SPECIES ASSESSMENT FOR GRIZZLY (BROWN) BEAR (*URSUS ARCTOS*) IN WYOMING

prepared by

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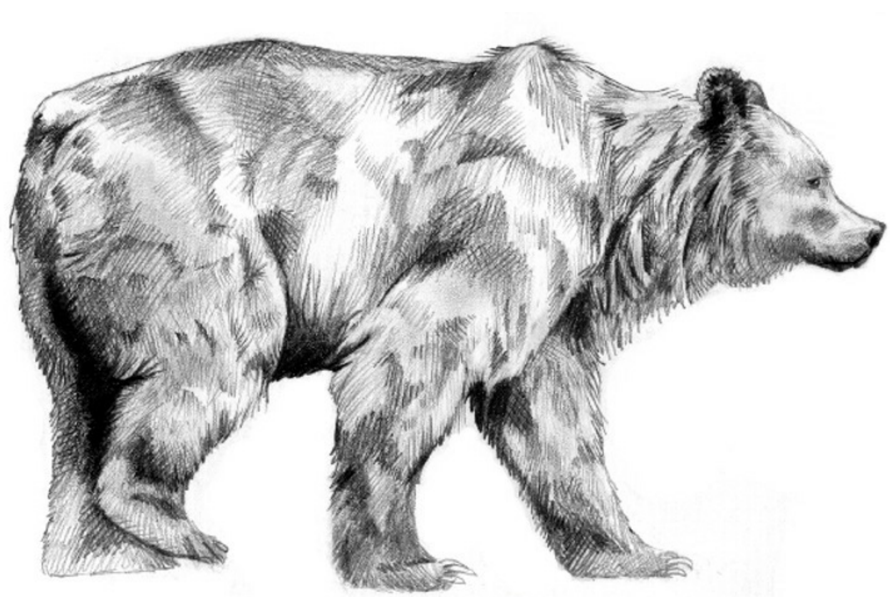

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Introduction

Capable of exploiting a variety of habitats, the grizzly or brown bear (*Ursus arctos*) once occurred throughout much of western North America. Since European settlement however, grizzly bear populations have been eliminated from more than 98% of their historic range in the lower 48 States (Figure 1). As a consequence the species was listed as "Threatened" under the U.S. Endangered Species Act (ESA) in 1975. Primary threats contributing to decline and extirpation of the species are excessive human-caused mortality and habitat loss. Low reproductive potential, large area requirements, and sensitivity to human disturbance also increase vulnerability to endangerment. Protection of the extant grizzly bear population in Wyoming is critical to recovery and conservation of the species. Current and future distribution modeling is necessary for effective grizzly bear habitat management and maintenance of critical corridors linking regional population centers.

Natural History

Morphological Description

The grizzly bear is large and powerful with a massive head, prominent nose, small rounded ears, small eyes, and short tail (Pasitschniak-Arts 1993). The species is recognized in the field by its dished facial profile; prominent shoulder hump; and long, slender, slightly recurved foreclaws twice the length of the hind claws (Pasitschniak-Arts 1993, Wilson and Ruff 1999). Dorsal guard hairs of some individuals from western North America are variegated and show a silver tipped or grizzled appearance, hence the common name "grizzly". In North America, pelage color varies from nearly yellow to black and may be any shade of brown (Kays and Wilson 2002, Wilson and Ruff 1999). Head and shoulders are typically lighter than the sides, legs, and venter often with a pale wash of yellow (Fitzgerald et al. 1994). The predominate pelt color pattern of Yellowstone grizzlies is medium to dark brown with brown shoulder hump, legs, and venter and light to medium grizzling on the head and portion of the back (Pasitschniak-Arts 1993, Schwartz et al. 2003). A distinct mane of long hairs on the shoulders is usually present.

Of 55 adult males and 55 adult females from Yellowstone National Park (YNP), average body measurements and weights were: total length 1.643 m, 1.511 m; height 95.2 cm, 87.4 cm; girth 130.5 cm, 114.6 cm; neck circumference 78.6 cm, 65.4 cm; length of head 41.7 cm, 37.8 cm; length of hind foot 189 mm, 163 mm; and width of hind foot 136 mm, 118 mm; mean adult mass 193 kg, 135 kg (Pasitschniak-Arts 1993). The largest grizzly bear weighed in the Greater Yellowstone Ecosystem (GYE) registered 509 kg (Craighead 1979). Males are usually 8-10% larger than females and skulls show some sexual dimorphism. Grizzly bears, like most bears, show a great degree of plasticity in physical dimensions; in general, size varies positively with amount and quality of food.

The greatest crown length of the last maxillary molar (M2) is greater than 31 mm (Pasitschniak-Arts 1993) and is more than one times the length of the first maxillary molar (Fitzgerald et al. 1994). Length of maxillary toothrow is more than 110 mm (Fitzgerald et al. 1994). Crown length and width of the first mandibular molar are always greater than 20.4 and 10.5 mm, respectively (Pasitschniak-Arts 1993).

Some adult black bears (*U. americanus*) closely resemble grizzly bears and may be misidentified in the field (Clark and Stromberg 1987). The black bear has a smaller hump, lacks the mane of hairs present on the shoulders of the grizzly bear, and the tips of dorsal guard hairs are never grizzled. In addition, the rump of a black bear usually appears high or higher than the shoulder area when standing whereas grizzly bears usually appear slightly taller in the shoulder

(Fitzgerald et al. 1994). The black bear has a straight profile, slightly longer and more tapered ears with less hair. Many dark colored black bears have a pale muzzle (Wilson and Ruff 1999). Claws on the front paws of black bears are about the same length as the claws on the hind paws and are shorter and more tightly curved than those on grizzly bears. In the field, the grizzly bear may be most easily distinguished from the black bear by its prominent shoulder hump, concave facial profile, longer pelage and longer claws (Nowak 1999).

Taxonomy and Distribution

Taxonomy

The taxonomy of this bear has been described as “formidable and confused” (Wilson and Ruff 1999). The generally accepted current classification of North American grizzly bears is that proposed by Rausch (1963) (Schwartz 2003). Rausch identified two extant subspecies of *U. arctos* in North America based on skull measurements. Rausch assigned mainland grizzly bears to the subspecies *U. a. horribilis* and bears from the Kodiak Island archipelago to *U. a. middendorffi*. Hall (1984) on the other hand proposed on the basis of cranial and dentition dimensions, 7 North American subspecies of which *U. a. middendorffi, U. a. gyas, U. a. dalli, U. a. sitkensis* Merriam, and *U. a.. alascensis* were restricted to Alaska and *U. a. stikeenesis* to coastal British Columbia, Washington, and Oregon. Under Hall’s proposal, *U. a. horribils* includes all inland populations in Canada and the lower 48 States. Numerous other classifications have been proposed and genetic analyses are likely to yield additional subspecies designations. Regardless, there is apparently only one subspecies, *U. a. horribils,* in the Rocky Mountains.

