The ecology of grizzly bears and black bears in the Cooke City, Montana area
by Steven Richard Yonge

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
The Cooke City Basin in the northeast comer of the Greater Yellowstone Ecosystem (GYE) is characterized by high quality whitebark pine (Pinus albicaulis) foraging areas for grizzly bears (Ursus arctos horribilis) and black bears (Ursus americanus), as well as high levels of human activity and important mineral deposits. During the preparation of the Environmental Impact Statement (EIS) for the proposed New World Mine, the Gallatin National Forest (GNF) conducted a base line study during 1990 and 1991 addressing bear habitat use and the distribution of bears in relationship to human activity. I repeated the study during 1996 and 1997 to increase the number of years for a pooled sample and to determine if bear habitat use patterns had changed since 1990-1991 in response to increased human use. Although the effects of roaded habitat on bears are well documented, I investigated bear foraging strategies in pursuit of a high quality food source in areas with high road densities. Bear activity was surveyed by walking a series of line transects established within eight drainages adjacent to Cooke City, Montana. The density of bear activity was similar between the 1990-1991 and 1996-1997 periods. However, bear activity was not distributed evenly throughout the study area subunits. Food habits analysis indicated the importance of whitebark pine seeds during spring and fall, verified by the greater amount of bear activity recorded in mature whitebark pine cover types,. Herbaceous material was common during all months, with peak occurrence in summer feces. Bear activity was equally distributed among “core” (unroaded) and “non-core”(roaded) habitat. Black bears were less influenced by human activity levels than grizzly bears. The tendency of grizzly and black bears to avoid open areas more than roaded forest areas suggested that forested cover played a greater role in bear habitat utilization in the Cooke City Basin than road density. Cover and the availability of high quality foods mitigates the risk bears will take to acquire whitebark pine seeds in the Cooke City Basin.

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APPROVAL

of a thesis submitted by

Steven Richard Yonge

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

Dr. Lynn R. Irby — Lynn R. Irby (Signature) — 16 May 2001 Date

Approved for the Department of Ecology

Dr. Jay J. Rotella — Jay Rotella (Signature) — 18 May 2001 Date

Approved for the College of Graduate Studies

Dr. Bruce R. McLeod — Bruce R. McLeod (Signature) — 6-4-01 Date

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ABSTRACT

The Cooke City Basin in the northeast corner of the Greater Yellowstone Ecosystem (GYE) is characterized by high quality whitebark pine (*Pinus albicaulis*) foraging areas for grizzly bears (*Ursus arctos horribilis*) and black bears (*Ursus americanus*), as well as high levels of human activity and important mineral deposits. During the preparation of the Environmental Impact Statement (EIS) for the proposed New World Mine, the Gallatin National Forest (GNF) conducted a base line study during 1990 and 1991 addressing bear habitat use and the distribution of bears in relationship to human activity. I repeated the study during 1996 and 1997 to increase the number of years for a pooled sample and to determine if bear habitat use patterns had changed since 1990-1991 in response to increased human use. Although the effects of roaded habitat on bears are well documented, I investigated bear foraging strategies in pursuit of a high quality food source in areas with high road densities. Bear activity was surveyed by walking a series of line transects established within eight drainages adjacent to Cooke City, Montana. The density of bear activity was similar between the 1990-1991 and 1996-1997 periods. However, bear activity was not distributed evenly throughout the study area subunits. Food habits analysis indicated the importance of whitebark pine seeds during spring and fall, verified by the greater amount of bear activity recorded in mature whitebark pine cover types. Herbaceous material was common during all months, with peak occurrence in summer feces. Bear activity was equally distributed among "core" (unroaded) and "non-core"(roaded) habitat. Black bears were less influenced by human activity levels than grizzly bears. The tendency of grizzly and black bears to avoid open areas more than roaded forest areas suggested that forested cover played a greater role in bear habitat utilization in the Cooke City Basin than road density. Cover and the availability of high quality foods mitigates the risk bears will take to acquire whitebark pine seeds in the Cooke City Basin.

INTRODUCTION

From the inception of Yellowstone National Park (YNP) in 1872 until the 1970's, garbage was deliberately or casually made available to grizzly bears (*Ursus arctos horribilis*) and black bears (*Ursus americanus*). Consequently, dumps were an important food source for several generations of Yellowstone bears. The closure of dumps in and around Yellowstone and the subsequent dramatic grizzly bear population decline generated considerable controversy and was a major factor in the 1975 listing of the grizzly bear in the lower 48 states under the Endangered Species Act (Mattson and Reid 1991, Schullery 1992, Eberhardt and Knight 1996). Attempts by Federal and State agencies to protect the Yellowstone grizzly bear appear to have been successful in increasing numbers of bears. Recent evidence suggests that the Yellowstone grizzly population may be at or near carrying capacity in YNP (Mattson and Reid 1991). If the population in YNP is near carrying capacity, the demand for preferred habitat and food resources outside YNP has likely increased.

