# Yellowstone Grizzly Bear Investigations 1996

Bear 84, 5/24/84, IGBST photo

## Annual Report of the Interagency Grizzly Bear Study Team

# YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

## Report of the Interagency Grizzly Bear Study Team

## 1996

U.S. Geological Survey, Biological Resources Division
National Park Service
Wyoming Game and Fish Department
U.S. Fish and Wildlife Service
Montana Department of Fish, Wildlife and Parks
U.S. Forest Service
Idaho Fish and Game Department

Written by: Richard R. Knight, Bonnie M. Blanchard, and Mark A. Haroldson

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# INTRODUCTION

The Interagency Grizzly Bear Study Team (IGBST) was initiated in 1973 and is a cooperative effort of the Biological Resources Division of the U.S. Geological Survey, 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. IGBST annual reports are intended to facilitate the timely transfer of research results and perspectives to management 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 (Mattson et al. 1991), population parameters (Knight and Eberhardt 1985), and growth patterns (Blanchard 1987).

Distribution of grizzly bears within the study area (Basile 1982, Blanchard et al. 1992), movement patterns (Blanchard and Knight 1991), food habits (Mattson et al. 1991), habitat use (Knight et al. 1984), and population dynamics (Knight and Eberhardt 1985, Eberhardt et al. 1994) have been largely determined and are now being studied on a monitoring and updating level. Efforts are being concentrated on developing a GIS-based Cumulative Effects Model and assessing the effects of land use practices.

Movement data conclusively indicate 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 (cf. Blanchard and Knight 1991). 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) and Mattson et al. (1991). The study area has been described in detail by Blanchard and Knight (1991) and Mattson et al. (1991).

# RESULTS AND DISCUSSION

## Monitoring/Population Trend

### *Marked Animals*

Thirty-six individual grizzly bears were captured and marked during 1996 (Table 1), including 8 females (5 adult) and 28 males (19 adult). Twenty-six had not been marked previously. Twenty-five captures were a result of research efforts and the bears were released on-site. Fifteen captures resulted from management actions involving conflicts on private land (4), campground-trailhead conflicts (1), livestock depredation (8), roadside habituation (1), and conflict in a development (1); and 10 were transported to release sites within the Yellowstone ecosystem (Table 2).

A total of 76 grizzly bears were monitored for varying intervals during 1996, including 26 adult females. A maximum of 23 adult females were monitored consecutively during October and 21 were wearing active transmitters at denning.

Since 1975, 284 grizzly bears have been radio-marked (Table 3).

### *Unduplicated Females*

One method of monitoring population trend is recording the number of unduplicated females with cubs-of-the-year (COY) each year. A summary of procedures used to determine whether or not observations are duplicates was reported by Knight et al. (1995).

Thirty-three unduplicated females with 70 COY were observed in 12 Bear Management Units (BMUs) within the Recovery Zone during 1996 (Fig. 1). The current running 6-year average (1991-96) for the entire study area is 23 females/year with an average litter size of 2.16 cubs (Table 4). This 6-year average has steadily increased from 12 females/year with 1.85 cubs/litter during the period of 1973-78.

Table 1. Grizzly bears captured during 1996.

| Bear | Sex | Age | Date | Location[a] | Release site[a] | Trapper[b] |
|---|---|---|---|---|---|---|
| 266 | M | Subadult | 4/28 | Fir Cr, BTNF | On site | WY |
| 267 | F | Subadult | 4/28 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 199 | M | 9 | 5/2 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 268 | M | Adult | 5/5 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 269 | M | Adult | 5/12 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 270 | F | Adult | 5/15 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 168 | M | 10 | 5/16 | Diamond G Ranch, Dunoir R, WY | On site | WY |
| 271 | F | Adult | 5/18 | Mormon Cr, SNF | On site | IGBST |
| 272 | M | Adult | 5/22 | Mormon Cr, SNF | On site | IGBST |
| G58 | F | 1 | 5/25 | The Oxbow, GTNP (mgt) | Snake River Pit, JDRMP | GTNP |
| 273 | M | Adult | 6/12 | Sunlight Basin, SNF | On site | IGBST |
| 274 | M | Adult | 6/14 | Game Cr, BTNF | On site | WY |
| 275 | M | Adult | 6/22 | Mesa Pit, YNP | On site | IGBST |
| 276 | F | Adult | 6/26 | Beam Gulch, SNF | On site | IGBST |
| 206 | M | 22 | 6/28 | Mesa Pit, YNP | On site | IGBST |
| 277 | M | Adult | 6/31 | Spread Cr, BTNF | On site | WY |
| | | | 7/2 | Spread Cr, BTNF | On site | WY |
| | | | 7/4 | Spread Cr, BTNF | On site | WY |
| 278 | M | 2 | 7/1 | Lodgepole Cr, SNF | On site | IGBST |
| 103 | M | 22 | 7/14 | Little Thumb, YNP | On site | IGBST |
| 225 | M | 3 | 7/14 | Spread Cr, BTNF | On site | WY |
| 279 | F | 2 | 7/22 | Blackrock Cr, BTNF | On site | WY |
| 280 | M | Adult | 7/27 | Flat Mountain Arm, YNP | On site | IGBST |
| 224 | M | 8 | 7/28 | Elk Ranch, GTNP | On site | WY |
| 281 | M | Adult | 7/28 | Pinedale, WY (mgt) | Otter Cr, YNP | WY |
| 209 | M | 9 | 8/3 | Elk Ranch, GTNP (mgt) | Mgt removal | WY |
| 233 | M | 3 | 8/7 | AMK Ranch, GTNP (mgt) | Hummingbird Peak, GNF | GTNP |
| | | | 8/15 | Boulder River, GNF (mgt) | Mgt removal | MT |
| 282 | M | Adult | 8/18 | Rock Creek Butte, BTNF (mgt) | Oxbow Cr, YNP | WY |
| 283 | M | Adult | 8/17 | Adobe Hill, BTNF (mgt) | Lodgepole Cr, SNF | WY |

Table 1. Continued.

| Bear | Sex | Age | Date | Location[a] | Release site[a] | Trapper[b] |
|---|---|---|---|---|---|---|
| 284 | F | Adult | 8/19 | Badger Cr, TNF (mgt) | Sunlight Cr, SNF | WY |
| G59 | M | Cub | 8/21 | Badger Cr, TNF (mgt) | Sunlight Cr, SNF | WY |
| G60 | M | Cub | 8/21 | Badger Cr, TNF (mgt) | Sunlight Cr, SNF | WY |
| 216 | F | 10 | 8/23 | Diamond J Ranch, MT (mgt) | Self-defense kill | MT |
| 227 | M | 4 | 8/25 | Mesa Pit, YNP | On site | IGBST |
| 285 | M | 1 | 8/28 | Big Sky, MT (private, mgt) | Big Game Ridge, BTNF | MT/IGBST |
| | | | 10/5 | Flagg Ranch, JDRMP (private, mgt) | Mgt removal | GTNP |
| G61 | M | 1 | 8/28 | Big Sky, MT (private, mgt) | Mgt removal | MT/IGBST |
| 286 | M | Adult | 9/5 | Pinedale, WY (mgt) | Mirror Plateau | WY |
| 287 | M | Adult | 10/16 | Norris, YNP | On site | IGBST |

| Individuals | | Females | Males |
|---|---|---|---|
| | Adults | 5 | 19 |
| | Subadults | 3 | 9 |

| | | Females | | Males | |
|---|---|---|---|---|---|
| Total captures | | Ad | SAd | Ad | SAd |
| | Research | 3 | 2 | 16 | 4 |
| | Management | 2 | 1 | 5 | 7 |

New Bears: 26
Total Individual Bears: 36
Total Captures: 40

[a] BTNF = Bridger-Teton National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, JDRMP = John D. Rockefeller, Jr., Memorial Parkway, SNF = Shoshone National Forest, YNP = Yellowstone National Park, (mgt = management action).

[b] GTNP = Grand Teton National Park; IGBST = Interagency Grizzly Bear Study Team; MT = Montana Department of Fish, Wildlife and Parks; WY = Wyoming Game and Fish Department.

Table 2. Grizzly bears monitored, captured, and transported, 1980-96.

| Year | Number monitored | Individual bears captured | Total captures Research | Total captures Management | Transports |
|---|---|---|---|---|---|
| 1980 | 34 | 28 | 32 | 0 | 0 |
| 1981 | 43 | 36 | 30 | 35 | 31 |
| 1982 | 46 | 30 | 27 | 25 | 17 |
| 1983 | 26 | 14 | 0 | 18 | 13 |
| 1984 | 35 | 33 | 20 | 22 | 16 |
| 1985 | 21 | 4 | 0 | 5 | 2 |
| 1986 | 29 | 36 | 19 | 31 | 19 |
| 1987 | 30 | 21 | 15 | 10 | 8 |
| 1988 | 46 | 36 | 23 | 21 | 15 |
| 1989 | 40 | 15 | 14 | 3 | 3 |
| 1990 | 35 | 15 | 4 | 13 | 9 |
| 1991 | 42 | 27 | 28 | 3 | 4 |
| 1992 | 41 | 16 | 15 | 1 | 0 |
| 1993 | 43 | 21 | 13 | 8 | 6 |
| 1994 | 60 | 43 | 23 | 31 | 28 |
| 1995 | 71 | 39 | 26 | 28 | 22 |
| 1996 | 76 | 36 | 25 | 15 | 10 |

Table 3. Status of radio-marked grizzly bears, December 1996. (Age when died or age in 1996).

| Known dead | | | | | | | | Suspected dead | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Human-caused | | | | Natural | | Unknown | | Human-caused | | Natural or unknown | |
| 3 | (7) | 94 | (1) | 1 | (28[a]) | 77 | (9) | 7 | (5) | 2 | (25[a]) |
| 4 | (5) | 95 | (11) | 12 | (25[a]) | 108 | (4) | 11 | (7) | 13 | (25[a]) |
| 5 | (14) | 97 | (16) | 56 | (1) | 238 | (3) | 24 | (2) | 16 | (27[a]) |
| 6 | (8) | 105 | (Ad) | 65 | (3) | | | 32 | (4) | 19 | (25[a]) |
| 8 | (17) | 110 | (5) | 145 | (2) | | | 75 | (1) | 36 | (25[a]) |
| 9 | (17) | 113 | (2) | 161 | (20) | | | 102 | (2) | 42 | (25[a]) |
| 10 | (12) | 120 | (3) | 187 | (5) | | | 147 | (10) | 51 | (26[a]) |
| 14 | (12) | 121 | (6) | 180 | (5) | | | | | 54 | (1) |
| 15 | (12) | 122 | (3) | 200 | (11) | | | | | 55 | (1) |
| 17 | (2) | 127 | (1) | 241 | (2) | | | | | 57 | (25[a]) |
| 18 | (3) | 134 | (8) | | | | | | | 68 | (25[a]) |
| 20 | (14) | 150 | (5) | | | | | | | 84 | (31[a]) |
| 22 | (9) | 154 | (4) | | | | | | | 86 | (25[a]) |
| 25 | (5) | 158 | (7) | | | | | | | 109 | (7) |
| 26 | (22) | 160 | (5) | | | | | | | | |
| 27 | (2) | 163 | (11) | | | | | | | | |
| 28 | (16) | 176 | (5) | | | | | | | | |
| 29 | (1) | 177 | (12) | | | | | | | | |
| 30 | (2) | 181 | (18) | | | | | | | | |
| 31 | (cub) | 183 | (4) | | | | | | | | |
| 34 | (22) | 186 | (4) | | | | | | | | |
| 38 | (13) | 191 | (18) | | | | | | | | |
| 39 | (3) | 198 | (Ad) | | | | | | | | |
| 45 | (6) | 202 | (4) | | | | | | | | |
| 46 | (5) | 209 | (9) | | | | | | | | |
| 47 | (2) | 216 | (10) | | | | | | | | |
| 49 | (3) | 223 | (2) | | | | | | | | |
| 58 | (2) | 226 | (12) | | | | | | | | |
| 59 | (8) | 230 | (SAd) | | | | | | | | |
| 60 | (6) | 231 | (2) | | | | | | | | |
| 62 | (3) | 233 | (3) | | | | | | | | |
| 63 | (4) | 235 | (4) | | | | | | | | |
| 67 | (4) | 236 | (14) | | | | | | | | |
| 69 | (3) | 240 | (SAd) | | | | | | | | |
| 76 | (6) | 244 | (9) | | | | | | | | |
| 79 | (22) | 250 | (5) | | | | | | | | |
| 81 | (4) | 255 | (cub) | | | | | | | | |
| 83 | (19) | 256 | (cub) | | | | | | | | |
| 87 | (15) | 257 | (SAd) | | | | | | | | |
| 88 | (7) | 259 | (SAd) | | | | | | | | |
| 90 | (2) | 285 | (1) | | | | | | | | |
| 93 | (2) | | | | | | | | | | |
| 83 Total | | | | 10 Total | | 3 Total | | 7 Total | | 14 Total | |

[a] Suspected died of old age.
[b] Known alive in 1991.
[c] Known alive in 1992.
[d] Known alive in 1993.
[e] Known alive in 1994.
[f] Known alive in 1995.
[g] Known alive in 1996.