Distribution

Ursus arctos is native to North America and Eurasia. The range of grizzly bears in North America before European settlement extended south from Alaska to northern Mexico and east from the Pacific coast to the Canadian Prairies and U.S. Great Plains west of the Mississippi River. Historically, grizzly bears occurred throughout most of Wyoming (Long 1965) and were present in neighboring states as well. Grizzly bears were also common throughout Colorado, Idaho, and Montana, were widely distributed in Utah, and occurred across the western parts of South Dakota and Nebraska (Davis 1939, Armstrong 1977, Hall and Kelson 1959, Hall 1981, Jones et al. 1983, Fitzgerald et al. 1994, Mattson and Merrill 2002, Patterson et al. 2003, Schwartz et al. 2003; Figure 1).

The distribution of grizzly bears in Alaska and northern Canada has changed very little since historic times. The species persists in British Columbia and Alberta, but is no longer present in the prairies of Canada. Grizzly bears have been extirpated from Mexico, and in the lower 48 States occupy less than 2% of their historic range. Only five remnant populations remain below the Canadian border (Servheen 1999; Figure 1). The U.S. portion of the Cabinet-Yaak population in extreme northwest Montana and northeast Idaho is 20-30 individuals and is not expanding its range. The Selkirk population in extreme northwest Idaho and extreme northeast Washington is estimated to be 25-35 bears. This population estimate includes the U.S. and Canadian portions of the Selkirk ecosystem. The Selkirk population appears to be increasing and some bears have been seen outside of previously assumed range in the U.S. The U.S. portion of the northern Cascades population in Washington is very small (five animals); the population is not expanding and its distribution is unclear. Grizzly bears in the Northern Continental Divide Ecosystem (NCDE) in northcentral Montana, and in the GYE in eastern Idaho, southwestern Montana, and northwestern Wyoming on the other hand appear to be doing quite well. There are 400-500 grizzly bears in the NCDE and 350-500+ in the GYE. Both populations appear to be expanding their ranges. Current range expansion of the GYE population is particularly evident in the southern portion of the ecosystem in Wyoming (Schwartz et al. 2002) (Figure 2).

The Primary Conservation Area (PCA) of the Yellowstone grizzly bear encompasses 23,833 km^2 centered on YNP and includes Grand Teton National Park, John D. Rockefeller Memorial Parkway, contiguous portions of the Shoshone, Bridger-Teton, Targhee, Gallatin, Beaverhead, and Custer National Forests, Bureau of Land Management lands, and over 222 km^2 of State and private lands in southeast Idaho, southwest Montana, and northwest Wyoming (Figure 2).

The Wyoming portion of the GYE includes portions of Park, Hot Springs, Fremont, Teton, Sublette and Lincoln counties. It includes all lands within the Shoshone, Bridger-Teton, and Targhee National Forests, Yellowstone and Grand Teton National Parks, the National Elk Refuge, and the western portion of the Wind River Indian Reservation. It also incorporates private, state and federal lands within and adjacent to the above mentioned national forests.

The current extent of the grizzly bear's range in Wyoming within the GYE and beyond is difficult to estimate because of population expansion and the fact that dispersing individuals are increasingly appearing in distant sites. Wyoming grizzly bears consistently occupy Grand Teton National Park, YNP, and portions of adjacent national forest and private lands to the south and east extending to the eastern edge of the Absaroka Mountains, the western portion of the Owl Creek Mountains, south in the Gros Ventre Range to the Pinnacle Peak area, and south in the Wind River Range to the Green River Lakes area (Moody et al. 2002).

Wyoming intends to restrict grizzly bears to the following area when/ if they are delisted from the ESA: "The established outer boundary for grizzly bear occupancy (by natural dispersal) encompasses most of the area within the Wyoming portion of the GYE. Specifically, it includes an area with an outer boundary beginning at the intersection of Wyoming Highway 120 and the Montana border; southerly along said highway through Cody and Meeteetse to U.S. Highway 20 in Thermopolis; southerly along said highway to Wyoming Highway 789 in Shoshoni;

southwesterly along said highway to Wyoming Highway 134; westerly along said highway to Wyoming Highway 132; southerly along said highway to U.S. Highway 287; southeasterly along said highway to Wyoming Highway 28 approximately eight miles south of Lander; southerly along said highway to U.S. Highway 191 in Farson; northerly along said highway through Pinedale to U.S. Highway 189; southerly along said highway to U.S. Highway 30 in Kemmerer; west along said highway to the Utah border" (Moody et al. 2002, p. 28).

Habitat Requirements

General

Grizzly bears occupy a variety of habitats throughout their range. Grizzly bears are highly adaptable and are capable of exploiting different landscapes given their omnivorous generalist lifestyle and overall adaptability and intelligence. This indication is further reinforced by the wide range of habitats utilized by any one population.

Occupied grizzly bear habitat in the lower 48 States is characterized by extensive forest cover often interspersed with grasslands and meadows. Though grizzly bears do not intrinsically require such cover, populations living near developed areas may require the isolation provided by forest cover. Home ranges must encompass a complex of habitat types because the animals move among these habitats seasonally to take advantage of various food items as they become available. In addition, home ranges must include sites suitable for hibernation.

Craighead et al. (1995) used satellite images to characterize and examine the distribution of habitat types present within the home ranges of five radio-collared grizzly bears and three core areas (centers of activity within home ranges) in YNP. The study area, centered on Hayden Valley, lies mostly in the subalpine zone and contains parklands characterized by forest interspersed with grass and shrublands. Coniferous forest constitutes approximately 45% of the area and mountain grassland and shrubland habitat types and associated riparian communities comprised 23% of the area. The dispersed pattern of forest and grass-shrubland present in the study area provides habitat conditions preferred by the grizzly bear. Consequently, the study area was almost entirely encompassed by the ranges of these and other marked grizzly bears. The habitat pattern present in this study area enabled bears to access graminoids, succulent forbs, berries (e.g., *Vaccinium* spp.), and whitebark pine (*Pinus albicaulis*) seeds all within relatively small home ranges, even though these foods ripen at different times throughout the season.