Human demands for resources have also increased in the Greater Yellowstone Ecosystem (GYE) exacerbating the potential for bear / human conflicts. Extraction of commodities such as timber and minerals leads to more roads and altered habitat. A growing interest in nonconsumptive recreational pursuits that result in a proliferation of human activity in roaded and non-roaded areas has also increased [Dan Tyers, Gallatin National Forest (GNF), pers. comm.].

Competition among bears for preferred habitat is based on social status. Mature males can exclude other bears from habitat that is productive and secure from humans. Other classes of the population, including females with cubs and subadults, appear to avoid males and use the remaining habitat where risks associated with human encounters are greater and foraging is energetically more stressful (Mattson and Reid 1991, Mattson 1993). Land ownership patterns, agency management restrictions, and commercial enterprise have centralized some human activities in the GYE. Females with cubs, the focus of population conservation efforts, may have developed foraging strategies to utilize these areas. Therefore, minimizing human-caused bear mortalities requires understanding bear habitat use in the more developed portions of the GYE.

The Cooke City Basin in the northeast corner of the GYE presents a management dilemma. How does one encourage an expanding grizzly population in an area with high levels of human use? High quality whitebark pine foraging areas for grizzly and black bears as well as high road densities and levels of human activity define this area. It is already an identified population sink (Knight et al. 1988). Significant amounts of forest cover have been removed through the 1988 Yellowstone fires and subsequent salvage logging. I used the Cooke City Basin to investigate bear foraging strategies in a disturbed area with high quality natural foods where foraging risks may be greater than in the surrounding designated wilderness.

Although heavily roaded, whitebark pine habitat in the Cooke City Basin offers a critical food source to bears. Whitebark pine seeds are an important spring and fall food for grizzly and black bears in the GYE (Craighead and Craighead 1972, Mattson and Jonkel 1990, Mattson et al. 1991, Mattson and Reinhart 1996). Grizzly bear survival and fecundity is dependent upon the whitebark pine cone crop (Mattson and Reinhart 1996). Mattson et al. (1992) reported a strong correlation between poor whitebark pine cone production and increased bear management actions and mortality. However, cover may provide the concealment and security necessary for bears to successfully feed on important natural foods while moving inconspicuously near roads and human developments.

Roads and cover have been identified as important determinants of bear habitat use. Mattson et al. (1987) and Mattson et al. (1992) found that road density, traffic volume, and seasonal food availability affected bear movements and foraging strategies in the Yellowstone area. On the East Front of the Rocky Mountains, Schallenberger and Jonkel (1980) reported the average distance of grizzly bear radio locations from automobile and 4 wheel drive roads was 3.4 km and 6.2 km, respectively. In YNP, grizzly bears avoided habitat within 500 m of primary roads during spring and fall (Mattson et al. 1987). In the Cabinet Mountains of northwestern Montana and northern Idaho, Kasworm and Manley (1990) discovered that black bears used habitat < 274 m from roads less than expected during spring and habitat < 914 m from roads less than expected during fall. In the Swan Mountains of Montana, Mace et al. (1996) reported that bears avoided habitat near roads with traffic volumes exceeding 60 cars per day. The northeast entrance of YNP, located on Highway 212, receives vehicle traffic similar to the Swan Mountains study area (USDOT 1998).

McLellan and Shackleton (1989) found that cover was an important factor in mitigating grizzly bear responses to human activity. Bears showed a strong response to human activity at distances of < 150 m in open habitat. In contrast, bears in cover showed no reaction to human activity at the same distance. Blanchard (1983) found that 90% of radio collared grizzly bear locations in YNP between 1977-1979 were in timbered cover. Blanchard (1983) also reported that of 191 grizzly observations in open habitat, 75% were < 100 m from forest cover.

To compensate for human activity and lack of cover, bears may increase nocturnal movements and decrease diurnal traveling. McLellan and Mace (1985) found that bears used roads more frequently at night. Schleyer (1983) reported that YNP grizzly bears demonstrated nocturnal habits with crepuscular peaks. However, YNP black bears were predominately diurnal during summer months (Schleyer 1983).

In response to these data, government agencies have attempted to regulate vehicle access to protect bears and bear habitat. Less attention has been given to bear requirements for cover. Management guidelines for road density and proportions of unroaded to roaded areas have been established for the GNF (IGBC 1998). However, their effectiveness in relation to bear use of cover, roaded landscapes, and important food sources is poorly understood.

In 1990, Noranda Minerals Inc. proposed the development of the New World Mine, to extract precious metals from Mount Henderson, Cooke City Basin. As part of the effects analysis for the Environmental Impact Statement (EIS), the GNF conducted a baseline study of grizzly and black bear habitat use during 1990 and 1991 (Reinhart and Mattson 1992). The study used line transects to record bear habitat use and addressed bear activity, habitat parameters, and the relationship between existing human activities and bear distribution in the vicinity of the New World Mine. However, the proposed mineral extraction project was removed from consideration by direct intervention of President Clinton in 1996 (USDI and USDA 1997). Although mining activity has ceased, other human activities including mining reclamation will continue to influence grizzly and black bear habitat use in the Cooke City Basin.