Table 3. Continued.

| Off air | | | | | | Active | | | |
|---|---|---|---|---|---|---|---|---|---|
| 21 | (23) | 124[g] | (17) | 181[b] | (7) | 103 | (22) | 284 | (Ad) |
| 23 | (20) | 126 | (24) | 182[g] | (8) | 106 | (20) | 286 | (Ad) |
| 33 | (21) | 128[f] | (11) | 184[d] | (15) | 125 | (13) | 287 | (Ad) |
| 35 | (21) | 129 | (15) | 185[c] | (10) | 168 | (10) | | |
| 37 | (18) | 130 | (14) | 190 | (11) | 179 | (7) | | |
| 40 | (21) | 131 | (15) | 192 | (9) | 188 | (8) | | |
| 41 | (18) | 132 | (13) | 193 | (10) | 189 | (15) | | |
| 43 | (19) | 133 | (15) | 194 | (20) | 199 | (7) | | |
| 44 | (unk) | 135 | (15) | 195[c] | (9) | 206 | (22) | | |
| 48 | (18) | 136[g] | (14) | 196[e] | (11) | 215 | (Ad) | | |
| 50 | (22) | 137 | (16) | 197[d] | (12) | 224 | (8) | | |
| 61 | (20) | 138 | (18) | 201[g] | (7) | 225 | (3) | | |
| 64 | (18) | 139 | (17) | 203[g] | (Ad) | 227 | (4) | | |
| 70 | (18) | 140[f] | (17) | 204[e] | (6) | 229 | (13) | | |
| 71 | (18) | 141[b] | (10) | 205[f] | (12) | 237 | (13) | | |
| 72 | (19) | 142[c] | (15) | 207[g] | (15) | 242 | (15) | | |
| 73 | (17) | 143 | (17) | 208[f] | (8) | 243 | (5) | | |
| 74 | (15) | 144 | (10) | 210[g] | (14) | 246 | (8) | | |
| 78 | (17) | 146 | (16) | 211[g] | (7) | 248 | (3) | | |
| 80 | (16) | 148[f] | (13) | 212[f] | (5) | 249 | (8) | | |
| 82 | (20) | 149 | (Ad) | 213[e] | (4) | 251 | (8) | | |
| 85 | (20) | 151[g] | (17) | 214[g] | (5) | 253 | (5) | | |
| 89 | (15) | 152[d] | (23) | 217[f] | (12) | 254 | (7) | | |
| 91 | (15) | 153 | (16) | 218[f] | (7) | 258 | (9) | | |
| 92 | (17) | 155[d] | (10) | 219[e] | (6) | 262 | (3) | | |
| 96 | (unk) | 156 | (14) | 220[f] | (13) | 264 | (5) | | |
| 98 | (unk) | 157 | (Ad) | 221[g] | (5) | 265 | (8) | | |
| 99 | (15) | 159 | (Ad) | 222[g] | (5) | 266 | (4) | | |
| 100 | (13) | 162 | (22) | 228[e] | (6) | 267 | (4) | | |
| 101[f] | (14) | 164[b] | (12) | 232[g] | (4) | 269 | (Ad) | | |
| 104[f] | (14) | 165[b] | (18) | 234[f] | (11) | 272 | (Ad) | | |
| 107 | (17) | 166[g] | (14) | 239[f] | (Ad) | 274 | (Ad) | | |
| 111 | (13) | 167 | (21) | 245[f] | (5) | 275 | (Ad) | | |
| 112[f] | (23) | 169[c] | (10) | 247[g] | (8) | 276 | (Ad) | | |
| 114 | (14) | 170 | (15) | 252[g] | (8) | 277 | (Ad) | | |
| 115 | (20) | 171 | (15) | 260[g] | (6) | 278 | (2) | | |
| 116 | (22) | 172 | (9) | 261[g] | (7) | 279 | (2) | | |
| 117[b] | (13) | 173[b] | (Ad) | 263[g] | (9) | 280 | (Ad) | | |
| 118 | (13) | 174[g] | (11) | 268[g] | (Ad) | 280 | (Ad) | | |
| 119 | (15) | 175[b] | (Ad) | 270[g] | (Ad) | 282 | (Ad) | | |
| 123 | (12) | 178[b] | (10) | 271[g] | (Ad) | 283 | (Ad) | | |
| | | | | 273[g] | (Ad) | | | | |
| | | 124 Total | | | | | | 44 Total | |

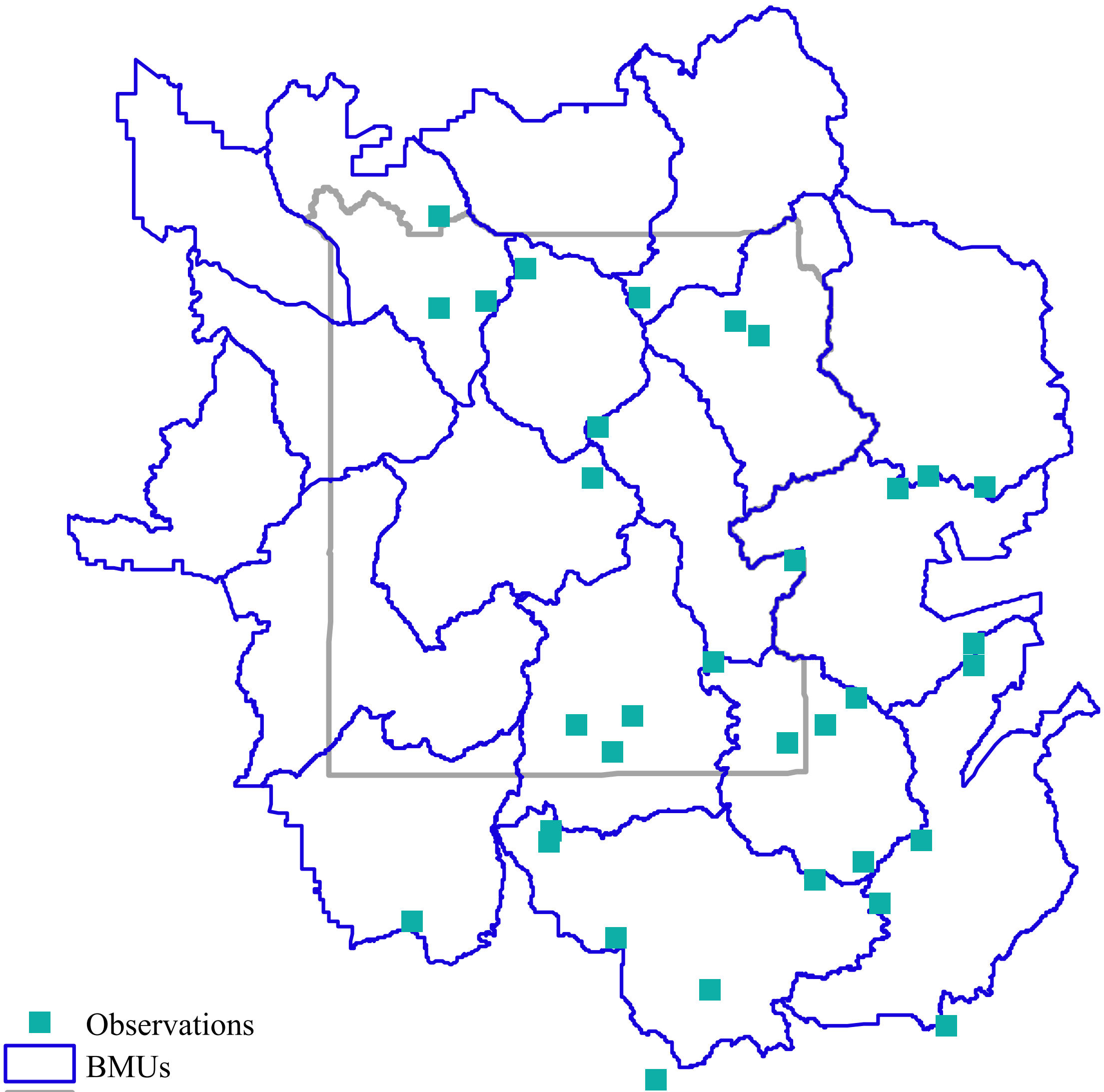


Fig. 1. Locations of initial observations of 33 unduplicated females with cubs-of-the-year within Bear Management Units inside the Recovery Zone during 1996.

Table 4. Annual unduplicated female grizzly bears with cubs-of-the-year and adult female deaths, 1973-96.

| 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 |
| 1989 | 16 | 30 | 1.88 | 0 |
| 1990 | 24 | 57 | 2.38 | 4 |
| 1991 | 24 | 43[a] | 1.87 | 0 |
| 1992 | 23 | 56 | 2.43 | 0 |
| 1993 | 20 | 41 | 2.05 | 3 |
| 1994 | 20 | 47 | 2.35 | 3 |
| 1995 | 17 | 37 | 2.18 | 3 |
| 1996 | 33 | 70 | 2.12 | 3 |
| Total | 393 | 793 | | |
| Mean | 16.38 | 33.04 | 2.02 | 2.35 |

[a] Number of cubs for 23 females; litter size for 1 female unknown.

### *Observation Flights*

During 1996, 39% of the unduplicated females with COY were seen on IGBST observation flights (Table 5). Observation flights accounted for an average 40% of the unduplicated observations during 1986-96 when methodology was similar; 10% were recorded incidentally on observation flights made by other researchers over the study area, 34% from ground sightings, and 16% from IGBST trapping efforts and radio-tracking flights only.

The 18 BMUs were flown at least once between 1 July and 7 September for an average of approximately 2.2 hours each. Grizzly bear observation rate was 1.36 unmarked bears/hour on 35 observation flights (Table 6) compared to 0.38 unmarked bears/hour on 84 radio-tracking flights. Females with COY were seen an average of 0.22/hour on observation flights and 0.04/hour on radio-tracking flights. Radio-marked bears were seen 7% of the time on radio-tracking flights.