The grass and shrublands in this area were dominated by Wyoming big sagebrush (*Artemisia tridentata*), blue bunch wheatgrass (*Agropyron spicatum*), and Idaho fescue (*Festuca idahoensis*). Perennials present included geranium (*Geranium viscosissimum*), larcbell (*Campanula rotundifolia*), old man's whiskers (*Geum triflorum*), white clover (*Triflorum repens*), elk thistle (*Cirsium scarosium*), and yampa (*Perideridia gairneri*). Riparian communities were commonly dominated by sedges (*Carex* spp.).

Coniferous forests in the study area were primarily represented by various seral stages of subalpine fir (*Abies lasiocarpa*) with substantial components of pine grass (*Calamagrostis rubescens*), huckleberry (*Vaccinium globulare*), and whortleberry (*Vaccinium scoparium*). These last two species are important grizzly bear foods during periods of heavy berry production. Coniferous forest on dry ridges and eastern exposures was often composed of whitebark pine with a whortleberry understory. Spruce stands used by foraging grizzly bears were typically situated along streams, and were characterized by Engelmann spruce (*Picea englemannii*) over an understory of twinflower (*Linnaea borealis*), huckleberry, and whortleberry. Though not preferred feeding types, Douglas fir (*Pseudotsuga menziesii*) stands were frequented by grizzly bears.

Alpine meadows and coniferous krummholz were poorly represented within the study area. Although grizzly bears in YNP appear to use these types infrequently, grizzly bears in the NCDE use them heavily during late June and July when seeking aggregated army cutworm moths (*Euxoa auxiliaris*) and emerging alpine plants such as biscuitroot (*Lomatium* spp.), spring beauty (*Claytonia* spp.), elk sedges (*Corex* spp.), and various graminoids. Grizzly bears in parts of Wyoming adjacent to YNP may similarly use the alpine zone for these resources.

All grizzly bear core use areas examined by Craighead et al. (1995) contained forest, grass-shrubland, and riparian communities. The presence of riparian vegetation and subalpine fir/ whortleberry stands in all core use areas indicates their great importance to the grizzly bear.

Preferred bedding sites are located in alder thickets, lodgepole pine (*Pinus contorta*) downfalls and other dense vegetation generally near to feeding areas (Craighead and Craighead 1972, Craighead and Scaggs 1982). Denning sites are most commonly located in the subalpine fir stands on north-facing exposures (Craighead et al. 1995).

Generally speaking, the most suitable grizzly bear habitat in Wyoming is in the northwestern portion of the state in large tracts of undisturbed habitat and minimal human disturbance. Human-caused mortality and disturbance is the major limiting factor on population expansion of most large mammalian carnivores in the Rocky Mountains (e.g., Beck 1991, Anderson et al. 1992, Noss et al. 1996); grizzly bears are clearly no exception to this rule (e.g., Wieglus et al. 1994, Mace et al. 1996). In any given region there is a positive relationship between human density and human-caused mortality of grizzly bears via a variety of mechanisms. In this context, and considering "habitat" broadly as the complete suite of environmental factors that promote persistence of a taxon, one of the most important habitat features required by grizzly bears is minimal human density. Current grizzly bear distribution better reflects areas of minimal human settlement than any particular pattern of vegetation or topography. Road density may be a relatively robust surrogate for human impacts on grizzly bears; this may be an important physical factor to use to map grizzly bear habitat.

Active seasons

During the active period of the year grizzly bears concentrate their activity in the most productive environments for a given season. The pattern of seasonal elevation use observed in the GYE is similar to that of other populations occurring in the interior western mountains.

Mealy (1977) identified three feeding "economies" (valley/ plateau, mountain, and lake) and associated seasonal habitat use patterns in YNP. The valley/ plateau and mountain feeding economies were centered on areas with fertile soils. Little feeding, aside from that in the lake economy, was apparent on infertile soils.

The highest densities of grizzly bears observed by Mealy (1977) were in the valley/ plateau economy on the rich grasslands of Hayden, Pelican, and Lamar valleys of YNP. Plateaus with infertile soils and lodgepole pine forests surrounding these valleys provided cover and only occasional food. Activities by grizzly bears in this economy were primarily concentrated on the fertile transported soils of the valleys. General pattern of seasonal habitat use here followed plant phenology. Prior to the growing season, grizzly bears congregated on ruminant wintering grounds. As succulent herbaceous material became available bears concentrated activity at feeding site in open areas near cover. After the growing season, bears moved to moist sites where succulent grasses and forbs remained available. As valley vegetation desiccated, bears moved to conifer forests to exploit late season foods such as whitebark pine seeds, berries, mushrooms (*Russula* spp.), and smilacina rhizomes.

The Gallatin and Washburn ranges were the major centers of the mountain economy. The mountain meadows, herblands, parklands, and ridgetops of the mountain economy were characterized by fertile andesitic and sedimentary soils. The most important foods on ridgetop herblands were spring beauty, grasses and sedges, roots of Umbelliferae, and whitebark pine seeds. The seasonal habitat use pattern here also followed plant phenology. Grizzly bears in the mountain economy moved directly to snow free locations at lower elevations following emergence from winter dormancy. Grizzly bears moved along an elevational gradient following snowmelt and green-up, reaching highest elevation habitats in late June and August. After desiccation of plants on high ridgetops in late August, grizzly bears returned to lower elevations where plants still remain green in stream bottoms, springs, and herblands associated with persistent snowbanks. Following desiccation of herbs at lower elevations in October, grizzly bears once again concentrated activity on ridges at approximately 2740 m where they ate whitebark pine seeds, Umbelliferae roots and spring beauty corms. In October and November grizzly bears concentrated activity on ridges offering whitebark pine seeds.

The lake economy consisted of Yellowstone Lake and tributaries that support spawning Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). The seasonal habitat use cycle of this economy was directly related to cutthroat trout spawning activities. Mattson and Reinhardt (1995) found that grizzly bears who fed on cutthroat trout concentrated activity within 12 km of spawning streams year-round and within 2 km of streams during spawning season (1 May-15 July).

Denning period

In North America grizzly bear dens are typically located in treeless alpine areas, the forest-alpine ecotone, or forest, depending on availability. Grizzly bears select den sites with stable snow conditions for the duration of time required. Stable snow conditions are most often present at middle elevations where slope and aspect offer protection from prevailing wind and sun exposure (Linnell at al. 2000). These requirements generally result in avoidance of valley bottoms and high peaks for den site selection. The typical den documented for grizzly bears in North America is excavated under trees where root systems provide stability for the roof. Such dens are rarely reused, perhaps because excavated dens often do not persist long enough (Schwartz 2003). Natural cavities are reused with varying frequency. Successive excavated dens for individual bears tend to be within the same region, roughly 1.7-8.8 km apart (Linnell et al. 2000). Females show greater den-area fidelity than males. Grizzly bears likely use the most suitable denning habitat within their home range but local tradition may play a role in site selection and den construction. For instance, dens in the Mission and Rattlesnake Mountains of Montana occurred either singly, in dispersed groupings with dens approximately 200-500 m apart, or in compact groups of 2 or more within an area of less than 1 ha (Servheen and Klaver 1980). Den grouping may occur because of restricted availability of suitable denning habitat or learning of, and returning to, suitable sites through experience.