In 1996 and 1997, I repeated transects established for the New World Mine EIS baseline study (Reinhart and Mattson 1992) to contrast bear habitat use patterns between the two sample periods and to increase the number of years for a pooled sample. These data should assist managers attempting to protect bears in the GYE, an environment where competition for resources among bears and between bears and humans is increasing. Specifically, they should provide insights into the effects of roads and cover on bear habitat use.

My study objectives were:

1. Compare levels of bear activity between the two study periods.
2. Examine bear cover type use versus availability.
3. Identify and summarize important seasonal food habits.
4. Examine the effects of road density, core habitat, and cover on bear activity distribution.

STUDY AREA

The Cooke City study area was located 6 km (4 miles) from YNP's northeast entrance and encompassed 91 km^2 (Reinhart and Mattson 1992) within the Yellowstone Grizzly Bear Recovery Zone (USFWS 1993) (Fig. 1). The terrain and climate were characteristic of an intercontinental high elevation environment at the 45th parallel. Steep, rugged mountains and valley bottoms were the common landforms. The valley floor elevation was 2,427 m (7,400 ft.) and adjacent peaks exceeded 3,477 m (10,600 ft.). Although a portion of the Absaroka Range, my study area was located at the geologic break with the Beartooth Plateau, an extensive alpine region dominated by tundra and rock. The Beartooth Plateau consists of Precambrian granite gneiss and unmetamorphosed granite dated to approximately 2.7 billion years. The Cooke City structural zone is Paleozoic sedimentary rock and Tertiary volcanics (USDI and USDA 1997). The area was glaciated during the Pleistocene period, forming cirques, valleys, glacial lakes, and morainal deposits. Alluvial and colluvial material was common throughout the study area (USDI and USDA 1997).

Vegetation was a mosaic of forested community types fragmented by talus slides, avalanche chutes, nonforested openings, and alpine meadows. Forested areas at upper tree line consisted of krumholtz Engelmann spruce (*Picea engelmannii*), whitebark pine (*Pinus albicaulis*) and subalpine fir (*Abies lasiocarpa*). Mature to old growth stands of Engelmann spruce, whitebark pine, subalpine fir, and lodgepole pine (*Pinus contorta*) occurred at mid to low elevations (Reinhart and Mattson 1992). Extensive burned areas (Yellowstone fires of 1988) were found to the north and northeast of Cooke City at lower elevations. Avalanche chutes were dominated by subalpine fir and Engelmann spruce and accompanied by a grouse whortleberry (*Vaccinium scoparium*) understory (Reinhart and Mattson 1992). Alpine meadows supported a