Table 5. Annual unduplicated female grizzly bears with the cubs-of-the-year by prioritized method of observation, 1986-96.

| | Observation flights | | Ground | Radio | |
|---|---|---|---|---|---|
| Year | IGBST[a] | Other | sightings | flights/trap | Total |
| 1986 | 9 | 2 | 10 | 4 | 25 |
| 1987 | 5 | 1 | 4 | 3 | 13 |
| 1988 | 7 | 1 | 7 | 4 | 19 |
| 1989 | 7 | 2 | 5 | 2 | 16 |
| 1990 | 8 | 0 | 12 | 4 | 24 |
| 1991 | 17 | 2 | 2 | 3 | 24 |
| 1992 | 10 | 4 | 6 | 3 | 23 |
| 1993 | 3 | 4 | 10 | 3 | 20 |
| 1994 | 12 | 4 | 2 | 2 | 20 |
| 1995 | 2 | 2 | 12 | 1 | 17 |
| 1996 | 13 | 1 | 10 | 9 | 33 |

[a] IGBST = Interagency Grizzly Bear Study Team.

Table 6. Unmarked grizzly bears observed during observation flights, 1973-96.

| Year | Number of flights | Total hours | Total bears | Bears per hour | Unduplicated females with cubs-of-the-year per hour |
|---|---|---|---|---|---|
| 1973 | 24 | 75.90 | 59 | 0.78 | 0.03 |
| 1974 | 47 | 146.30 | 128 | 0.87 | 0.06 |
| 1975 | 24 | 47.20 | 20 | 0.42 | 0.02 |
| 1976 | 5 | 18.50 | 30 | 1.62 | 0.05 |
| 1977 | 0 | | | | |
| 1978 | 0 | | | | |
| 1979 | 7 | 23.00 | 14 | 0.61 | 0.13 |
| 1980 | 6 | 22.30 | 27 | 1.21 | 0.18 |
| 1981 | 4 | 16.00 | 13 | 0.81 | 0.25 |
| 1982 | 6 | 23.70 | 23 | 0.97 | 0.13 |
| 1983 | 41 | 124.30 | 36 | 0.29 | 0.03 |
| 1984 | 11 | 29.00 | 27 | 0.93 | 0.24 |
| 1985 | 16 | 30.50 | 21 | 0.69 | 0.07 |
| 1986 | 24 | 52.00 | 29 | 0.56 | 0.17 |
| 1987 | 20 | 47.20 | 35 | 0.74 | 0.11 |
| 1988 | 17 | 33.87 | 62 | 0.66 | 0.21 |
| 1989 | 37 | 88.71 | 87 | 0.98 | 0.08 |
| 1990 | 39 | 86.01 | 81 | 0.94 | 0.09 |
| 1991 | 46 | 99.24 | 257 | 2.59 | 0.17 |
| 1992 | 31 | 68.73 | 204 | 2.97 | 0.15 |
| 1993 | 29 | 58.42 | 43 | 0.74 | 0.05 |
| 1994 | 32 | 64.46 | 112 | 1.75 | 0.19 |
| 1995 | 30 | 65.20 | 70 | 1.07 | 0.08 |
| 1996 | 35 | 77.09 | 105 | 1.36 | 0.22 |

### *Mortalities*

Fifteen mortalities were recorded in 1996 (Table 7). Nine were human-caused, including 1 subadult and 3 adult females. Four deaths were management removals, 3 self-defense, 1 illegal, 1 road kill, and 4 natural. Cause of death for 2 bears could not be determined; decomposed carcasses were found and time of deaths could have been during the spring of 1996 or fall of 1995.

Table 7. Grizzly bear mortalities recorded during 1996.

| Bear | Sex | Age | Date | Type | Location[a] | Cause |
|---|---|---|---|---|---|---|
| 238 | M | 3 | | Known | Crevice Cr, BNF | Unknown: carcass found by bow hunters (from spring or previous fall) |
| Unm | Unk | 25+ | | Known | Firehole, YNP | Unknown: bones and hair found 9/30/96 (from spring or previous fall) |
| Unm | M | Cub | 3/25 | Known | N Fork Shoshone R, SNF | Natural: malnutrition |
| Unm | M | Cub | 5/18 | Known | Swan Lake Flats, YNP | Natural: unknown |
| Unm | F | Cub | 6/18 | Known | Lewis Falls Bridge, YNP | Human-caused: road kill |
| 241 | F | 2 | 7/12 | Known | Sepulcher Mountain, YNP | Natural: several broken bones, poss. by bigger bear |
| Unm | Unk | Cub | July | Known | Wildcat Peak, BTNF | Natural: unknown |
| 233 | M | 3 | 7/15 | Known | Boulder River, GNF | Human-caused: mgt removal (in garbage/human food) |
| 209 | M | 9 | 8/3 | Known | Elk Ranch, GTNP | Human-caused: mgt removal (killing cattle) |
| 216 | F | 10 | 8/23 | Known | Diamond J Ranch, MT | Human-caused: self defense after mgt capture/release |
| Unm | M | Subadult | 8/23 | Known | Sheridan Cr, SNF | Human-caused: illegal (shot by black bear hunter) |
| G61 | M | 1 | 8/28 | Known | Big Sky, MT | Human-caused: mgt removal (aggressiveness/in garbage/human habituated) |
| Unm | F | Adult | 9/26 | Known | Counts Peak, SNF | Human-caused: self defense by hunter (2 yearlings) |
| 285 | M | 1 | 10/5 | Known | Flagg Ranch, JDRMP | Human-caused: mgt removal (garbage/human habituated) |
| 79 | F | 22 | 11/8 | Known | Beattie Gulch, MT | Human-caused: self defense by elk hunters (3 COY) |

[a] BTNF = Bridger-Teton National Forest; GFN = Gallatin National Forest; JDRMP = John D. Rockefeller, Jr. Memorial Parkway; SNF = Shoshone National Forest; YNP = Yellowstone National Park.

Grizzly bear mortalities from 1973-96 are depicted in Table 8. These deaths include known and probable mortalities as defined by Craighead et al. (1988).

Table 8. Known and probable grizzly bear deaths, 1973-96.

| Year | All bears | | All adult females | |
|---|---|---|---|---|
| | Human-caused | Other[a] | Human-caused | Other |
| 1973 | 14 | 3 | 4 | 0 |
| 1974 | 15 | 1 | 4 | 0 |
| 1975 | 3 | 0 | 1 | 0 |
| 1976 | 6 | 1 | 1 | 0 |
| 1977 | 16 | 1 | 6 | 0 |
| 1978 | 7 | 0 | 1 | 0 |
| 1979 | 8 | 0 | 1 | 0 |
| 1980 | 6 | 4 | 1 | 0 |
| 1981 | 10 | 3 | 3 | 2 |
| 1982 | 14 | 3 | 4 | 0 |
| 1983 | 6 | 1 | 2 | 0 |
| 1984 | 9 | 2 | 2 | 0 |
| 1985 | 6 | 7 | 2 | 0 |
| 1986 | 9 | 2 | 2 | 0 |
| 1987 | 3 | 0 | 2 | 0 |
| 1988 | 5 | 8 | 0 | 2 |
| 1989 | 2 | 1 | 0 | 0 |
| 1990 | 9 | 0 | 6 | 0 |
| 1991 | 0 | 0 | 0 | 0 |
| 1992 | 4 | 4 | 0 | 0 |
| 1993 | 3 | 2 | 2 | 1 |
| 1994 | 10 | 1 | 3 | 0 |
| 1995 | 17 | 1 | 4 | 0 |
| 1996 | 9 | 6 | 3 | 0 |

[a] Includes deaths from natural and unknown causes.

## Food Habits

### *Scat Analysis*

Food habits represented by fecal analysis often do not accurately reflect relative proportions of ingested items because different diet items are digested at varying rates and to different degrees. More easily digested items such as meat and berries are under-represented in fecal analysis while vegetal items are over-represented.

A brief summary of fecal analysis for scats collected by the IGBST during 1996 is presented in Table 9. Spring scats were composed primarily of graminoids, including *Melica* roots and *Taraxacum*. The forbs *Taraxacum*, *Epilobium*, *Heracleum*, *Osmorhiza*, and *Cirsium* along with graminoids dominated the composition of the summer. Fall scats indicated almost exclusive use of whitebark pine (*Pinus albicaulis*) seed. Fig. 2 depicts percent volumes of major food items observed in 1996 scats by season.

### *Whitebark Pine Cone Production*

Grizzly bears generally consume the seeds of whitebark pine to the near exclusion of other food items when available in sufficient quantities. These seeds are largely unavailable to bears until cone production approaches 20 cones/tree (Blanchard 1990). Widespread use by bears generally occurs when production exceeds 22 cones/tree (Mattson et al. 1992). Cone production during 1996 averaged 25.05 cones/tree for the 19 transects in the Yellowstone ecosystem, the best recorded since 1989 (Table 10, Figs. 3 and 4). Production was good throughout the study area. Poorer producing stands were high-elevation, pure whitebark stands. The transects in mesic, mixed coniferous stands produced greater numbers of cones.

During years of low whitebark pine seed availability, grizzly bears often seek alternate foods in association with human activities and the number of management actions and mortalities both increase during fall. During August-November, grizzly bears were captured 13 times, 8 of which resulted in transport of the bears away from conflict situations at lower elevations. When virtually no whitebark pine seeds were available in 1995, grizzly bears were captured 38 times during the same time period.

## Table 9. Seasonal grizzly bear scat contents during 1996.

| | Spring [a] ($n$ = 20) | | Summer [b] ($n$ = 39) | | Fall [c] ($n$ = 47) | | Total ($n$ = 118) | |
|---|---|---|---|---|---|---|---|---|
| | % freq. | % vol. | % freq. | % vol. | % freq. | % vol. | % freq. | % vol. |
| Whitebark pine seeds | | | 12.82 | 12.18 | 84.00 | 75.06 | 39.83 | 35.83 |
| Berries | | | | | | | | |
| *Shepherdia canadensis* | | | 5.13 | 1.28 | 2.00 | 0.20 | 2.54 | 0.51 |
| *Vaccinium* | 5.00 | 3.25 | 5.13 | 0.90 | 4.00 | 0.80 | 4.24 | 1.19 |
| *Arctostaphylos uva-ursi* | | | | | 2.00 | 0.10 | 0.85 | 0.04 |
| Sporophytes | | | | | | | | |
| mushrooms | | | 2.56 | 0.26 | 4.00 | 0.14 | 2.54 | 0.14 |
| *Lycopodium* | | | | | | | 0.85 | 0.01 |
| Foliage | | | | | | | | |
| Graminoids | 80.00 | 55.15 | 48.72 | 28.28 | 26.00 | 9.88 | 43.22 | 24.79 |
| *Melica* (roots) | 20.00 | 9.75 | | | | | 3.39 | 1.65 |
| Forbs | 50.00 | 34.85 | 80.00 | 30.23 | 18.00 | 11.06 | 37.29 | 25.70 |
| *Cirsium* | | | 5.13 | 4.87 | 2.00 | 0.60 | 2.54 | 1.86 |
| *Epilobium* | | | 12.82 | 6.03 | | | 7.63 | 5.37 |
| *Taraxacum* | 30.00 | 29.60 | 23.08 | 7.56 | 14.00 | 8.46 | 19.49 | 11.95 |
| *Trifolium* | | | 10.26 | 1.54 | | | 5.08 | 0.89 |
| *Osmorhiza* | | | 5.13 | 5.10 | | | 2.54 | 2.19 |
| *Heracleum* | | | 5.13 | 5.13 | | | 1.69 | 1.69 |
| *Lomatium* (roots) | 15.00 | 3.50 | | | 2.00 | 2.00 | 3.39 | 1.44 |
| *Perideridia* (roots) | 10.00 | 1.75 | | | | | 1.69 | 0.30 |
| Mammals | 15.00 | 1.80 | 23.08 | 11.85 | 8.00 | 0.08 | 14.41 | 4.68 |
| Elk | 10.00 | 1.75 | 10.25 | 5.61 | 2.00 | 0.02 | 2.54 | 1.22 |
| Moose | | | 2.56 | 2.56 | | | 0.85 | 0.85 |
| Insects | | | | | 10.00 | 1.78 | 11.02 | 1.83 |
| Ants | | | 20.51 | 3.26 | 8.00 | 0.48 | 10.17 | 1.28 |
| Debris | 30.00 | 4.95 | 33.33 | 11.77 | 4.00 | 0.90 | 18.64 | 5.28 |

[a] Spring = March, April, May, and June.
[b] Summer = July and August.
[c] Fall = September and October.