The most frequently used denning habitat in the GYE is located in subalpine fir forest (Craighead et al. 1995). Dens examined by Craighead and Craighead (1972) were commonly dug in timbered, secluded areas away from developments and human activity. All but one den were located on northern slopes with the den entrance facing north. The prevailing southwest winds in the Yellowstone area force accumulation of snow on northern exposures. This deep snow insulates the chamber and reduces the risk of snow melt in the event of a Chinook wind. Natural shelters were not utilized as dens though matted windfalls and rock caves were available. Seven of 11 dens were dug at the base of trees with large downward and outward sloping roots, three were situated at the base of stumps or with entrances beneath horizontal logs, only one den was located in open habitat. Interestingly, grizzly bear dens in the Swan Range of Montana were on open or open timbered sites more often than on heavily forested sites (Mace and Waller 1997). Dens of known pregnant females in the GYE were located at least 100 m higher than other females or male bears (Haroldson et al. 2002). Mean elevation of den sites for females that emerged from dens with cubs was 2,696 m (n=49, SD=271). Differences in elevation of den sites for other females and males were not observed. Mean elevation for other females and males were 2581 m (n=102, SD=278) and 2574 m (n=83, SD=248) respectively.

Podruzny et al. (2002) constructed a spatially explicit model using known den locations and a geographic information system (GIS) to map potential denning habitat in the GYE. Potential denning habitat appears to be abundant within the GYE and well distributed across the ecosystem. Because elevation was an important variable, the 80th percentile model excluded the highest and lowest elevations from potential denning habitat. The 80th percentile model also excluded areas with less forest cover and extreme flatness or steepness of slope (e.g. large valleys and alpine peaks).

Grizzly bears in the GYE enter the den for winter dormancy sometime between late September and late December and emerge from the den between late March and late May. Prehibernation activities and movement are discussed in greater detail in the Movement and Activity Patterns.

Landscape Pattern

As discussed above, grizzly bears use a mosaic of environments that provide denning sites and enable seasonal exploitation of important food items. Craighead et al. (1995, p. 308) expressed this as "the entire complex of habitat types within in Yellowstone Ecosystem [is] essential and critical for the grizzly bear." Clearly, minimal contact with people is a critical factor; grizzly bears are general enough in habitat use and diet to persist probably anywhere in western North America with relatively high primary productivity as long as there is minimal contact with people. This is reflected in their current restriction to wilderness landscapes.

Area Requirements

The area required by an individual grizzly bear is determined by habitat quality and food availability and may therefore change seasonally and annually. Male grizzly bears typically have annual home ranges several times larger than those of adult females. Estimated mean home ranges of males and females in the GYE are 874 km^2 and 281 km^2, respectively (Schwartz et al. 2003). The 23,300 km^2 area available to Yellowstone grizzly bears is roughly six times the size of the average male lifetime home range and 26 times the size of the average female lifetime range (Mattson and Reid 1991).

Home range overlap among sex and age classes of grizzly bears in the GYE is extensive. Core areas, however, do not overlap and are well spaced. Core areas for animals tracked by Craighead et al. (1995) were small, rarely exceeding 2.6 km^2 each.

Home ranges sizes are also influenced by topography. In the southwest Yukon, the greatest densities and smallest home ranges (males, 287 km^2; females, 86 km^2) were found in areas with the most rugged terrain and the highest habitat diversity (Servheen 1987). The large home ranges in the GYE relative to the high mountain ecosystem may be due to its plateau topography.

In addition, Yellowstone grizzly bear habitat is characterized by sporadic and widely fluctuating food production primarily controlled by weather. As a result, the natural carrying capacity of the area fluctuates (Picton et al. 1985). During years of low productivity, bears compensate by using a larger area. Mortality is also higher during these periods and fecundity decreases.

Several parameters sensitive to variation in habitat conditions, including mortality, natality, weights, and movements, indicate the Yellowstone grizzly population may be nearing carrying capacity and undergoing K selection over much of its core range centered on YNP (Mattson and Reid 1991). If the Yellowstone population is in fact approaching carrying capacity, and if habitat conditions remain roughly the same, little room exists for additional grizzly bears in the GYE.

Area requirements of populations are influenced by individual home range sizes and population size and density in addition to habitat quality and carrying capacity. Wielgus (2002) predicted that a naturally regulated population in the Flathead Valley of southeastern British Columbia comprised of 250 animals at a density of 6.4 bears/100 km^2 at or near carrying capacity would require a reserve size of approximately 3906 km^2.

Movement and Activity Patterns

Movement and activity patterns are influenced by a number of factors including weather, key food items, breeding, reproductive status, security, and human disturbance, and therefore can be extremely variable within and among populations of grizzly bears.

Grizzly bears engage in five kinds of movements: movement to an abundant or preferred food source, localized movement, intensive feeding prior to denning, movement to a den site (Servheen 1987), and natal dispersal. Rates of movement are moderate when averaged per day. For example, the average rate of movement for male grizzly bears in the GYE is only 4 km/ day. Grizzly bears living in one geographic area tend to remain in the same general area throughout the active seasons and typically have smaller annual rates of movement. Individuals living in home ranges comprised of two geographic units separated by a corridor typically shift ranges with the food seasons, traveling more often and significantly greater distances. Movement to an abundant or preferred food source, particularly fall food sources, and movement to a den site are typically abrupt and rapid. Craighead et al. (1995) observed a number of bears with summer ranges in Hayden Valley, YNP and fall ranges and wintering sites outside the park. Some of these bears moved 40-60 air km between sites; others moved significantly farther. Duration of such treks is usually several hours to a few days.