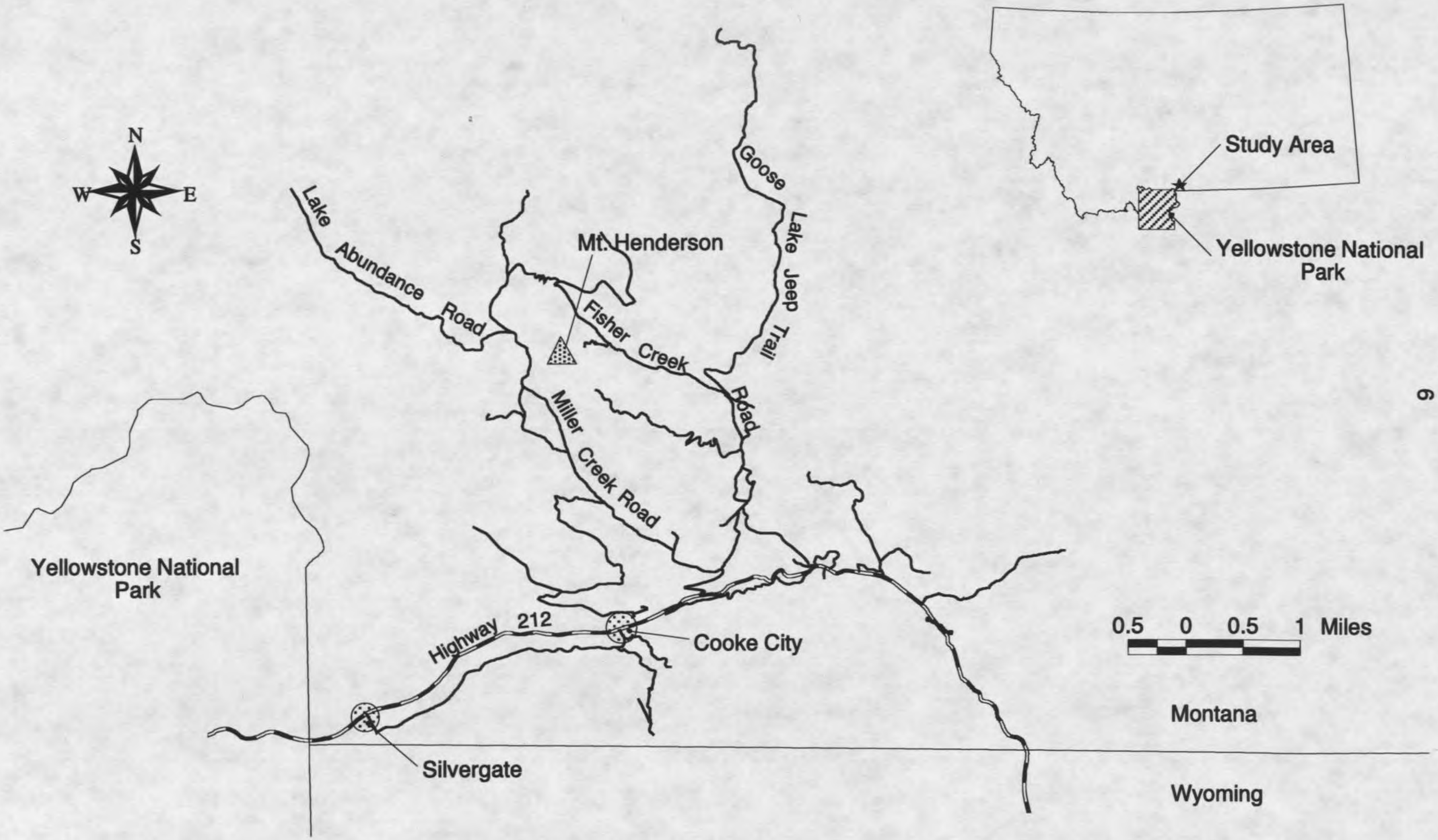

Figure 1. The Cooke City study area with landscape features and place names mentioned in the text.

variety of forb and grass species with species composition dependent on moisture content and soil type. Wet meadows occurred at the upper reaches of most streams. Willow (*Salix* spp.) communities were found in lower elevation riparian zones (Reinhart and Mattson 1992). Moist to dry forest openings, dominated by forbs and grasses, were common throughout the forest matrix.

Forest Service land management restrictions allowed for a wide variety of human activities and facilities, including timber harvesting, motorized travel, dispersed recreation, developed campgrounds, and until recently, mineral extraction (USDA 1987). In contrast, the surrounding areas were unroaded and part of the Absaroka-Beartooth and North Absaroka Wilderness areas of the Gallatin, Custer, and Shoshone National Forests (Reinhart and Mattson 1992). The remainder of the Basin was juxtaposed with YNP (USDI and USDA 1997). Most of the valley floor was in private ownership. In addition to commercial and residential pursuits, human activity while I collected data (1996 and 1997) included hiking, camping, backpacking, hunting, horseback riding, snowmobiling, cross-country skiing, four-wheel driving, and firewood cutting.

There was an extensive system of private, county, and Forest Service roads in the Cooke City Basin, most of which was constructed during a period of intense mining activity that originated in 1864 and ended with the closure of the McLarens mine in 1953 (USDA 1999). Two maintained county roads (Miller Creek and Fisher Creek) connected at Daisy and Lulu Pass and provided a popular vehicle loop route (USDI and USDA 1997). Primitive roads (Lake Abundance and Goose Lake jeep trail) accessed the edge of the Absaroka-Beartooth Wilderness. Vehicle use on all roads was greatest during July through mid-September (USDI and USDA 1997).

Forest Service developed recreation sites encouraged visitor use. Three campgrounds (Soda Butte, Colter, and Chief Joseph) in and adjacent to the study area received approximately 9,000 visitors annually (USDI and USDA 1997). Four trailheads (Lady of the Lakes, Republic

Pass, Lake Abundance, and Clarks Fork), provided access to a network of backcountry trails. Approximately 7,000 recreation visits were recorded at the Clarks Fork trailhead in 1995 (USDI and USDA 1997).

Highway 212, a National Scenic Highway, bisected the study area. Approximately 5-7% of the 3 million visitors annually entered Yellowstone via this route (USDI and USDA 1997). Three settlements (Cooke City, Silver Gate, and Colter Pass) were along the highway and within the Basin. There were approximately 124 year round residents and 318 seasonal residents living primarily along the road corridor. The 1990 census estimated 277 housing units and projected 3-4 new homes/cabins would be built per year on private lands (USDI and USDA 1997).

After the Yellowstone fires of 1988, logging increased (USDI and USDA 1997). Salvageable burned timber was removed from the lower portions of the Fisher and Miller Creek drainages starting in 1990 (Reinhart and Mattson 1992). Post-fire reforestation projects involved planting conifer seedlings throughout the same area until 1996 (Roger Gown, GNF, pers. comm.).

Whitebark pine, an important forest component in the study area, is an extremely valuable food source for bears within the GYE and the Cooke City Basin (Kendall 1983). Approximately 947 ha of mature and 20 ha of immature whitebark pine forest existed in and adjacent to the study area in 1995 (USDI and USDA 1997). The whitebark pine zone occurs in the upper subalpine and timberline areas between 2,440-2,870 m (8,006-9,416 ft). This elevational gradient averages < 0° C, is extremely windy, and is subjected to significant snow accumulations (Weaver 1990).

