14 visits, tracks of small bear were found only once. On another stream where tracks of large bears were found only 7 out of 16 visits, small bear tracks were found on 6 of the visits.

Variation in classes and numbers of bears using spawning streams among years was especially evident in stream groups I (n = 3 years), V (n = 3 years), and VII (n = 2 years). In stream group I, the greatest difference among years was attributable to twice as many family groups and increased proportionate representation of family group tracks in 1987 compared to 1985 and 1986 ($Z = 3.82$; $P < 0.001$). Number of large lone bears using the east shore was consistently high all years, although their tracks were proportionately fewer in 1987. In group V, 2 large lone bears were present all 3 years, although the proportionate number of large tracks tended to be lower in 1987 ($Z = 1.49$; $P < 0.07$). There were fewer family groups in stream group V during 1985, but proportionately the same amount of use by this class as during other years ($x^2 = 0.48$; df = 2; $P < 0.79$). In stream group VII there were consistently few (2) family groups, and proportionate representation of black bear and large lone bear tracks tended to be higher in 1987 compared to 1986 ($Z = 1.46$; $P < 0.08$). A much greater number of tracks were recorded in 1987 on all major stream groups, especially compared to 1985.

DISCUSSION

Methods

Tracks have been used to census or index bear populations elsewhere (Edwards and Green 1959, Klein 1959,

Table 2. Estimated number of individuals and percent of total tracks among different bear species and classes, for all stream groups, 1985-87. Proportions of large, small, family group, and black bear tracks differed significantly ($P < 0.001$) among stream groups in 1987 (df = 7; χ^2 = 49.1, 24.6, 59.2, and 80.9, respectively); proportions of medium-sized tracks did not (χ^2 = 13.0; df = 7; P = 0.08). Proportions of grizzly bear tracks, total, were not tested, but are complementary to proportions of black bear tracks.

	Year and stream group																
	1985					1986				1987							
Bear class or species	I	II	III	IV	V	I	V	VII	VIII	I	II	III	IV	V	VI	VII	VIII
	Number of bears (*n*)																
Large lone bears[a,b]	5	2	0	2	2	5	1-2	2	1	3	3	2	2-3	2	1	2	0
Medium-size lone bears[a]	2	2	1	3	2	2-3	3	3	3	3-4	4	3	3-5	3-5	4	3	1-2
Small lone bears[a,c]	2	2	4	7-8	4-5	2	4	5	0	3-4	1	3	4	4-5	1	5	1
Family groups[a]	4	0	0	2	2	4	6-7	2	0	7-8	2	0	1-2	4-5	1	2	1
Black bears	[d]	[d]	[d]	[d]	[d]	4-5	4-5	4	1	1-2	1	4	4-5	4-6	4	4	1
Grizzly bears	[d]	[d]	[d]	[d]	[d]	9	10-11	8	3	15-17	9	4	6-9	9-11	3	8	2-3
Total bears	13	6	5	14-15	10-11	13-14	15-16	12	4	16-19	10	8	10-14	13-17	7	12	3-4
	Tracks (%)																
Large lone bears[a,b]	40	[e]	[e]	7	21	42	13	23	[e]	16 AB[f]	30 C	14 AB	24 BC	10 A	24 BC	30 C	0 D
Medium-size bears[a]	33	[e]	[e]	31	18	32	36	18	[e]	35	46	62	45	40	55	38	54
Small lone bears[a,c]	7	[e]	[e]	43	36	6	32	33	[e]	10 A	5 A	24 B	24 B	24 B	14 AB	22 B	7 A
Family groups[a]	20	[e]	[e]	19	24	20	19	26	[e]	39 A	19 C	0 E	8 D	26 BC	7 D	10 CB	39AB
Black bears	[d]	[d]	[d]	[d]	[d]	11	28	23	[e]	3 A	3 A	36 BC	37 BC	32 B	48 C	47 C	7 A
Grizzly bears	[d]	[d]	[d]	[d]	[d]	89	72	77	[e]	97	97	64	63	68	52	53	93
Total no. of tracks	46	8	11	42	32	79	69	39	5	153	57	37	67	135	29	91	28

[a] Includes both black and grizzly bears.
[b] Track size >12.8 cm.
[c] Track size <10.9 cm.
[d] No data are available; during 1985 we were refining our technique for distinguishing black and grizzly bear tracks.
[e] Insufficient data for calculating percentages.
[f] Percentages within a class with the same letters are not significantly different ($P < 0.05$) among stream groups.