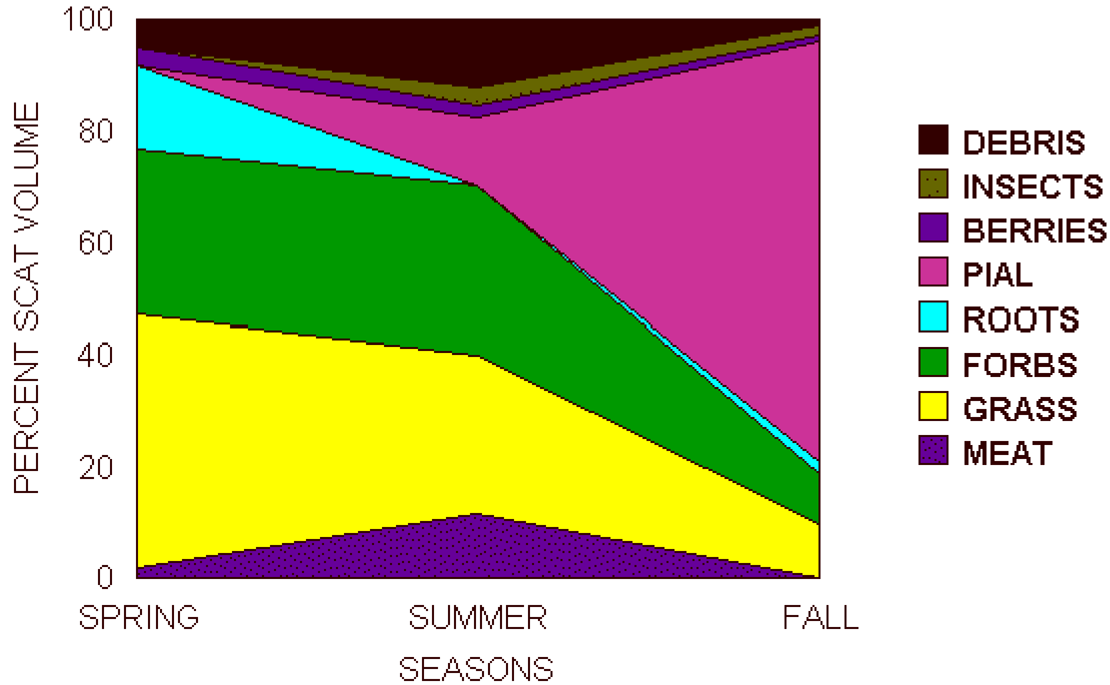


Fig. 2. Percent volume of food items by season for scats collected during 1996.

Table 10. Mean annual whitebark pine cone production on study transects, 1980-96.

| Year | Total cones | Total trees | Total transects | Mean cones per tree | Mean cones per transect | Cones/transect/year SD | Cones/transect/year Min. | Cones/transect/year Max. | Mean Julian date read each year |
|---|---|---|---|---|---|---|---|---|---|
| 1980 | 2,312 | 90 | 9 | 25.69 | 256.89 | 122.99 | 139 | 562 | 212 |
| 1981 | 1,191 | 90 | 9 | 13.23 | 132.33 | 148.69 | 8 | 489 | 204 |
| 1982 | 1,443 | 85 | 9 | 16.98 | 160.33 | 154.18 | 0 | 463 | 229 |
| 1983 | 1,531 | 88 | 9 | 17.40 | 170.11 | 88.78 | 78 | 372 | 211 |
| 1984 | 360 | 56 | 6 | 6.43 | 60.00 | 41.41 | 14 | 124 | 220 |
| 1985 | 2,312 | 85 | 9 | 27.20 | 256.89 | 192.27 | 17 | 625 | 214 |
| 1986 | 103 | 75 | 8 | 1.37 | 12.88 | 13.18 | 0 | 38 | 207 |
| 1987 | 394 | 155 | 16 | 2.54 | 24.63 | 37.49 | 0 | 118 | 217 |
| 1988 | 406 | 169 | 17 | 2.40 | 23.88 | 44.32 | 0 | 148 | 208 |
| 1989 | 10,199 | 209 | 21 | 48.80 | 485.67 | 384.27 | 7 | 1,473 | 206 |
| 1990 | 319 | 207 | 21 | 1.54 | 15.19 | 51.52 | 0 | 243 | 212 |
| 1991 | 2,744 | 177 | 18 | 15.50 | 152.44 | 107.99 | 7 | 366 | 215 |
| 1992 | 2,876 | 187 | 19 | 15.38 | 151.37 | 81.67 | 19 | 294 | 209 |
| 1993 | 1,926 | 189 | 19 | 10.19 | 101.37 | 114.97 | 0 | 456 | 217 |
| 1994 | 361 | 178 | 19 | 2.03 | 19.00 | 54.25 | 0 | 244 | 207 |
| 1995 | 514 | 188 | 19 | 2.73 | 27.05 | 61.41 | 0 | 277 | 215 |
| 1996 | 4,709 | 188 | 19 | 25.05 | 247.84 | 148.34 | 42 | 527 | 203 |

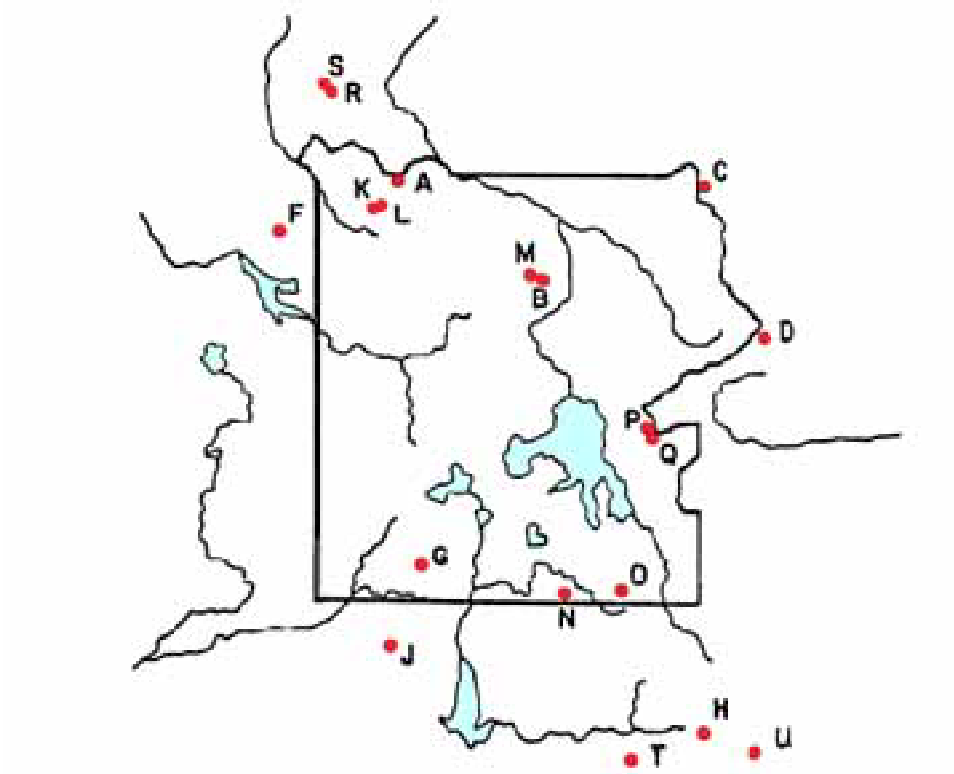

Fig. 3. Locations of whitebark pine cone transects within the study area.

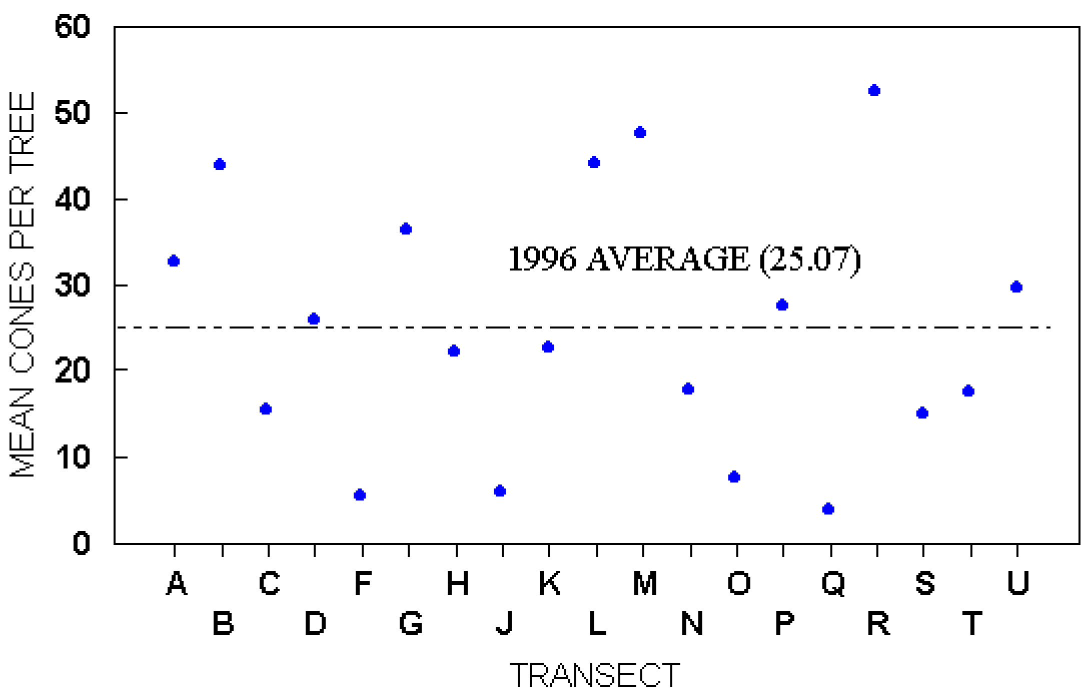

Fig. 4. Whitebark pine cone production on study area transects during 1996.

### *Feed Sites*

Ground investigations at 34 aerial locations of radio-marked grizzly bears from May-October revealed evidence of feeding activity at 44% of the sites. Evidence of activity other than feeding was recorded at an additional 5 sites, and no sign of bear activity was evident at the remaining 15 sites.

Grizzly bear activity was recorded at an additional 59 sites not associated with an aerial location of bear (47 with feeding activity and 12 with other sign recorded). Activities are summarized in Table 11 for those sites with evidence of feeding.