Other carnivores common to the study area included coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and mountain lions (*Felis concolor*). Wolverines (*Gulo luscus*) and gray wolves (*Canis lupus*) may also have used the area but were rare (USDI and USDA 1997). The area supported a variety of ungulates, including bighorn sheep (*Ovis canadensis*), mountain goats (*Oreamnos americanus*), mule deer (*Odocoileus hemionus*), Shiras moose (*Alces alces shiras*) and elk (*Cervus elaphus*). The red squirrel (*Tamiasciurus hudsonicus*) and Clark's nutcracker (*Nucifraga columbiana*), two species responsible for whitebark pine consumption and dispersal (Kendall 1983, Reinhart and Mattson 1990), were also common.

METHODS

Study Area Subunits

The Cooke City study area was divided into eight subunits based on geographic location and hydrologic divides (Reinhart and Mattson 1992) (Table 1, Fig. 2). Each subunit was adjacent to or within the original New World Mine project area and was established to assess the potential impacts mining activity would have on the surrounding area.

Table 1. The eight subunits where bear activity was recorded.

Subunit	Location Description
Fisher Creek	Upper portion of the Fisher Creek drainage above the Fisher Creek bridge crossing to Lulu Pass.
Miller Creek	Upper portion of the Miller Creek drainage to Daisy Pass.
Mud Lake	Area northeast of Fisher Creek, encompassing the Goose Lake jeep trail and a series of high mountain lakes, including Round Lake, Ovis Lake, Mud Lake, and Corner Lake.
Sheep Creek	Upper portion of the Sheep Creek drainage above Sheep Creek Falls.
Stillwater	Headwaters of the Stillwater River, below Crown Butte to Lake Abundance.
Republic Creek	Republic Creek drainage to Republic Pass.
Woody Creek	Woody Creek drainage including the area southeast of Cooke City to Colter Pass.
Cooke Face	Lower portion of the Sheep, Fisher, and Miller Creek drainages northwest of Cooke City.

Data Collection

I used line transects to determine bear distribution patterns following procedures reported in Reinhart and Mattson (1992). A USGS 15-minute topographic map and 1:30,000 color aerial