Valkenburg 1976, Pulliainen 1983). In these other studies, use of tracks was compromised by frequent rains, highly variable substrates and track ages, and high bear densities. However, Valkenburg (1976) and Klein (1959) suggested that tracks could be legitimately used with lower bear densities and when comparing relative numbers of bear types in different areas.

Conditions in our study area were favorable for using track measurements, especially to elucidate inter- and intraspecific bear relationships. An average of 3, and in all cases <7 bears, were estimated to have used a given stream at a given time. Trackable substrate was abundant and good quality tracks were numerous. Rains were also less frequent in Yellowstone Park than coastal Alaska.

Our analysis was inherently conservative and probably underestimated the total number of bears using spawning streams. Because we were not continually monitoring streams, we almost certainly did not record all bear visits and associated tracks. A significant number of bears probably had nearly identical track sizes, and were identified as a single bear by track analysis. Our consolidation of bears among time periods and adjacent stream groups was also conservative. We likely derived the most accurate estimates for individual streams and visits.

Our indirect survey methods had limits due to the time intervals between surveys and the ephemerality of the sign measured, so that we could not estimate the total number of fish eaten or the precise number of bears present. However, our objective was to evaluate bear use of spawning streams on a larger scale, and so we required a means of repeatedly surveying all streams tributary to Yellowstone Lake in a comparable, systematic manner. This necessitated our use of indirect measures and synthetic indices.

Bear Use of Riparian Habitats

Our data suggest a number of factors influencing bear use of riparian habitats around Yellowstone Lake. These include the density of fish spawners, the overall habitat complex, inter- and intraspecific relationships, and the presence of humans.

Fish Density. — W.P. Hoskins (Yellowstone Lake Tributary Study, Interagency Grizzly Bear Study Team. Unpubl. rep., 1975) and Mealey (1980) suggested that bear use of spawning trout on Yellowstone Lake depended on stream characteristics and linear density of fish. Our results suggest that bear fishing success depended on volumetric fish density. Logically, volumetric density more closely reflects the impediment posed to bear fishing by stream size. Streams with the same absolute number of spawners, but smaller cross-sectional area, typically receive substantially greater bear fishing use. Linear density and absolute number of spawners are misleading indicators of potential bear use.

Habitat Complex. — The drainage basin of the backcountry west shore and south arms was characterized by numerous small tributaries with open riparian corridors or alluvial meadows surrounded by lodgepole pine forest. Many west shore streams had high fish densities and were fished heavily, whereas south arm streams offered less fishing opportunity. Backcountry streams on the west shore and south arms both received substantial bear use, even when fish were absent or present only in low densities. This was reflected principally in high regression equation intercepts for these areas. Apparently the lush riparian vegetation in meadows and forest openings associated with these streams was heavily used by bears, which was especially likely, given the paucity of bear foods in surrounding upland forests. The large amounts of graminoids in scats from the west shore (Reinhart and Mattson 1987) support this interpretation. The nearness of numerous smaller streams to primary spawning tributaries, especially in stream group V, could also explain substantial bear use along streams with virtually no spawners.

The east shore environment differed from that of other lake areas. Tributaries from surrounding high relief mountains were typically fewer, larger, and bounded by forest. There were also other foraging options for bears at higher elevations, including use of overwintered whitebark pine (*Pinus albicaulis*) seeds (Kendall 1983), biscuitroot (*Lomatium cous*), and graminoids in lush mountain meadows. Bears on the east shore probably did not use the riparian habitat complex associated with spawning streams as they did on the west and south shores. The lower regression intercept and strong relationship between bear stream use and fish density during 1985 reflected a pronounced attraction to fish by bears occupying east shore streams. Bears were apparently using east shore stream habitats primarily for fishing, and were apparently foraging elsewhere when not. The predominance of fish in scats collected along the east shore compared to other lake areas (Reinhart and Mattson 1987) supports this interpretation.

Humans. — The presence of humans appeared to affect bear use of front-country spawning streams. The habitat complex containing front-country streams was similar to that containing west shore backcountry streams. Bear use of front-country streams differed from the west shore by proportionately more black bear and large lone bear use and by less family group use. Regression equation intercepts were also consistently much lower for front-country compared to west shore backcountry streams. There was very little bear use of streams without spawners when humans were present. This suggests that in similar habitat, attraction of bears to front-country streams was more contingent on fish than the overall riparian habitat.