Table 11. Seasonal frequencies of 65 activities at 62 feeding sites during 1996.

| Feeding activity | Spring[a] (*n* = 12) | Summer[b] (*n* = 16) | Fall[c] (*n* = 37) | Total (*n* = 65) |
|---|---|---|---|---|
| Whitebark pine seeds | 0 | 0.06 | 0.76 | 0.45 |
| Grazing | 0 | 0.31 | 0 | 0.08 |
| Digging roots | 0.08 | 0.06 | 0.05 | 0.06 |
| Digging rodents/caches | 0.50 | 0 | 0 | 0.09 |
| Large mammals | 0.25 | 0.06 | 0.03 | 0.08 |
| Searching for insects | 0.08 | 0.38 | 0.16 | 0.20 |
| Mushrooms | 0 | 0.06 | 0 | 0.02 |
| Thermal dig | 0.08 | 0.06 | 0 | 0.03 |

[a] Spring = May-June.
[b] Summer = July-August.
[c] Fall = September-October.

Digging for pocket gophers (*Thomomys talpoides*) and their root caches was the most frequently recorded spring feeding activity. Predation on ungulates was also common. During summer, searching for insects (mostly ants) and grazing on succulent vegetation were the most frequently observed feeding activities. Feeding on whitebark pine seeds was the predominant fall activity.

**Movements And Feeding Strategies**

Annual range sizes and seasonal rates of movement were not significantly different from the cohort means recorded 1975-87 (Tables 12 and 13), except for 2 individuals. One adult male (No. 215) had an annual range of 3,600 $km^2$, compared to the average of nearly 1,000 $km^2$ for that cohort. One female with 3 COY (No. 237) had a range of 1,207 $km^2$ compared to the average 230 $km^2$. Neither bear had been trapped or transported during 1996. Fall rates of movement were generally lower compared to the preceding 3 years due to an abundant whitebark pine crop. Virtually no cones were produced 1993-95. When preferred native foods are abundant, bears are not forced to range widely in search of alternate foods. Whitebark pine seeds are a preferred high fat content food.

Table 12. Annual range sizes (km$^2$) of grizzly bears located ≥12 times and during all 3 seasons of 1996.

| Cohort | Number of locations | MCP[a] | 1975-87 cohort mean MCP | (SD) |
|---|---|---|---|---|
| Females | | | | |
| With cubs | 23 | 411 | 231 | (136) |
| | 28 | 1,207 | | |
| | 30 | 221 | | |
| | 23 | 39 | | |
| | 19 | 133 | | |
| | 25 | 103 | | |
| | 26 | 245 | | |
| | 41 | 747 | | |
| Lone adult | 16 | 141 | 236 | (114) |
| | 22 | 33 | | |
| Unknown adult | 19 | 46 | | |
| | 19 | 147 | | |
| | 20 | 877 | | |
| | 24 | 201 | | |
| Subadult | 32 | 133 | 365 | (191) |
| | 21 | 119 | | |
| Males | | | | |
| Adults | 17 | 202 | 674 | (630) |
| | 18 | 3,600 | | |
| | 20 | 756 | | |
| Subadults | 16 | 523 | | |
| | 36 | 919 | 698 | (598) |
| | 21 | 1,816 | | |

[a] Minimum Convex Polygon.

Table 13. Seasonal rates of movement for radio-marked grizzly bears during 1993-96.

| | | Mean km/day/animal | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | 1975-87 | |
| Season | Cohort[a] | 1993 | 1994 | 1995 | 1996 | mean | (SD) |
| Spring | Adult females with COY | 1.6 | 0.4 | 0.4 | 0.6 | 0.7 | (0.3) |
| | Females with yearling | 0.6 | 1.8 | 0.4 | | 1.1 | (0.7) |
| | Lone adult females | 1.1 | 0.8 | 0.6 | 1.2 | 1.0 | (0.6) |
| | Unknown adult females | | | | 0.5 | | |
| | Subadult females | | 0.9 | 0.8 | 0.4 | 1.1 | (0.6) |
| | Subadult males | 1.0 | 0.8 | 0.4 | 0.8 | 1.3 | (0.8) |
| | Adult males | 0.2 | 0.9 | 0.6 | 0.8 | | |
| Summer | Adult females with COY | 1.3 | 0.6 | 0.5 | 0.9 | 1.3 | (1.0) |
| | Females with yearling | 0.9 | 1.7 | 0.9 | | 1.7 | (0.9) |
| | Lone adult females | 0.5 | 1.1 | 0.9 | 0.5 | 1.3 | (0.7) |
| | Unknown adult females | | | | 0.6 | | |
| | Subadult females | | 1.2 | 0.5 | 1.2 | 1.1 | (0.9) |
| | Subadult males | 0.9 | 0.9 | 0.7 | 1.7 | 1.9 | (1.1) |
| | Adult males | 0.5 | 1.6 | 1.3 | 1.8 | | |
| Fall | Adult females with COY | 0.9 | 0.6 | | 0.7 | 1.2 | (1.0) |
| | Females with yearling | 0.7 | 1.4 | 1.0 | | 1.6 | (0.9) |
| | Lone adult females | 0.7 | 1.0 | 0.7 | 0.2 | 1.0 | (0.7) |
| | Unknown adult females | | | | 0.5 | | |
| | Subadult females | | 0.7 | 0.5 | 0.7 | | |
| | Subadult males | 0.8 | 0.9 | 1.1 | 0.8 | 1.1 | (0.8) |
| | Adult males | 0.4 | 1.3 | 1.7 | 1.0 | 1.4 | (0.8) |

[a] COY = cub-of-the-year.

# EFFECTIVENESS OF ATTRACTANTS TO LURE GRIZZLY BEARS INTO HAIR COLLECTION SITES FOR FUTURE DNA FINGERPRINTING

## North Fork of Shoshone and Hayden Valley Study Areas

Preliminary Findings

By: Mark Haroldson and Chuck Anderson

## Introduction

Grizzly bear (*Ursus arctos horribilis*) populations that reside in mountainous, timbered habitats are notoriously difficult to enumerate with any degree of confidence (Mace et al. 1994). Efforts to produce estimates for these populations, such as grizzly bears in the Greater Yellowstone Ecosystem (GYE), have required long-term, intensive, and intrusive trapping and radio-collaring programs (Eberhardt and Knight 1996). Because of the controversy that generally surrounds published estimates of grizzly bear numbers in the GYE, techniques generating more precise estimates are needed. Traditional methods have been imprecise and contain inherent risks to bears and researchers because trapping and handling is required. Thus the search continues for methods that will allow researchers to produce reliable population estimates without the need to handle bears.

Efforts by Mace et al. (1994) and Beck (1995) have produced relatively precise population estimates for grizzly and black bears, respectively, using a remote photo-detection system. However, both of these efforts required an initial handling of bears to attach markers. Other inherent problems included unequal catchability among cohorts, degradation in photo-detection rates as bears became accustom to camera sites, and frequent inability to uniquely identify markers on individual bears.

Recent advances in DNA biotechnology enable researchers to uniquely identify bears through the analysis of hair roots and thus "mark" individuals. Using such "marks", population estimates can theoretically be produced without the expensive and time-consuming process of capturing and handling bears (French et al. 1996). Proctor (1995) applied this technology to estimate black bear numbers in Glacier National Park, British Columbia. During 1996, several ambitious Canadian studies employed this technique over extensive areas to obtain grizzly bear population estimates (Workshop-The Use of DNA in Field Ecology, Columbia Mountain Institute, Revelstoke, British Columbia, Canada). Unfortunately, protocol and lure selection varied little among most Canadian studies; thus it is unknown if bear response rates could be improved by altering lures, lure presentation, or design of hair collection sites.

In the Yellowstone ecosystem, a cooperative pilot study designed to determine the best approach to lure grizzly bears into hair collection corrals (HCCs) was undertaken during 1996 by the Interagency Grizzly Bear Study Team (IGBST), the Wyoming Game and Fish Department, and the Yellowstone Grizzly Foundation. The goal of this pilot study was to identify the most effective and practical attractant(s) and method of presentation to entice grizzly bears into HCCs. Our ultimate goal is to apply the protocol developed from this pilot study to obtain statistically valid mark-recapture grizzly bear population estimates from the GYE using unique DNA markers from grizzly bear hair samples. This pilot study occurred in 3 study areas during 1996: the North Fork of the Shoshone River area (NFA) in Shoshone National Forest, the Hayden Valley area (HVA) in Yellowstone National Park, and the Blackrock/Spread Creek area (BSA) in Bridger-Teton National Forest. The effectiveness of different lures to entice grizzly bears into HCCs was examined at NFA (using pork skins, cattle blood, fatty acid scent, and wild ungulate rumen) and HVA (using shellfish scent, cattle blood, fatty acid scent, and wild ungulate rumen), and these results were used to address the most efficient method of lure presentation at BSA. Preliminary findings from NFA and HVA are presented here and results from BSA are presented in the next section.

## Study Area Descriptions

### *North Fork of the Shoshone*

The NFA occurs along North Fork of the Shoshone River within the Shoshone National Forest in northwestern Wyoming. The North Fork canyon is a narrow valley running primarily east-west with extremely steep slopes. Large secondary drainages such as the Elk Fork, Clearwater, Fishhawk, and Eagle creeks typically drain from the north or south into the North Fork. Highway 14/16 parallels the river through the valley to the East Entrance of Yellowstone National Park. Elevations range from 1,800 m on the river at the lower end of the valley to 3,400 m on higher peaks at the upper end. Vegetation varies from big sagebrush (*Artemisia tridentata*)/grassland habitats at the lower elevations to subalpine fir (*Abies lasiocarpa*)/ Englemann spruce (*Picea englemannii*) forests at higher elevations. Forest canopies at mid-elevations vary from limber pine (*Pinus flexilis*)/juniper (*Juniperus scopulorum*) types on drier sites to Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) on more mesic sites. Riparian habitats contain several species of cottonwood (*Populus* spp.). Grizzly bears are known to use the North Fork valley during the spring as evidenced by IGBST trapping success in 1994-95 (8 bears captured: 2 adult and 2 subadult males, 2 adult and 2 subadult females).

### *Hayden Valley*

The HVA occurs near the geographic center of Yellowstone National Park. This large, high-elevation valley contains approximately 140 $km^2$ of open sagebrush/grass meadows with several large island stands of lodgepole pine occurring throughout the valley. Lodgepole pine also dominates the forest canopy surrounding the valley. Riparian zones are typically dominated by sedges (*Carex* spp.). Hayden Valley is a known high-use area for grizzly bears during the spring and summer and has been an area of primary residency for several radiocollared adult females over the past several years.

## Methods

### *General Procedures*

Timing of scent station surveys is important to obtain reliable carnivore population data (Mace et al. 1994). Thus we avoided sampling during time periods when particular food resources were abundant (e.g., elk calving season, spawning season). Additionally, each study area was baited and monitored during time periods when grizzly bears were known to frequent study areas in an attempt to maximize sample sizes. Physical and vegetative characteristics of scent station sites were recorded on standardized field forms prior to hair collection.