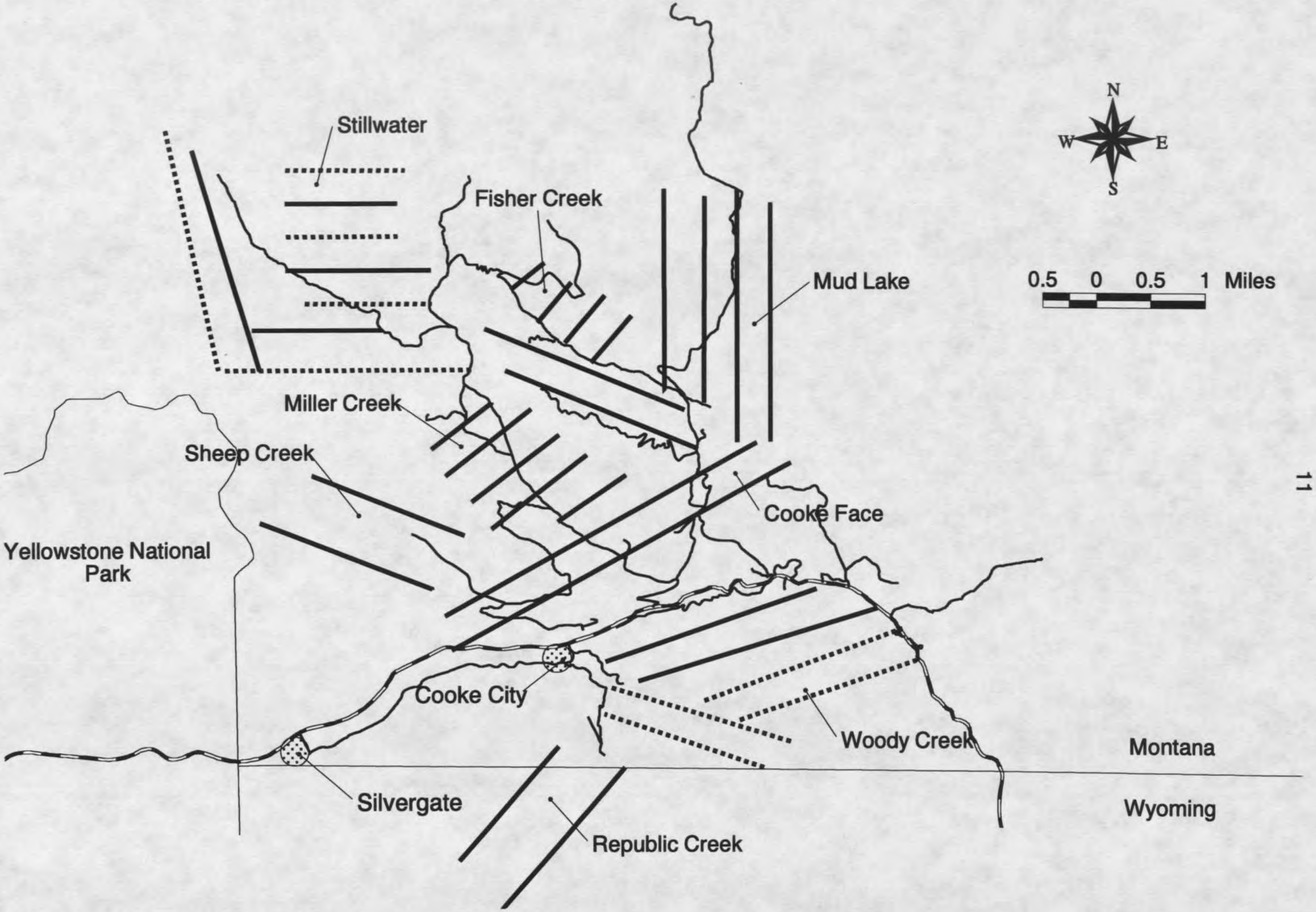

Figure 2. The location of the original 36 transects within the 8 subunits sampled during 1990 and 1991 by Dan Reinhart. The solid transect lines represent transects I resampled in 1996 and 1997.

photos were used to establish line transects within each subunit. Transects were placed 0.5 to 1.0 km apart and oriented perpendicular or parallel to topographic contours to cover elevational gradients within the eight subunits. Transect placement was dictated by landscape attributes, and no attempt was made to include or exclude specific habitat types. Transect length was determined by measurements on aerial photographs and topographic maps corrected for slope (Reinhart and Mattson 1992).

Line transects were sampled at approximately one month intervals to monitor the seasonal pattern of bear activity. Bear activity consisted of tracks, scat, daybeds, excavated red squirrel middens, bear sightings, torn logs, and feeding sites (Reinhart and Mattson 1992). Reinhart sampled 36 line transects (97 km) from June 25 to September 27 during 1990 and from June 20 to October 23 during 1991 (Reinhart and Mattson 1992). Reinhart sampled transects 2-4 times ($\bar{x}$=3.28) in 1990 and 4-5 times ($\bar{x}$=3.33) in 1991, covering a total of 295 km and 404 km, respectively (Reinhart and Mattson 1992).

I resampled 25 of the original 36 line transects (63 km) in 1996 and 27 transects (74 km) in 1997. I consulted with Reinhart to determine which transects should be repeated during 1996 and 1997. I repeated all transects in the Fisher Creek, Mud Lake, Miller Creek, Republic Creek, and Sheep Creek subunits. I resampled 4 of 9 transects within the Stillwater subunit, 2 of 6 transects in the Woody Creek subunit, and repeated the Cooke Face transects in 1997 (Fig. 2). I conducted fieldwork from July 17 through October 9 during 1996 and from July 5 through October 17 during 1997. I surveyed transects 3-4 times during 1996 ($\bar{x}$=3.52) and 1997 ($\bar{x}$=3.37) and sampled a total of 216 km and 249 km, respectively.

In both sampling periods, a transect compass bearing was held by one observer while another walked a zigzag pattern documenting bear activity. Bear activity was sampled out to 250 m from the transect line. Community site analysis was conducted at each bear activity site.

elevation, cover type (Mattson and Despain 1985), habitat type (Pfister et al. 1977), distance to nonforested/forested opening, burned/unburned forest designation, topographic position (ridge, upperslope, midslope, lowslope, bench, or bottom), and general site description (Appendix A, Fig. 16). Bear activity was dated to the approximate time of occurrence. When possible, bear tracks [Palmisciano technique (Brown 1993)], bear sightings, and hair samples were used to distinguish between black bear and grizzly bear activity sites. Thin layer chromatography (TLC) was used to differentiate between grizzly and black bear scats collected during 1991 (Reinhart and Mattson 1992), 1996, and 1997. All bear scats recorded by Reinhart and myself were collected for diet composition analysis.

The line transect survey method has been used in previous studies to assess wildlife abundance and population size (Eberhardt 1978, Roth 1980, Reinhart and Mattson 1990). Indirect measures have been an effective method used to compare animal abundance and habitat use patterns between areas and time periods (Halvorson 1984). My inability to differentiate grizzly bear from black bear sign did limit my interpretation of habitat use patterns and food habits. Thin layer chromatography alleviated some of these problems for identifying bear scats. Habitat utilization analysis was also affected by the probability of sign detection. Bear travel and grazing activity along with the associated habitat is potentially under represented due to the inconspicuous nature of this type of sign (Reinhart and Mattson 1992).

Despite its limitations, the line transect method is a cost-effective monitoring technique, and is relatively simple to repeat and logistically inexpensive, when compared to intense telemetry movement studies. This method is also less intrusive to the animal and is capable of capturing the annual variation in bear use patterns, habitat parameters, and overall bear food habits.