This comparison is complicated by some front-country streams consistently having much higher spawner densities than backcountry west shore streams. These high spawner densities may explain the tendency towards greater use of front-country streams by large lone bears; high densities of fish may have attracted larger bears despite the presence of humans. Proportionately less family group use of front-country streams could have resulted from avoidance of both humans and/or large lone bears.

Very little use of streams <1 km from developments was recorded, despite sometimes high spawner densities. This pattern varied between 1986 and 1987, probably as a consequence of differences in timing of spawning runs relative to the opening of lakeshore developments. Park developments opened mid- to late May in 1986 and 1987. The 1986 spawning runs began in mid-June because of a deep snowpack and later snowmelt (Soil Conservation Service Snotel data), and overlapped entirely with the period of heavy human use. Bear use of spawning streams <1 km from developments was likely 90% less than expected by fish densities during 1986 because of this concurrence. During 1987, the snowpack was shallower and snowmelt earlier; spawning runs began in early to mid-May, before the opening of major developments. Consequently, bear use of streams close to developments was only 30% less than expected. Clearly, timing of spawning runs relative to opening of developments had substantial impacts on bear use of streams closest to human facilities.

Intra- and Interspecific Spacing. — The 1987 east shore regression equation appears to be anomalous by all factors considered so far. The intercept is high and the straight line relationship between fish density and bear use of streams is not significant. This seemingly contradicts the hypothesis that bears were attracted to fish when using east shore streams. However, during 1987 on the east shore, more family groups were present and accounted for a larger proportion of stream use than for any other stream group in any other year. During 1986, a high number of cub-of-the-year litters was observed in the Yellowstone area compared to other years (Knight et al. 1987). Front track sizes of dependent young on the east shore in 1987 were mostly in the range of yearling dependents, 8.0 to 10.0 cm. The consistent presence of no more than 2 family groups on a single large stream at a given time suggests considerable spacing among family groups, probably compounded by avoidance of large lone bears. With 7 to 8 family groups present, and only 2 high quality fishing streams available, other family groups were probably temporarily forced to occupy streams with lower spawner densities or use other foraging options. This probable intraspecific spacing could have resulted in bear distribution among streams that obscured their attraction to fish.

Other spacing of bear species and classes was evident around Yellowstone Lake. Small lone bears were the most common users of streams with the least use by large lone bears, including streams on the south arms and west shore that had some of the lowest spawner densities on the lake. Even when present in a stream group used by several large lone bears, small bears typically did not use the best spawning streams or typically only when large lone bears were absent. Small bears were apparently avoiding big bears, and probably making do with poorer quality spawning streams and associated riparian habitat. Comparable subadult avoidance of adult bears has been documented in other studies (Hornocker 1962, Stonorov and Stokes 1972, Egbert and Stokes 1976, Herrero 1983).

Black bear use of streams was also increasingly common, progressing from the east shore to the west shore. This pattern probably reflected a number of factors, including differences in the overall habitat complex. However, black bears made very little use of the area with the largest number of large lone grizzlies and grizzly bear family groups on the lake. Avoidance of typically larger and probably more aggressive grizzlies by smaller black bears was suggested, as was the tendency for black bears to use the vicinity of human developments more often.

CONCLUSIONS

Cutthroat trout were an important, high quality food to a substantial number of bears in the Yellowstone ecosystem from May through July. Previous food habits studies (Mealey 1980) in Yellowstone National Park have not demonstrated a high overall level of trout use by bears. This may be attributable to underrepresentation of fish in scats, due to their high digestibility, and undersampling associated with meat scats and remote backcountry locales.

Bears were apparently using more spawning streams and fish during 1985-87 compared to 10 years earlier. This was most likely due to changes in fisheries management that resulted in more large fish. Previous studies were also likely dealing with a bear population in transition from making substantial use of human foods to using habitat in a way much less affected by humans. Earlier studies did not mention bear use of spawning streams during 1959-70 (cf. Craighead and Craighead 1971, Craighead 1976, Craighead et al. 1982).

Humans significantly affected bear use of spawning streams. Streams <1 km from major developments, including streams in the vicinity of park hotels, stores, and campgrounds, were most dramatically affected. Human effects were greatest when spawning runs coincided with human use and occupancy of developments. These effects could be mitigated by reducing the temporal overlap of spawning runs and human use of developments. Given that bears are better able to adapt to predictable human behavior (Jope 1985), a fixed but late opening schedule for lakeshore developments may be required for effective mitigation.

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