#### Lure Selection/Handling

Lure selection for this study was based on past experience in the GYE, other attractant studies (Roughton and Sweeny 1982, Beck 1995, Mace et al. 1996), and resemblance of lures to natural food items available throughout the active season for bears. Depending on the study area, 4 of the following 6 lures were evaluated: cattle blood mixed with heparin (to prevent clotting), wild ungulate rumen, fatty acid scent (FAS) tablets (Pocatello Supply Depot, Pocatello, Idaho), liquid FAS in a mineral oil suspension, domestic pig hide, and commercial shellfish scent. Blood was presented in 3.8-liter plastic jugs filled about 3/4 full; caps were removed and 2 8-cm holes were cut in the upper portion of the jugs. Approximately 3.8 liters of rumen was placed into 19-liter plastic buckets, and the lid and upper portion of each bucket was perforated. Two FAS tablets were placed into 3.8-liter jugs with 2 8-cm diameter holes cut in the top half of each jug with the lids removed. Two 20 x 60 cm pieces of pig hide were hung inside open 19-liter plastic buckets. Liquid FAS was applied at 50 ml of solution placed in 3.8-liter plastic jugs with 4 6-cm diameter holes cut in the top third of each jug; a cotton wick was hung from the top of the jug into the liquid scent solution. The shellfish scent was combined with vegetable shortening at a ratio of 1 pint to 3 gallons (T. Beck, Colorado Division of Wildlife, personal communication) and heated to incorporate the scent into the shortening; small burlap bags were soaked in this mixture and allowed to cool until the shortening set. Two scent-soaked burlap bags were used per HCC.

Hair Collection Sites

HCCs consisted of a single perimeter wire (barbed with 2 prongs/barb) placed 50 cm above ground (measured at the center of the span) and about 4-5 m from the suspended lure using ≥3 trees as supports (Proctor 1995). Yellow tent stakes were placed in the center of each HCC to provide a visual cue to draw bears into the HCCs (T. Beck, Colorado Division of Wildlife, personal communication). Lures were suspended about 4 m above the ground and ≥2 m from support trees. Minor spills of attractants were dug up and removed or spaded into the soil away from the HCC. Hemp ropes were used to suspend lures.

Sampling Design

Lures were rotated at each site every fifth day for a total of 16 nights of monitoring in each study area using a balanced design (i.e., equal number of trap sites baited with each lure; Roughton and Bowden 1979). Lures were assigned randomly without replacement until all 4 lures had been placed at consecutive sites using a block design consisting of 4 hair collection sites per block. For example, when lures were initially put out, site 1 had an equal chance of receiving all 4 lures; site 2 had an equal chance of receiving the 3 lures not selected at site 1, etc. This process was repeated at sites 5 through 8 and so on, until all HCCs had been assigned lures. Lures were rotated at each trap site after 4 trap nights (1 trap baited/night = 1 trap night) and again selected randomly without replacement as described above. Thus, at the end of each study, all 4 lures had been available for 4 trap nights at each hair collection site with random order. This block design was applied to facilitate an even distribution of lures across each study area during each sampling period. Blocks consisted of 4 consecutive drainages at NFA and 2 x 2 grids at HVA.

### *North Fork of the Shoshone*

Sites selected for establishment of HCCs were located near the mouths of side drainages that flow into the North Fork of the Shoshone River. To assure independence, HCCs were placed ≥1.6 km apart. Sixteen HCCs consisting of 4 blocks of 4 hair collection sites each were established in the NFA between 7-9 May 1996 and baited on 9 May with cattle blood, wild ungulate rumen, FAS tablets, or domestic pig hide. Random drawings for the initial selection of lures to be placed at HCCs were conducted on 8 May.

Sites were re-visited every 4 trap-nights. At time of inspection the barbed wire was searched for bear hair and any samples found were collected. All hairs caught on a single barb were treated as a single sample for DNA analyses (Proctor 1995). Field personnel wore latex gloves while collecting samples to avoid DNA contamination. Samples were placed in envelopes, sealed, and uniquely labeled. The area surrounding the HCCs was also searched for bear sign and attractants were changed during each visit.

### *Hayden Valley*

Eight hair collection sites were established in Hayden Valley during 23-24 June 1996. HCC placement followed a grid system with 1 HCC per 12.5 $km^2$ grids (3.5 x 3.5 km) organized into 2 blocks of 4 grids each (2 x 2). Block 1 contained grids 1, 2, 7, and 8, and block 2 consisted of grids 3, 4, 5, and 6.

Based on the limited bear response observed in the NFA, several modifications in HCC design were implemented at HVA. We used 4-pronged barbed wire with an approximate span of 7.5 cm between barbs, included a center tree(s) inside the corral and reduced corral diameter to roughly 91-122 cm between the perimeter wire and center trees (S. French, Yellowstone Grizzly Foundation, Jackson, Wyoming, personal communication), added pole deflectors above the wire to exclude ungulates, lowered lures to approximately 3 m above the ground, and tied orange flagging around the center tree about 50 cm above ground.

We used cattle blood, wild ungulate rumen, liquid FAS in a mineral oil suspension, and a commercial shellfish scent to lure bears into HCCs at the HVA. Lure placement was similar to NFA except that containers were painted black and more ventilation holes were drilled in the buckets containing rumen.

Lure selection at HCCs followed a standard Latin square cross-over design (T. McDonald, Western EcoSystems Technology, Cheyenne, Wyoming, personal communication). We placed lures at HCCs on 25 June, and re-visited sites every 4 nights. During each visit the barbed wire was searched for bear hair and any samples found were collected. Hair contained on 1 barb was considered 1 sample. The areas surrounding the HCCs were searched for bear sign and the attractants were reassigned following the Latin square design. This process was repeated until each lure was available at each site for 4 consecutive nights.

Sloppy Treatment

To adequately evaluate lure effectiveness at HCCs, site contamination was avoided at NFA and HVA. We acknowledged, however, that additional lure placed on the center tree and on the ground within the HCC may increase the number of bears entering hair corrals leaving hair samples. In order to evaluate whether or not this was the case, we initiated a "sloppy treatment" at HVA after the initial test of lure effectiveness was completed. Eight nights after lures were removed from HCCs, concluding the lure treatment at HVA, the sloppy treatment was initiated. During this treatment, the same type of lure as last available at each HCC was returned, but the volume of each lure was doubled. Half of the attractant was suspended as in the previous test and the other half was poured on trees within the perimeter wire. Hair samples were collected after 8 nights of sampling.

### *Statistical Analyses*

The influence of lures within each study area was examined using contingency table analyses (Zar 1984, Mehta and Patel 1992; StatXact) where presence or absence of grizzly bear hair within each sampling period served as the response variable. Lure effects between study areas (NFA and HVA) and treatments (HVA), and the combined effects of sites and lures within each study area were examined using logistic regression analyses (Hosmer and Lemeshow 1989, Mehta and Patel 1993; LogXact). Because the asymptotic $chi^2$ distribution may not hold for sparse data sets (Zar 1984:49, Mehta and Patel 1993:Appendix A), *P*-values were calculated using exact estimation procedures. The Fisher exact test (Mehta and Patel 1992) was applied to univariate comparisons, and the exact conditional scores test was applied to multivariate comparisons (Mehta and Patel 1993). Lure categories were collapsed when cell frequencies were similar and the resulting $chi^2$ score improved. We considered tests significant at $P \leq 0.10$. Power of tests (1 - beta; Zar 1984:43) to determine significance was approximated using the power analysis program PASS for $chi^2$ tests (Hintze 1993). We noted that statistical power might have been over-estimated since non-asymptotic tests were used to obtain *P*-values and PASS assumes asymptotic distributions.

## Results And Discussion

### *North Fork of the Shoshone*

Lures at HCCs in the NFA were available from 9-25 May. Bear hair was collected from HCCs baited with blood on 3 occasions, baited with FAS twice, and with pork skin once (Table 14). Two sites produced bear hair during the first 2 sampling periods, and bear hair was collected from only 1 site each during periods 3 and 4 (Table 14). Ten bear hair samples were obtained during the 16-night sampling period (Table 15). Five hair samples were obtained from 3 different sites baited with the blood, 4 samples were obtained from 2 sites baited with FAS tablets, and 1 sample was obtained from a site baited with pork skin.

On 7 occasions, field crews observed bear sign in the vicinity of HCCs but did not detect hair samples on the barbed wire (Table 16). We also noted that 7 radiocollared grizzly bears were using the North Fork drainage during the sampling period. Poor success of attractants may have been due to the cold and wet weather that persisted throughout the sampling period, inhibiting the effective range of lure odors. Lures that are dependent on microbial activity to produce scent would not be expected to perform well when nightly temperatures are routinely below freezing.

In addition to cold and wet weather, it also appeared the tent stakes placed in the center of HCCs and the relatively large size of the hair corrals did not enhance bear visitation (Table 16). Thus several factors were adjusted at HVA to enhance visitation rates: including a center tree within the HCC, using black lure containers, reducing HCC size, lowering the height of the lure within the HCC, replacing pork skin with shellfish scent, and replacing FAS tablets with liquid FAS wicked from the lure reservoir. On several occasions, we also observed ungulate hair on the perimeter wire at NFA. Thus we attached cross-poles to HCCs at HVA to restrict ungulate use of hair collection sites.

### *Hayden Valley*

Lures at HCCs in the HVA were available from 25 June to 7 July. Bear hair samples were collected on 5 occasions using blood, 3 times each using FAS and rumen, and once using shellfish scent (Table 17). We obtained bear hair samples from 3 sites during each of the 4 sampling periods (Table 17). We collected 93 bear hair samples during the 16-night sampling period at HVA (Table 18). Thirty-four hair samples were obtained from 5 different sites baited with the blood, 25 sample were obtained from 3 sites baited FAS, 22 samples were obtained from 3 sites baited with rumen, and 12 samples were obtained from 1 site baited with shellfish scent (Table 18).

Table 14. Site names for the North Fork of the Shoshone River area hair collection corrals, nights attractants were available, and number of hair samples (#) obtained at each site.

| | Nights lures were available | | | |
|---|---|---|---|---|
| Site name | 9-12 May | 13-16 May | 17-20 May | 21-24 May |
| Pahaska | FAS (0) | Rumen (0) | Pork skin (0) | Blood (0) |
| Sleeping Giant | Blood (0) | Pork skin (0) | Rumen (0) | FAS (0) |
| Unnamed West | Pork skin (0) | Blood (0) | FAS (3) | Rumen (0) |
| Eagle Creek | Rumen (0) | FAS (1) | Blood (0) | Pork skin (0) |
| Wayfarers | Pork skin (0) | Blood (0) | Rumen (0) | FAS (0) |
| Kitty Creek | Blood (0) | Pork skin (0) | FAS (0) | Rumen (0) |
| Fishhawk Creek | Blood (1) | FAS (0) | Rumen (0) | Pork skin (0) |
| Chimney Rock | FAS (0) | Rumen (0) | Pork skin (0) | Blood (0) |
| Mesa Creek | Rumen (0) | Pork skin (0) | Blood (0) | FAS (0) |
| Sheep Creek | Pork skin (0) | Blood (0) | FAS (0) | Rumen (0) |
| Blackwater | FAS (0) | Rumen (0) | Blood (0) | Pork skin (1) |
| June Creek | Rumen (0) | FAS (0) | Pork skin (0) | Blood (0) |
| Unnamed East | Pork skin (0) | FAS (0) | Blood (0) | Rumen (0) |
| Clearwater | FAS (0) | Pork skin (0) | Rumen (0) | Blood (0) |
| Sweetwater | Blood (1) | Rumen (0) | FAS (0) | Pork skin (0) |
| Elk Fork | Rumen (0) | Blood (3) | Pork skin (0) | FAS (0) |

Table 15. Number of bear hair samples and hair collection sites producing hair for each attractant at the North Fork of the Shoshone River area.

| Attractant | # of hair samples | # of sites |
|---|---|---|
| Blood | 5 | 2 |
| FAS | 4 | 2 |
| Rumen | 0 | |
| Pork skin | 1 | 1 |
| Total | 10 | 5 |

Table 16. Bear sign observed in the vicinity of hair collection corrals without hair samples in the North Fork of the Shoshone River area.