Intensive feeding, termed hyperphagia, occurs in autumn prior to denning. Grizzly bears spend one to three weeks near the den site before entering winter dormancy. All or most grizzly bears observed by Craighead and Craighead (1972) entered dens to hibernate simultaneously four to five hours before a snowstorm. Tracks revealing den locations were not visible anywhere following the storm. Haroldson et al. (2002) investigated denning chronology and possible correlations to weather using monthly minimum and maximum temperatures, mean temperatures, mean precipitation, and snow depth; they did not detect the correlation reported by Craighead and Craighead (1972). In fact, Haroldson et al. (2002) did not detect any significant correlations to weather. Their investigation did yield critical chronology data however. Mean week of den entry of female grizzly bears in the GYE was the first week in November and ranged from the fourth week in September to the third week in December. Mean den emergence among females was the third week of April and ranged from the third week in March to the fourth week in May. Females who emerged from dens with cubs typically denned longer than other classes, averaging 171 days. Mean den entry for males was the second week in November and ranged from the second week in October to the second week in December. Mean den emergence among males was the fourth week in March and ranged from the first week in February to the fourth week in May. Males denned for the shortest period, averaging 131 days. Following emergence females with cubs restricted their movements to within 3 km of den sites until late May. All other bears likely moved to snow-free elevations soon after emergence. Mean elevations used by all classes converged in late May.

Dispersal

Natal dispersal of weaned male offspring is common and distances are often substantial. In the GYE, subadult males are known to disperse 45-105 km through "relatively friendly" habitat, moving on average 70 air km away from the maternal range (Blanchard and Knight 1991). Females, on the other hand, generally exhibit natal philopatry and establish a home range that overlaps somewhat with the maternal range and includes habitat never used by the mother.

Though grizzly bears exhibit home range fidelity, adults, especially males, are known to wander beyond and occasionally abandon home ranges. These behaviors are more common when important food items are scarce.

Natural barriers to dispersal resulting in isolation subpopulations or formation of a metapopulation do not exist in the GYE. However, some behavioral barriers do exist for many bears in the GYE. Such barriers are the product of behavioral responses of grizzly individual bears to certain human altered habitats. It is important to note that a certain behavioral barrier for one individual bear is not necessarily a barrier to all or even most other individuals. Roads for instance, may function as significant behavioral and/or structural barriers to dispersal. Effects of roads on long distance adult dispersal are discussed in greater detail in "Population Extent and Connectivity Trends."

Migration

Grizzly bears are generally considered non-migratory, though they often travel over very large areas and do exhibit seasonal shifts in use of elevation zones.

Daily Activity

Yellowstone grizzly bears are primarily crepuscular in all three of the active seasons with increased diurnal activity in spring. Grizzly bears in the GYE are less active than average during periods of no precipitation and more active during rainy periods. Temperature variations also have a noticeable effect with a peak of activity occurring around 50° F. Foraging frequently occurs at known and predictable high quality food sources or involves a wandering search, particularly when food is scarce. Wandering searches increase the probability of encountering carrion or other high energy food sources. During 8-12 hour periods of activity bears alternate foraging with resting.

Reproduction and Survivorship

Breeding Behavior

Grizzly bears are polygamous (Pasitschniak-Arts 1993). Male grizzly bears can sire litters with multiple females in a breeding season. Fights between males may erupt when competitors pursue a female at the same time. Dominant males often attempt to sequester a receptive female in estrus. Pair bonds may last a few hours or several weeks. Females may mate with multiple males resulting in a litter with offspring sired by different males (Craighead et al. 1995).

Breeding Phenology

Breeding occurs in late spring. In YNP, the earliest date of observed copulation was 18 May and the latest was 11 July (Craighead et al. 1995). Duration of estrus varies among females and years and may last 10-30 days (Pasitschniak-Arts 1993). Females may enter estrous more than once during the breeding season. In YNP females may have two estrous periods (Foresman 2001). Successful copulation may take 10–60 minutes. The mean duration of 64 successful copulations observed in the mid-1960s at YNP open-pit garbage dumps before their closure was approximately 24 minutes (Schwartz et al. 2003). Following copulation, females may be non-receptive for 4-18 days. This period probably coincides with follicular development following ovulation, after which females may mate again. The fertilized ova develop to the blastocyst stage and then arrest development. Embryonic diapause continues for approximately five months. Implantation occurs during winter dormancy in late November to early December, followed by a six to eight week gestation period and parturition (Pasitschniak-Arts 1993). Altricial young are born in the den between January and March; they are blind and weigh an average of 0.5 kg.

Females with new cubs are the last to emerge from hibernation. Lactation lasts 1.5-2.5 years. Offspring remain with the female for two to four years before weaning. This prolonged maternal investment enhances reproductive success by increasing the chance of cub survival to adulthood. Adoption and/or exchange of cubs among different maternal females have also been observed (Schwartz et al. 2003). Natal philopatry is common with many newly independent grizzly bears, especially females, continuing to reside within the maternal range.

Given the above information, population monitoring should occur in the spring following emergence from winter dormancy. Though females with cubs tend to be somewhat elusive and difficult to detect, surveys conducted annually at this time are sure to yield important data regarding cub survival.

Breeding Habitat

Mating can occur at concentrated food sources or in poor-quality foraging sites (Schwartz et al. 2003). Mated pairs observed in Denali were found in the areas where spring foraging items were most abundant. This pattern of habitat use likely enhances the probability of encounter between potential mates (LeFranc et al. 1987). Though grizzly bears do not appear to require undisturbed breeding sites, duration of copulation is influenced by privacy of the event (Craighead et al. 1995).

Human disturbance should be avoided during the breeding season to prevent interruption of pairing and copulation. Because parturition occurs during winter dormancy, den site security is particularly important. Interruption of hibernation and subsequent den abandonment are risky for adults and may be fatal to young (Linnell et al. 2000). Human disturbance should be avoided in the vicinity of dens with a female and offspring.

Fecundity and Survivorship

The grizzly bear has extremely low reproductive potential; it is often cited as the lowest reproductive potential of any mammal in North America. Age at first reproduction, litter size, and interbirth interval vary among populations and appear to be linked to body size and condition, which is positively related to diet quality (Schwartz et al. 2003).

Though sexual maturity may be reached at 3.5 years of age, breeding often does not occur until 4.5+ years old (Foresman 2001). Breeding, particularly in subadult females, does not always result in cub production the following spring. Of 15 Yellowstone females observed long enough, 7 produced first litters at 5 years of age, 5 at 6, 2 at 7, 0 at 8, and 1 at 9 (Craighead et al. 1995). Mean age at first litter production from this sample was 5.9 years. Reproductive longevity appears to approximate physical longevity. In North America and Sweden, maximum per capita litter production occurred at 8.7 years of age and reproductive performance remained high between 8 and 25 yrs of age (Pasitachniak-Arts 1993). In YNP, one female gave birth at 22.5 years and weaned her young two years later. The oldest live bear captured and aged was 25.5.