Thin Layer Chromatography Analysis

Thin layer chromatography was used to identify species (distinguishing grizzly from black bear) of bear scat collected in 1991,1996, and 1997. Mr. Laszlo Torma and staff from the Chemical Station Analytical Laboratory (Montana State University) prepared the chromatograms. Dr. Harold Picton (Emeritus Professor of Wildlife Management, Montana State University) read and interpreted the chromatograms and reported results. Procedures for TLC are reported in Picton (1991). The size and diameter of a bear scat is not considered a positive indicator for identifying species of bear (Hamer et al. 1981, Picton 1991), due to variation attributed to scat composition, moisture level, and scat age. Typically, one scat was analyzed from a group of scats collected from an activity site, and I assumed all other scats were deposited from the same individual bear. If a discrepancy existed (difference in scat size, fecal composition, or scat age) between scats within a scat grouping, multiple scats were analyzed. Scats were air dried, ground for 1 minute in a blender, and stored in film containers to deliver to the Chemical Station Analytical Laboratory. Picton's (1991) scat-key 12.1 was used to distinguish between black and grizzly bear scats. TLC results ranged from 100% to 56% probability for positive species identification. Results with a probability of $\leq$ 60% were cross referenced with field data summaries and deemed "unknown" if the bear sign was not classified by species in the field.

Density of Bear Activity

I calculated linear densities (n/km) (Reinhart and Mattson 1992) of bear activity incidence collected along transect routes. I compared levels of density among the eight subunits using data collected by Reinhart only from transects I repeated in 1996 and 1997 (Fig. 2). I compared levels of density between aggregated sample periods (1990-1991 versus 1996-1997) and between "good" (1991/1996) and "poor" (1990/1997) years of whitebark pine cone production using the nonparametric Wilcoxon paired rank test. I defined years of "good" whitebark pine cone production as years when cones averaged $\geq$ 13 cones per tree on IGBST monitored permanent transects. Mattson and Reinhart (1994) reported that when cones average >13-23 per tree, significant use by bears was observed. Years with <13 cones per tree were deemed "poor" cone production years. I then pooled all four years of bear activity site data and compared the density of bear activity among the eight subunits using the nonparametric Kruskal-Wallis test. Statistical significance was accepted at $P < 0.05$.

Cover Type Use – Availability Analysis

I utilized a 16,000 ha vegetation map developed as part of the New World Mine environmental assessment to assess grizzly and black bear cover type use versus availability. The vegetation map was verified by ground truth observations and mapped to a 2-acre polygon resolution. One hundred and twelve cover type combinations were recognized within the 250 m buffered area around all 36 transects. I consolidated cover types into 10 categories (Table 2) to facilitate analysis. Vegetative mosaics were designated when more than one cover type was in juxtaposition to another, where there was no true dominant cover type, or to identify vegetative ecotones.

I pooled all of Reinhart's bear activity data, including data from transects I did not repeat, and the data I collected during 1996 and 1997 and tested for goodness-of-fit of cover type use. I then pooled bear activity sites recorded during years of "poor" (1990/1997) and "good" (1991/1996) whitebark pine cone production and tested for goodness-of-fit. To capture potential differences in cover type use versus availability during the 1990-1991 and 1996-1997 periods, I separately tested for goodness-of-fit. I then pooled all grizzly bear activity locations recorded by Reinhart and myself and compared cover type use versus availability. Use versus availability analysis followed procedures described by Neu et al. (1974). Statistical significance was accepted at $P < 0.05$.

Table 2. Cover type categories where grizzly bear and black bear activity sites were recorded. For complete cover type definitions see Mattson and Despain (1985).

Cover Type	Description
Mature whitebark pine	Mature whitebark pine forest; contains Engelmann spruce, subalpine fir, and lodgepole pine.
Mature whitebark pine mosaic	Mature whitebark pine forest in a mosaic of other vegetative components.
Mature subalpine fir	Mature subalpine fir forest. May contain lodgepole pine, whitebark pine, and Douglas fir (*Pseudotsuga menziesii*).
Mature subalpine fir mosaic[a]	Mature subalpine fir forest in a mosaic of other vegetative components.
Disturbed subalpine fir mosaic	Wet or burned spruce and subalpine fir forest in a mosaic of other vegetative components. Incomplete canopy closure.
Mature lodgepole pine	Mature lodgepole pine forest. Subalpine fir, spruce, and whitebark pine in understory.
High elevation grassland/ tundra[a]	Open vegetative component consisting of high elevation rocky grasslands, grasslands and meadows, and tundra.
Meadow mosaic	Wet and dry grass and forb meadows in a mosaic of other vegetative components. Includes seeps and nonforested openings. Open habitat.
Rock	Cliff, talus slides, and exposed bedrock. Soils are shallow and vegetation is sparse or restricted to the margins.
Other	Standing water, aspen, and minor vegetative components.

[a]Excluded from grizzly bear cover type use-availability analysis; consolidated into "other" cover type category.

To assess the use of forested cover by grizzly and black bears, I consolidated existing cover types into 3 categories: open habitat and nonforested areas, forested and open cover type vegetative mosaics, and forested habitat. I pooled all bear activity locations collected by

Reinhart and myself and tested for goodness-of-fit among the three cover type categories. I then separately tested the goodness-of-fit for positively identified grizzly and black bear activity sites, recorded by Reinhart and myself, across all years (unknown bear activity sites were excluded). The analysis was specific to the 250 m buffered transect area. Use versus availability analysis followed procedures described by Neu et al. (1974). Statistical significance was accepted at $P < 0.05$.