| Site | Lure | Date | Front pad width (cm) | Distance to wire |
|---|---|---|---|---|
| Sleeping Giant | Blood | 13 May | 13.5 Grizzly | 30 m |
| Sleeping Giant | FAS | 17 May | 13.0 Grizzly | 150 m |
| Unnamed (West) | Rumen | 25 May | Poor track | 200 m |
| Wayfarers | Blood | 17 May | 16.0 Grizzly | 250 m |
| Fishhawk | Rumen | 21 May | 13.5 Grizzly | <50 m |
| Fishhawk | Pork skin | 25 May | 10.0 Black | 0 m |
| Sheep Creek | Blood | 17 May | 13.5 Unknown | <3 m |

Table 17. Site names for hair collection corrals, dates attractants were available, and number of hair samples (#) obtained at each site.

| | Dates lures were available | | | |
|---|---|---|---|---|
| Site | 25-28 June | 29 June-2 July | 3-6 June | 7-10 June |
| Pack Trail | FAS (0) | Shellfish (0) | Rumen (15) | Blood (12) |
| Big Island | Rumen (0) | FAS (0) | Blood (2) | Shellfish (0) |
| Violet Creek | Shellfish (0) | FAS (2) | Blood (0) | Rumen (1) |
| NW Corner | FAS (0) | Rumen (6) | Shellfish (0) | Blood (0) |
| SW Corner | Rumen (0) | Blood (0) | FAS (0) | Shellfish (0) |
| Small Isle | Blood (1) | Shellfish (0) | Rumen (0) | FAS (0) |
| Trout Creek | Shellfish (12) | Blood (3) | FAS (8) | Rumen (0) |
| Hot Spring | Blood (16) | Rumen (0) | Shellfish (0) | FAS (15) |

Table 18. Number of bear hair samples and hair collection sites producing bear hair for each attractant available at the Hayden Valley area.

| Attractant | # of hair samples | # of sites |
|---|---|---|
| Blood | 34 | 5 |
| FAS | 25 | 3 |
| Rumen | 22 | 3 |
| Shellfish | 12 | 1 |
| Total | 93 | 12 |

Sloppy Treatment

All lures were removed from HCCs on 11 July concluding the lure treatment at HVA. The lures last available at each HCC were replaced and smeared on center trees on 19 July, initiating the sloppy treatment. After 8 trap nights, we collected 53 bear hair samples from 2 sites baited with FAS, 24 hair samples from 2 sites baited with rumen, and 12 bear hair samples from 2 sites baited with blood; no hair samples were obtained from hair collection sites baited with shellfish (Table 19).

Table 19. Number of bear hair samples collected and lure used at each hair collection site during the sloppy treatment at the Hayden Valley area.

| Site | Lure | # of hair samples |
|---|---|---|
| Pack Trail | Blood | 3 |
| Big Island | Shellfish | 0 |
| Violet Creek | Rumen | 9 |
| NW Corner | Blood | 1 |
| SW Corner | Shellfish | 0 |
| Small Isle | FAS | 20 |
| Trout Creek | Rumen | 15 |
| Hot Spring | FAS | 33 |
| Total | | 81 |

An interesting result from this session was the presence of bear hair on the center trees containing FAS. FAS on the center trees apparently triggered marking behavior in the bears as they traversed the wire to rub those trees and may explain the increased number of samples observed over the lure treatment. During the lure treatment, blood produced the highest number of hair samples and visitation rates, followed by FAS and rumen, with the poorest response from sites baited with shellfish (Table 18). During the sloppy treatment, all hair collection sites containing FAS, rumen, and blood produced bear hair. The number of samples noticeably increased at sites baited with FAS and rumen, but did not appear to enhance response rates to hair collection sites baited with blood and shellfish. While the sloppy application appeared to increase the number of hair samples using FAS and possibly rumen, we could not determine whether this application produced hair samples from a higher number of bears or just more hair samples from a similar number of individuals; these questions can only be addressed upon completion of DNA microsatellite analysis (anticipated by fall 1997). Given the expense associated with bear identification from DNA samples, a lure that simply increases curiosity (resulting in more hair samples) without increasing the number animals visiting hair collection sites would be undesirable.

***Statistical Analyses of Lure Effects (NFA and HVA)***

While HCCs baited with cattle blood were visited most often in both study areas (Tables 14 and 17), bear response did not differ statistically among lures at NFA ($n$ = 64, $P$ = 0.49) or HVA (lure treatment; $n$ = 32, $P$ = 0.12). However, our ability to detect a difference among lures was reduced due to sparse data; there was a 57% chance at NFA and a 50% chance at HVA we were unable to detect a significant influence should one exist (i.e., chance of a type II or beta error). During the sloppy treatment at HVA, bear response to HCCs baited with blood, FAS, and rumen was greater than those baited with shellfish ($n$ = 8, $P$ = 0.04). Logistic regression analysis indicated that lure effects between NFA and HVA (lure treatment) differed ($P$ < 0.01). Lure effects also differed from the lure and sloppy treatments at HVA ($P$ = 0.09). Thus data from NFA and HVA and lure and sloppy treatment data from HVA could not be pooled to increase statistical power. The influence of hair collection sites on grizzly bear response within NFA and HVA (lure treatment) was investigated and found not to be significant (NFA: $P$ = 0.70, HVA: $P$ = 0.68). Again, low statistical power limited our ability to investigate this relationship (NFA: 1 - beta = 0.67, HVA: 1 - beta = 0.45).

## Preliminary Conclusions

During lure comparisons at NFA and HVA, cattle blood provided bear hair from more hair collection sites than the other lures examined. Additional FAS or rumen applied to the center tree provided more bear hair samples than blood during the sloppy treatment at HVA, but we could not determine if more individuals were sampled. Of the lures examined, blood is the least expensive and simplest to obtain. If DNA microsatellite analyses reveal that blood provides similar or greater bear response rates to HCCs, blood should remain the lure of choice. Considering the level of rubbing observed on center trees baited with FAS, combining a suspended blood call lure with FAS applied to the center tree may also be desirable. Given the expense of bear identification from DNA samples and the high cost of FAS, however, these lures should only be combined if further analyses suggest a higher number of individuals will be sampled.

Final assessment of these results will require DNA microsatellite analysis of hair samples. Once this work is finished, we can determine the number of individual bears that visited each type of lure in each study area and complete a more detailed interpretation of these results.

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# EFFECTIVENESS OF ATTRACTANTS TO LURE GRIZZLY BEARS INTO HAIR COLLECTION SITES FOR FUTURE DNA FINGERPRINTING

## The Blackrock/Spread Creek Area Study - 13-30 August 1996

Preliminary Findings

By: Chuck Anderson and Mark Haroldson

**Background**

A cooperative pilot study to determine the best approach to lure grizzly bears into hair collection corrals (HCCs) was initiated during 1996 by the Interagency Grizzly Bear Study Team (IGBST), the Wyoming Game and Fish Department (WGFD), and the Yellowstone Grizzly Foundation (YGF). Three study areas were selected during 1996 consisting of the North Fork of the Shoshone River area (NFA) in Shoshone National Forest, the Hayden Valley area (HVA) in Yellowstone National Park, and the Blackrock/Spread Creek area (BSA) in Bridger-Teton National Forest. The effectiveness of 6 lures to entice grizzly bears into HCCs was examined at NFA (pork skins, cattle blood, fatty acid scent, and wild ungulate rumen) and HVA (shellfish scent, cattle blood, fatty acid scent, and wild ungulate rumen); these results are presented in the previous section. Preliminary results from both study areas indicated that cattle blood provided the highest grizzly bear response rates. Results from HVA, however, suggested that fatty acid scent (FAS) may also provide relatively high grizzly bear response rates if applied to the center tree within the HCC. After consultation between WGFD, IGBST, and Western EcoSystems Technology (Cheyenne, Wyoming; contracted by YGF), we decided the study at BSA should address the best presentation of blood lure in combination with FAS while maintaining a statistically valid protocol for future mark-recapture studies.

**Objectives**

1. Identify the most efficient method of luring bears into HCCs baited with cattle blood or cattle blood with FAS considering cost/effort and statistical requirements for future mark-recapture statistics.

2. Compare bear response rates to HCCs baited with blood and blood with FAS to determine if the addition of FAS increases capture rates.

## Methods

### *Hair Collection Corrals*

HCCs consisted of a single strand of barbed wire encircling 3 to 6 trees with a center tree in the middle. Each barb of the barbed wire consisted of 4 prongs/barb and were spaced 11.5 cm apart. We stapled barbed wire to the perimeter trees at 56-64 cm above the ground. Each barb was numbered consecutively beginning at the southwest perimeter tree; only barbs free from the perimeter trees were numbered. HCC size was minimized by selecting sites that provided a minimum distance of 81 cm between the center tree and the perimeter wire. We placed pole deflectors between perimeter trees horizontally above the wire to prevent ungulates from entering HCCs. Blood was hung in a 3.8-liter (1 gallon) milk jug 2.5-3 m above the ground near the center of the HCC. Three 5-cm holes were cut into the top of each jug to enhance odor dispersal. Within the HCC, we placed jugs away from the center tree and perimeter trees to minimize lure vandalism by bears. To enhance visual attraction of HCCs, about 0.6 m of orange flagging was hung from each jug and the center tree at breast height. The configuration and dimensions of each HCC were sketched on the back of each trap site data form.

### *Sampling Design*

The BSA was divided into 36 equal-sized trapping units. Each trapping unit was 3.5 x 3.5 km square and delineated on USGS 1:24,000 scale topographic maps. Our motivation for assigning HCCs within this design was to present as many HCCs as possible while maintaining independent hair collection sites. HCCs were placed near the center of each trapping unit depending on accessibility and proximity to habitat edges. Large continuous timber stands were considered poor bear travel corridors and were therefore avoided. HCCs were constructed in timber stands 5-50 m from the timber edge.

To control for differences caused by elevation, habitat type, and bear density, 3 blocks of trapping units were delineated. Each block consisted of 12 trapping units: block 3 comprised the eastern third of BSA, had the highest mean elevation (2,800 m), was dominated by whitebark pine and spruce/fir timber stands, and exhibited the highest bear activity based on past telemetry experience; block 2 comprised the center third of BSA, mean elevation was intermediate (2,500 m), was dominated by lodgepole pine and spruce/fir, and exhibited relatively low bear activity; and block 1 comprised the western third of BSA, had the lowest mean elevation (2,200 m), was dominated by aspen and spruce/fir, and also exhibited relatively low bear activity.

***Treatments/Lure Presentation***

Treatment structure at BSA followed a factorial design. The 3 experimental factors were: blood volume in jugs (2.8 liters versus 1.4 liters), application of blood or FAS to the center tree, and dragging a blood soaked rag into the HCC versus no dragging. Center tree lure application consisted of either 10 ml of FAS applied at breast height or wiping a blood soaked rag from breast height to the ground. The drag treatment consisted of dragging a blood soaked rag into the HCC from 4 cardinal directions (east, west, north, and south) at 50 m. The rag was soaked with blood prior to each dragging.

Combinations of experimental factors resulted in 8 different treatments applied to the 12 trapping units within each block. The following numbers were assigned to each treatment:

1) 2.8 liters of blood only (no FAS or drag),

2) 1.4 liters of blood only,

3) 2.8 liters of blood with drag,

4) 1.4 liters of blood with drag,

5) 2.8 liters of blood with FAS,

6) 1.4 liters of blood with FAS,

7) 2.8 liters of blood with drag and FAS,

8) 1.4 liters of blood with drag and FAS.