Litter size has been correlated with adult female body mass and intake of dietary meat and garbage and is related to latitude, climate, and a climate-carrion index. Litter size is also age related, with young and old females producing fewer cubs per litter than prime-age adults. Mean litter size in YNP was 2.24 cubs (Servheen 1987). Two cub litters are most common with one, three, or four cub litters less common (Clark and Stromberg 1987). Litter size has less demographic significance than age at first parturition, interbirth interval, and cub survivorship (Schwartz et al. 2003).

In North America interbirth interval is generally 3+ years and is related to maternal nutrition and litter loss before weaning. This is consistent with findings in Wyoming (Clark and Stromberg 1987). Production of litters subsequent to loss or weaning of offspring depends on maternal body condition, age, and other factors. Females in rich environments may be able to replenish body reserves faster and may be more likely to produce a litter in the year following litter loss or weaning than females in poor environments.

Reproductive rate (cubs/ female/ year) for grizzly bears is low and varies among populations; rates of 0.42 - 0.87 have been observed. Population ecologists are particularly interested in the number of female offspring produced per reproductive female per year. Average reproductive rate of Yellowstone grizzlies between 1975 and 1992 was 0.328 female cubs/ female/ year (Eberhardt et al. 1994). Low reproductive rate is counterbalanced by high annual adult survival. In fact, the YNP population appears to be increasing in light of this relatively low reproductive rate; the degree of increase, however, is debatable (Boyce et al. 2001, Eberhardt and Knight 1994, Eberhardt and Knight 1996, Pease and Mattson 1999).

Annual survival of adult females is high (>90%). Annual survival rate of adult females in Wyoming is 92.3% (Eberhardt et al. 1994). Adult male survival varies among populations but is generally lower in hunted populations. In protected populations however, the proportion of adult females and males is nearly equal as in YNP. In YNP and surrounding areas male survival to age 5 is substantially less than that of females. Differences in post-weaning survival rates between genders may be explained by gender-linked behavioral characteristics such as dispersal, denning chronology, home range size, and vulnerability to harvest. Survival of dependent young is generally lower than that of adults. Survival of subadult females is usually equal to or slightly less than that of adult females. Subadult female survival in Wyoming is 88.7%. Survival of male subadults can be variable but tends to be lower than that of the other independent bears. Yearling survival is usually greater than that of cubs. Documented cub survival in Wyoming is 84.5%.

Causes of grizzly bear mortality are numerous and often human-related. Because grizzly bears cannot sustain high mortality due to low reproductive rate, managers of small, threatened populations seek to reduce or control grizzly bear mortality, especially adult female mortality. Natural mortality can result from diseases, parasites, starvation, old age, intra- and interspecific killing, den collapse, rock fall, and snow avalanche (Schwartz 2003). Cub mortality is highly variable and can be as low as 13% or as high as 44%. Researchers in Denali National Park observed mortality rates as high as 100% with an average mortality rate of approximately 70% (Owen 2002). Though the exact cause of mortality in dependent young is often unknown because they are rarely radio-collared, most deaths are thought to be from natural causes. The primary causes of subadult and adult mortalities are human related. Hunting, management removal, and defense of life and property by citizens can constitute as much as 90% of recorded mortalities. Causes and rates of mortality documented in the GYE in 2001 are similar to those of recent years. Of the 31 mortalities documented during 2001, 20 (64.5%) were human-caused (Haroldson and Frey 2001). Human-related bear kills are usually in the vicinity of human facilities and access routes.

Population Demographics

Limiting Factors

The primary factor limiting population growth and geographic expansion within the GYE is human-caused mortality, supplemented by ongoing habitat loss and lack of secure habitat outside of currently occupied range. Though the Yellowstone population appears to be increasing (Eberhardt and Knight 1996) and expanding its range (Schwartz et al. 2003), it is generally understood that it is nearing carrying capacity and undergoing K selection over much of its core range (Mattson and Reid 1991).

Metapopulation Dynamics

The Yellowstone grizzly bear population does not currently function as a metapopulation. Individuals range widely across most environmental types in the area, precluding any substantial within-GYE patchiness of the population. Most grizzly bear researchers and managers accept that there is no exchange of individuals with other grizzly bear populations to the north in Idaho and Montana.

Genetic Concerns

Despite a slight decline in genetic diversity in the Yellowstone grizzly bear population, evidenced by a drop in allelic diversity since the early 20th century, genetic factors are not likely to have a substantial effect on the viability of the population over the next several decades (Miller and Waits 2003). To counteract or prevent inevitable genetic consequences of inbreeding and isolation and to maintain genetic variability of the Yellowstone grizzly bear over the long term, gene flow via artificial transplantation or natural movements of one to two individuals per generation will be required within several generations.

Food Habits

Food items

Grizzly bears in the GYE utilize a variety of foods including whitebark pine seeds, army cutworm moths, ants, earthworms, rodents, spawning cutthroat trout (*O. c. bouvieri, O. c. lewisi, O. c. pleuriticus)*, ungulates (especially newborns, winter-killed and winter-weakened individuals, and rut-weakened adult males), gut piles of hunter killed ungulates, fungal sporocarps, horsetails (*Equistem arvense*), graminoids, forbs, berries, roots (especially of biscuitroot) and anthropogenic foods such as garbage, pet food, and livestock (Kendall 1980, Mace et al. 1997, Mattson 2001, Mattson et al. 1991a, Mattson et al. 1991b, Mattson et al. 2002a, Mattson et al. 2002b, Mattson and Reinhardt 1995, Mattson and Reinhardt 1997, Schwartz et al. 2003). Of these items, ungulates and whitebark pine seeds appear to be the two most important foods for Yellowstone grizzly bears (Mattson et al. 1992).

Ungulate meat is a major food source for Yellowstone grizzly bears, especially in spring when pine seeds and herbaceous biomass are unavailable. Mattson et al. (1991a) found that ungulate remains constituted a major portion (nearly one half) of early-season scats. Though in some years grizzly bears may ignore this food source in favor of an unusually good crop of some preferred plant, in other years grizzly bear survival may depend largely on this spring use of ungulates. On average, ungulate meat comprises nearly half of the annual energy intake for adult females and more than half for adult males (Reinhardt et al. 2001). Winter-killed and winter-weakened ungulates form the bulk of grizzly bear food in this context, with a lesser number of healthy young and even adults actively killed by bears.

Whitebark pine seeds are an important food for grizzly bears in most areas, and are critical to grizzly bears in Wyoming. The abundance of this food item can significantly influence fecundity; female grizzly bears who use whitebark pine seeds extensively reproduce at an earlier age, produce litters more frequently, and produce more three-cub litters than females who do not utilize this food item (Reinhardt et al. 2001). Unfortunately whitebark pine have been eliminated or significantly reduced over much of its former range by an exotic fungus, white pine blister rust

(*Cronartium ribicola*) (Schwartz et al. 2003). Though most stands in the GYE persist, white pine blister rust is present and appears to be spreading.