Food Habits

All bear scats located in 1990 and 1991 by Reinhart and all scats that I recorded in 1996 and 1997 were collected for diet composition analysis. Collected scats were identified according to transect location, estimated age, date collected, fecal diameter measurement, and possible species identification. Scats were air-dried approximately 1 week and stored in paper bags. The total number of scats collected each year varied due to survey intensity, weather conditions, and bear activity. Kevin Frey of Montana Fish, Wildlife, and Parks (MFWP) conducted the fecal analysis. Scats were rehydrated, broken apart, and washed through different diameter sieves for content identification and visual volume estimates (Mattson et al. 1991, Litvaitis et al. 1994, Kevin Frey, MFWP, pers. comm.). Scat contents were routinely identified to the finest taxonomic level possible. Scat content was summarized into eight major diet categories: whitebark pine seeds, fleshy fruits (berries), sporophytes, grasses/sedges, forbs, insects, miscellaneous (debris), and animal matter. Diet components were summarized by frequency of occurrence and percent fecal volume by season (spring, summer, and fall) (Mattson et al. 1991, Mattson and Reinhart 1992). Season definitions are described in the IGBST 1997 Yellowstone grizzly bear investigations annual report (Haroldson et al. 1997). Percent scat volume was averaged across all years and for aggregated years (Netter et al. 1993) giving each year's data equal weight.

I examined patterns of use by individual seasons, by species of bear, and across all years by season to determine the impacts of the temporal scale on interpretation of food habits. I summarized each diet item by its frequency of occurrence and percent fecal volume by year and season. I pooled Reinhart's data and the information I collected and analyzed the frequency of occurrence of the major diet items across all years by season. I also separately analyzed grizzly and black bear scat content collected by Reinhart and myself across all years by season because of sample size limitations (unknown species of bear scat were excluded). I used contingency table analysis to test for changes in use of the eight diet item categories among years (1990 versus 1991 versus 1996 versus 1997) and between bear species. Statistical significance was accepted at $P < 0.05$.

Core Area and Road Density Analysis

Road density analysis and "core" area estimates were conducted using moving windows analysis (Turner and Gardner 1990) in conjunction with the cumulative effects model (CEM) (USDA 1990). The disturbance submodel of the CEM quantifies the cumulative effects of disturbances associated with humans on grizzly bear habitat use (USDA 1990). The CEM uses four variables to stratify human activities: the type of activity, nature of activity, length of activity, and intensity of activity (USDA 1990). The cumulative effects of these four variables creates a "zone of influence" or buffered area around the human activity or disturbance, which represents the distance in which grizzly bears would likely be affected (USDA 1990). The buffered area represents "non-core" or sub-optimal bear habitat.

Existing road densities were categorized as either $\leq$ 1610 m/1610 m^2 ($\leq$ 1.0 mi/mi^2) or $\geq$ 1710 m/1610m^2 ($\geq$ 1.1 mi/mi^2) (J. T. Stangl, GNF, pers. comm.) based on Ruediger and Mealey's (1978) conclusion that road densities should not exceed 1610 m/1610 m^2 to provide adequate security for bears. Road density estimates included restricted and open roads, as defined by the Interagency Grizzly Bear Committee (IGBC) Taskforce Report (1998). The CEM quantifies road densities for two temporal periods (season 1 and season 2) to account for seasonal road restrictions or limited access. Season 1 ran from March 1 through July 15, and season 2 began July 16 and ended November 30.

Road densities were calculated for the 250 m buffered area around each transect. The area in each road density category was calculated as well. Season 1 and season 2 results were combined and analyzed together due to the lack of difference in road density between the two seasons. All bear activity site locations recorded by Reinhart and myself were pooled and tested for goodness-of-fit. Positively identified grizzly and black bear activity sites recorded by Reinhart and myself were pooled separately and also tested for goodness-of-fit across all years. Procedures described by Neu et al. (1974) were used to assess bear use versus availability of the two road density categories. Statistical significance was accepted at $P < 0.05$.

In conjunction with road density analysis, I calculated "core" and "non-core" area to account for the different levels of human activity and disturbance associated with roads and developments within the study area. The IGBC Taskforce Report (1998) defines a "core" area as having no motorized traffic and low levels of human use. I calculated "core" area associated with each transect based on human activity, road density, and road restrictions/access. Season 1 and season 2 classifications were used to account for annual changes in human use patterns and road accessibility. All habitat with roads and trails open to motorized vehicles and areas with roads and trails that received high intensity non-motorized use were excluded from my "core" area estimates (IGBC 1998). I defined high intensity use as 20 or more human parties per week or areas with concentrated activities (i.e. hunting) (USDA 1990, IGBC 1998). I defined "non-core" habitat as areas within 500 m of open roads and trails that allowed motorized use or areas that experienced high intense human use (Mattson et al. 1987, IGBC 1998).