Within each block, treatments were assigned randomly without replacement to each HCC. Once all 8 treatments were assigned within 8 of the 12 trapping units for each block, treatments were again selected randomly without replacement for the remaining 4 HCCs. Thus within each block, 4 of 8 treatments occurred once and the remaining 4 occurred twice. Order that trap sites received treatments was selected completely at random.

### *Telemetry Schedule*

Eighteen radiocollared grizzly bears and 12 radiocollared black bears had been located on BSA from 1994-96. Eleven grizzly and 9 black bears had functioning radiocollars during the study. Bears were located on BSA from 2200-0600 hours each night during the study to assess bear activity relative to trap site location. Telemetry locations were obtained within 1 of 4 2-hour time blocks each night. Time block selection was sequential each night with a random starting time for the first telemetry session (i.e., time period 4, 0400-0600 hours).

### *Data Collection Procedures*

HCCs within each block were baited on subsequent days. For example, HCCs in block 3 were baited on day 1, HCCs in block 2 were baited on day 2, and HCCs in block 1 were baited on day 3. Once baited, all HCCs within each block were visited at 3-day intervals for 15 days. We defined a hair sample as the total amount of hair collected from a single 4-pronged barb. During each visit, hair samples were placed in manila envelopes and assigned unique sample numbers. The number of hairs, apparent bear species, collection date, collectors, site location, treatment, and barb number were documented for each sample.

## Results

HCCs were constructed on BSA from 29 July to 3 August 1996. Treatments were assigned within each trapping unit on 12 August (Table 20). HCCs were baited in block 3 on 13 August, in block 2 on 14 August, and in block 1 on 15 August. HCCs within each block were checked every 3 days and were removed from block 3 on 28 August, from block 2 on 29 August, and from block 1 on 30 August.

### *Bear Activity on BSA*

From 14-30 August, we located 6 radiocollared grizzly bears and 8 radiocollared black bears on BSA. Only 2 of the 6 collared grizzlies were present for most of the study period; 3 were present for 1 night and another bear was present for 2 nights. In addition to marked grizzlies on BSA, we also observed sign of 3 unmarked grizzly bears: a female with 2 cubs, male-sized tracks, and female-sized tracks. Four of 8 collared black bears were present on BSA for most of the study period, and the other 4 bears were present for 1, 2, 5, and 7 nights, respectively.

Table 20. Site number and treatments assigned within each of 3 sampling blocks on the Blackrock/Spread Creek study area, Bridger-Teton National Forest, 13-30 August 1996.

| Block 1 | Block 2 | Block 3 |
|---|---|---|
| 1 - 2.8 liters blood | 13 - 2.8 liters blood/drag | 25 - 1.4 liters blood/drag/FAS |
| 2 - 1.4 liters blood/FAS | 14 - 2.8 liters blood/drag/FAS | 26 - 2.8 liters blood/FAS |
| 3 - 1.4 liters blood/drag/FAS | 15 - 2.8 liters blood/FAS | 27 - 1.4 liters blood |
| 4 - 2.8 liters blood/drag/FAS | 16 - 2.8 liters blood | 28 - 1.4 liters blood/FAS |
| 5 - 1.4 liters blood/drag/FAS | 17 - 2.8 liters blood/FAS | 29 - 1.4 liters blood |
| 6 - 1.4 liters blood/FAS | 18 - 1.4 liters blood/drag/FAS | 30 - 2.8 liters blood/drag/FAS |
| 7 - 2.8 liters blood/FAS | 19 - 2.8 liters blood/drag/FAS | 31 - 2.8 liters blood/drag |
| 8 - 2.8 liters blood/drag | 20 - 1.4 liters blood/drag | 32 - 1.4 liters blood/drag |
| 9 - 1.4 liters blood | 21 - 1.4 liters blood | 33 - 2.8 liters blood |
| 10 - 2.8 liters blood/drag/FAS | 22 - 1.4 liters blood/drag/FAS | 34 - 1.4 liters blood/FAS |
| 11 - 1.4 liters blood/drag | 23 - 1.4 liters blood/FAS | 35 - 2.8 liters blood/drag/FAS |
| 12 - 2.8 liters blood/FAS | 24 - 1.4 liters blood/FAS | 36 - 2.8 liters blood/FAS |

### *Hair Samples*

From 13-30 August, we collected a total of 62 hair samples from 11 hair collection sites (Table 21). Based on field observations, it appeared that hair samples were collected from black bears on 9 occasions and from grizzly bears on 4 occasions (Table 21). Whether or not these samples represent 9 and 4 different black and grizzly bears, respectively, must be determined from DNA microsatelite analyses. We expect completion of DNA analyses by fall of 1997. Based on telemetry locations, however, it appears hair samples were obtained from the 2 collared grizzlies that were present on BSA the majority of the study period. Apparently, we also collected samples from 1 unmarked grizzly. We currently do not know whether a marked or unmarked grizzly left hair samples during the fourth occasion grizzly hair was collected. The 4 collared grizzlies that were present on BSA for ≤2 days did not leave hair samples at HCCs. Collared black bear activities on BSA have not been analyzed at this time.

Table 21. Grizzly and black bear hair samples collected on the Blackrock/Spread Creek area, 13-30 August 1996.

| Site # (block #) | | Treatment | # of samples | Date collected | Bear species[a] |
|---|---|---|---|---|---|
| 5 | (1) | 1.4 liters blood/drag/FAS | 3 | 08/18/96 | Black |
| 14 | (2) | 2.8 liters blood/drag/FAS | 2 | 08/23/96 | Black |
| 21 | (2) | 1.4 liters blood | 2 | 08/20/96 | Black |
| 25 | (3) | 1.4 liters blood/drag/FAS | 1 | 08/22/96 | Grizzly |
| 26 | (3) | 2.8 liters blood/FAS | 3 | 08/22/96 | Black |
| 29 | (3) | 1.4 liters blood | 1 | 08/19/96 | Black |
| 31 | (3)[b] | 2.8 liters blood/drag | 11 | 08/16/96 | Grizzly |
| 33 | (3)[b] | 2.8 liters blood | 7 | 08/19/96 | Grizzly |
| 33 | (3) | 2.8 liters blood | 14 | 08/25/96 | 2-Black[c] |
| 34 | (3) | 1.4 liters blood/FAS | 2 | 08/25/96 | Black |
| 35 | (3) | 2.8 liters blood/drag/FAS | 12 | 08/28/96 | Black |
| 36 | (3)[b] | 2.8 liters blood/FAS | 4 | 08/22/96 | Grizzly |
| Total | | | 62 | | 9 Black<br>4 Grizzly |

[a] Species of hair estimated from physical characteristics. Must be verified from DNA microsatellite analyses.
[b] Lure jug destroyed by grizzly bear.
[c] Hair samples of 2 different colors were collected. We assumed 2 black bears visited the site.

***Treatments***

Seven of the 8 treatments presented provided bear hair samples (Table 22). Treatment number 4 (1.4 liters blood/drag) was the only treatment that did not provide bear hair. Treatment number 1 (2.8 liters blood) provided the highest number of hair samples and apparently attracted the highest number of bears (Table 22). Inspecting the 3 treatments separately by bear visits indicated that 2.8 liters of blood provided 8 visits versus 5 visits using 1.4 liters; 9 visits occurred without dragging versus 4 visits with dragging; and 7 visits when FAS was applied versus 6 without FAS (Table 22). Within each block, samples were collected 5 times at 3-day intervals. We documented 1 visit during sample periods 1 and 5, 3 visits during sample period 4, and 4 visits during sample periods 2 and 3 (Table 22).

Table 22. Treatments providing bear hair samples on the Blackrock/Spread Creek area, 13-30 August 1996.

| Sample/treatment | # of samples | # of bears[a] | Bear species[a] | Periods (1-5)[b] |
|---|---|---|---|---|
| 1 - 2.8 liters blood | 21 | 3 | 1 Grizzly<br>2 Black | 2, 4, 4 |
| 2 - 1.4 liters blood | 3 | 2 | Black | 2, 2 |
| 3 - 2.8 liters blood/drag | 11 | 1 | Grizzly | 1 |
| 5 - 2.8 liters blood/FAS | 7 | 2 | 1 Grizzly<br>1 Black | 3, 3 |
| 6 - 1.4 liters blood/FAS | 2 | 1 | Black | 4 |
| 7 - 2.8 liters blood/drag/FAS | 14 | 2 | Black | 3, 5 |
| 8 - 1.4 liters blood/drag/FAS | 4 | 2 | 1 Grizzly<br>1 Black | 3, 2 |

[a] Based on field observations. Must be verified from DNA microsatellite analyses.
[b] Samples were collected every 3 days for 15 days within each block.

## Discussion

Unfortunately, grizzly activity on BSA was reduced during August of 1996 compared to activity observed during 1994 and 1995, resulting in smaller sample sizes than expected. Thus conclusions from these results may be limited. Additionally, interpretation of these results will be more complete after DNA microsatellite and statistical analyses. Given these constraints, our discussion will be directed under the assumption that black and grizzly bears responded similarly to attractants presented at HCCs during this study. Species differences will be addressed where information allows discrimination.

It appeared applying 2.8 liters of blood, without dragging and without FAS, was the most efficient presentation method to entice bears into HCCs (Table 22). However, several factors must be considered before accepting this conclusion. Because of availability, FAS was applied at 10 ml at BSA whereas at HVA, where high response rates were observed, FAS was applied at 50 ml. A larger volume of FAS applied at BSA may have resulted in higher response rates from bears. FAS, however, is expensive to use and may not be economically feasible to apply in larger volumes. Dragging did not appear to enhance bear visitation rates to HCCs. However, rain may have reduced any dragging effect since rain occurred on 3 to 4 occasions (depending on the area) during this study. Logistically, it is unlikely that the potential influence of rain could be reduced (e.g., dragging after a storm) in an ecosystem-wide study. Blood volume did appear to increase bear response rates to HCCs. We noted a drying effect when blood was applied at 1.4 liters/jug. The surface solidified in all cases and volume was 20-50% solid when jugs were removed at the end of the 15-day sampling period. Slight surface skinning was typically observed from jugs containing 2.4 liters of blood, but solidification was minor. We also noted that when agitated, blood odor was much more noticeable regardless of volume. Thus it may be beneficial to design an agitation device (either using wind or electronics) to enhance bear response to HCCs in the future.

At 3 of the 11 HCCs visited, grizzly bears destroyed blood-filled jugs (Table 21). We expected black bears to vandalize more sites than grizzlies, however, none of the sites visited by black bears were vandalized. Apparently, grizzly bears more aggressively investigated the source of the attractant. It was difficult to keep the jugs inaccessible to bears given the small size of HCCs and access to jugs provided by the center tree. Whether or not vandalism poses a problem, however, is difficult to assess from this study given the only site revisited was a vandalized site (Table 21).

During 3 of 4 occasions grizzly bear hair was collected, multiple samples were obtained (Table 21). On the fourth occasion only a single sample was collected consisting of 3 hairs. During this instance, we believe bear 248 visited the site. Bear 248, a 3-year-old female, is the smallest radiocollared grizzly using BSA. Wire height at HCCs may have reduced the number of samples/hairs that could have been obtained had the wire been placed lower. Similarly, black bear samples typically consisted of relatively few hairs compared to grizzly samples; ≤3 hairs/sample was common. While not documented during this study, it is possible that black bears may have entered HCCs without leaving hair. Attaching the perimeter wire lower than 56-64 cm from the ground may be beneficial to enhance collection of black (where desirable) and grizzly bear hair.

Final assessment of these results will require DNA microsatellite analyses. We anticipate that DNA analyses will be completed by fall 1997. Once completed, a detailed interpretation of results and future recommendations will be presented.

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