Whitebark pine seeds are particularly important because of their high fat content and potential abundance during pre-hibernation hyperphagia. Grizzly bears feed on pine seeds almost exclusively when available. Pine seeds composed a substantial portion of fecal volumes May through October, with peak representation in September and October following maturation of the current year's crop (Mattson et al. 1991a). Seeds are acquired primarily by extraction from cones excavated from red squirrel (*Tamiasciurus hudsonicus*) middens, typically in mature stands (Mattson et al. 1992). The probability of a bear excavating a midden is positively related to size of the midden and to whitebark pine basal area and cone crop size, and is negatively related to nearness of roads and towns (Mattson and Reinhardt 1997). It is important to note that low elevation whitebark pine habitat is the primary source of this critical food item, because within the whitebark pine zone, red squirrels are more abundant at lower elevations.

The grizzly bear diet varies seasonally and yearly depending on the availability of high-quality foods. When preferred foods are not available grizzly bears will shift to eating lower quality foods. For instance, grizzly bears consume ants more heavily during years when known high-quality foods are scarce. Ants generally are not an important source of energy for Yellowstone grizzly bears (averaging <5% of fecal volume at peak consumption) but are likely to become a more important food as currently important foods decline because of disease and regional climate warming (Mattson 2001). Mattson. (2001) noted that grizzly bears tended to select large ants (>8 mm long) nested in logs over small ants (<6 mm long) nested under stones. Large ants were consumed at low elevations or on southerly aspects where there was abundant, large-diameter, well-decomposed woody debris under an open forest canopy. Moderately decomposed logs with a

4-5 dm diameter midpoint were most commonly selected. Ants nested under stones were consumed at low elevation non-forested sites.

Army cutworm moths are also be an important food item for grizzly bears in the GYE. Mattson et al. (1991b) observed greater use of aggregated army cutworm moths during July and August of years when high quality foraging alternatives were absent. Grizzly bears in the Shoshone National Forest were most often observed utilizing aggregated army cutworm moths at elevations above 3350 m on or near alpine talus with slopes greater than 30 degrees and south and west facing aspects.

Foraging Strategy

Grizzly bears are opportunistic omnivores capable of shifting foraging strategies seasonally and annually to take advantage of changing availability of various resources. During years of small seed crops bears exhibit greater movements and use lower elevations more frequently. Availability of whitebark pine seeds is a strong influence on the distribution of grizzly bears and the level of conflict between bears and humans. Mattson et al. (1992) observed that grizzly bears made very little use of areas near human facilities in the GYE during years of large pine seed crops, spending much of their time in whitebark pine habitat at higher elevations. In poor seed crop years, however, grizzly bears used areas near to roads and developments twice as intensively foraging for alternate native foods items. Consequently, mortality rates were 2.3 times higher for adult females and 3.3 times higher for subadult males, and the number of management trappings were on average 6.2 times higher in these years.

Excluding subadult siblings and females with offspring, grizzly bears generally forage alone. Interestingly, adult grizzly bears often tolerate the presence of non-related individuals at concentrated food sources. For instance, Yellowstone grizzly bears commonly congregate at army cutworm moth aggregation sites and at streams supporting spawning cutthroat trout. Such congregations may be risky for young bears. Mattson and Reinhardt (1995) observed that trout-eating females were less fecund than other females and lost a larger percentage of their dependent young. These cub losses likely resulted from higher rates of intraspecific killing by bears aggregated at spawning streams (Mattson and Reinhardt 1995).

Foraging Variation

In order to conform to the changing availability of high-quality foods and respond to digestive and nutrient constraints, large-scale seasonal diet switching occurs. This is evidenced by monthly variation in scat composition (Mattson et al. 1991a).

Grizzly bears are first active in the spring at high elevations near den sites. Use of carrion and predation of winter-starved moose (*Alces alces*) and elk (*Cervus elaphus*) peaks in early spring and remains high through May as herds disperse to summer ranges (Harting 1985). Yellowstone grizzly bears begin to eat herbaceous material as soon as it becomes available. Graminoids are consumed heavily in May and June, horsetails in June and July, forbs throughout the active season especially in July, roots throughout the active season, and fleshy fruits such as whortleberry, huckleberry, and buffaloberry (*Shepherdia canadensis*) in August. Truffles and mushrooms are consumed in August and September. Earthworms are consumed in April and May. Cutthroat trout are consumed during the spawning season (May 1 through July 15). Aggregated army cutworm moths are consumed June through September. Ants are consumed during the warmest months (usually July and August). Whitebark pine seeds are consumed throughout the active season especially during September and October.

Seasonal shifts in distribution may occur when animals move to new areas in order to exploit some or all of these items as they become available.

The diet of young animals does not appear to vary from that of adults and resource partitioning between sexes is not observed. Small and young bears and females with dependent young may avoid larger male bears. This avoidance behavior sometimes results in these bears utilizing poorer quality foraging sites.

Community Ecology

Being omnivores, grizzly bears are not highly efficient predators; as such the majority of their nutritional needs are met via herbivory (Craighead et al. 1995). The grizzly bear's role as a carnivore in the GYE is first as a scavenger, second as a predator of small prey species and third as predator of large prey (Craighead and Craighead 1972). On average, ungulate meat comprises nearly half of the annual energy intake for adult females and more than half for adult males (Reinhardt et al. 2001). Grizzly bears also scavenge or opportunistically prey upon birds, fish, rodents, ants, moths, bees, beetles, earthworms, grubs, and other invertebrates.

Limited dietary overlap between grizzly bears and other species has not resulted in substantial competition in the GYE, with the possible exception of black bears. Direct competition with black bears is minimized by temporal segregation; when the 2 species interact, grizzly bears typically displace black bears, with occasional killing and scavenging of the latter by the former.

Grizzly bears also interact with gray wolves (*Canis lupus*) at carcass sites, usually with some aggression. However, it is generally understood that grizzly bears have benefited from the re-establishment of wolves in the GYE, because wolf predation increases the availability of carrion across the landscape during all seasons. There are anecdotal reports of some male grizzly bears not denning during some years because the availability of carrion from wolf kills is high throughout the winter.

Although grizzly bears may be afflicted with a variety of diseases and parasites (Servheen 1987), major die-off in a grizzly bear population linked to disease or parasites has not been observed (Schwartz et al. 2003). Diseases observed in grizzly bears include Leptospirosis, Clostridium, Toxoplasmosis, canine distemper, rabies, neoplasms, and hypothyroidism. Endoparasites commonly found in grizzly bears are *Trichinella* and *Baylisascaris* species. Grizzly bears tend to be relatively free of ectoparasites, being host to only two genera of fleas and one tick species. Because a grizzly bear succumbs to such ailments only "occasionally" (Schwartz et al. 2003, p. 571), susceptibility to disease and parasites does not contribute to intrinsic vulnerability of this species at the present time.

Conservation

Conservation Status

USDI Fish and Wildlife Service

The grizzly bear was listed as "Threatened" in the lower 48 States under the ESA in 1975 (Federal Register 40, 145:31734-31736). A "Threatened" species is likely to become in danger of extirpation, in the foreseeable future, throughout all or a significant portion of its range. As a Threatened species, grizzly bears are protected wherever they occur in the lower 48 States. In addition, federal and state agencies are required to consult with the Fish and Wildlife service on any actions that may affect the species. This federal designation supercedes all other classifications.

USDI Bureau of Land Management

The grizzly bear does not appear on the Sensitive Species list maintained by the Wyoming State Office of the USDI Bureau of Land Management (BLM); this list explicitly excludes species already designated by the USDI Fish and Wildlife Service (USFWS) as Endangered or Threatened.

<u>USDA Forest Service</u>

Similar to the BLM, the USDA Forest Service (USFS) does not list the grizzly bear on its Sensitive Species lists because of the taxon's overriding designation as Threatened under ESA.

<u>State Wildlife Agencies</u>

The Wyoming Game and Fish Department classifies the grizzly bear as a "trophy game animal" (W.S. 23-1-302) (Moody et al. 2002). Once de-listed by the USFWS, this designation then places management of the species under the authority of the Game and Fish Commission and empowers that body to set hunting seasons and bag limits, and establish areas in which trophy game animals may be taken. Currently, the state prohibits hunting of grizzly bears in accordance with the ESA designation.

<u>State Natural Heritage Program</u>

The grizzly bear has been ranked **G4/ S1** by the Wyoming Natural Diversity Database (WYNDD; University of Wyoming). The **G4** indicates the species is relatively secure from extinction across its continental range; **S1** indicates a relatively high chance of extinction from the state of Wyoming. Also, WYNDD assigns a Wyoming Contribution Rank of **Low** to grizzly bears, which indicates that Wyoming populations contribute relatively little to the continental persistence of the species; this essentially reflects the low amount of total continental range that falls within the state.

Biological Conservation Issues

Abundance

Grizzly bear populations in the lower 48 states declined from more than 50,000 animals in 1800 to less than 1,000 grizzly bears in 1975 (USFWS 1993; Figure 1). Extirpation from the Great Plains occurred as fur trapping, mining, ranching, and farming pushed westward. As the mountainous areas were settled, logging and recreational development contributed to the increase in human-caused mortality of grizzly bears. The five remnant populations remaining below the Canadian border are stable but vulnerable to extinction without extensive management.

Grizzly bears of the NCDE and GYE populations are responding well to improved conservation efforts, exhibiting population growth and range expansion. The NCDE population is large, roughly 400-500 animals. The minimum population estimate of the grizzly bear population in the GYE is 365 with a maximum population estimate of 531. The status of the remaining three populations are poor and far below the levels necessary for viability. The Selkirk population is estimated to be 25-35 bears including Canada's portion of the population. The U.S. portion of the Cabinet-Yaak population includes 20-30 individuals. The U.S. portion of the northern Cascades population in Washington is very small, consisting of perhaps only five animals. Research is being conducted to monitor status of these remaining populations.

Because accurate estimates of grizzly bear abundance are difficult to obtain, wildlife managers count females accompanied by newborn cubs, the segment of the population most readily recognized. Counts of females with cubs of the year observed by qualified personnel are tallied with location, date, pelage color, size, and number of cubs. These counts yield a known minimum number of adult females alive to reproduce. Number of unduplicated females with cubs must offset existing mortality in the ecosystem. This parameter alone cannot be used to indicate trends or precise populations size, but it can be used to derive a minimum population estimate.

Minimum pop size and allowable numbers of human-caused mortalities are calculated as a function of the number of unique females with cubs of the year seen during a 3 year period. Keating et al. (2002) described the methods used to estimate the total numbers of adult females from counts of unduplicated females with cubs. This number is then used to estimate total population size. Population trends are based on a six-year running average.

Numerical targets of unduplicated females with newborn cubs for populations in the GYE, NCDE, Cabinet/Yaak Ecosystem, and Selkirk Ecosystem are 15, 22, 6 and 6 respectively (USFWS 1993). These numerical targets are conservative because not all females with cubs of the year are observed and there is a conservative protocol for excluding possible duplicate counts of individuals.

Trends

Abundance Trends

Prior to European settlement grizzly bears were abundant across much of western North America (Figure 1). Significant declines in populations resulting from persecution and habitat loss continued into the 1950s and later. Though abundance continues to be impacted by human-caused mortality and habitat loss, status of remaining populations has improved somewhat since the species was listed as threatened under the Endangered Species Act in 1975.

The Yellowstone grizzly bear population appears to be increasing at a rate of 4.6% per year (Eberhardt and Knight 1994). Annual average counts for unduplicated females in the Yellowstone grizzly bear PCA were 19.8 between 1987 and 1992. This number exceeds the numerical target of 15. These years were also characterized by relatively few human-caused mortalities. The annual average known human-caused female deaths was 1.8 and annual average known human-caused deaths of all bears was 4.0. These numbers are significantly below the annual average limit of 3 human-caused female deaths and 9 total human-caused deaths (USFWS 1993).

The abundance trend of the grizzly bear population in the NCDE between 1987 and 1992 is less obvious. The annual average of unduplicated females with cubs in or near the PCA was 24.6 females, slightly higher than the target set at 22. Average annual known human-caused female deaths was 5.7. This number exceeded the annual average limit of 4 known human-caused female deaths per year. Annual average of known human-caused deaths of all bears was 11.3, just under the limit set at 12 deaths per year.

The population in the Selkirk Ecosystem appears to be increasing (Servheen 1999). At the time of this document, information on the status of the populations in the North Cascades, Cabinet/Yaak Ecosystem was unavailable.

Population Extent and Connectivity Trends

Though grizzly bears once inhabited much of western North America, their distribution in the lower 48 States is now patchy and fragmented (Figure 1). Movement of individuals between the five remaining populations has not been documented; the GYE population is considered to be completely isolated from the others. A linkage zone assessment is underway to identify potential for connectivity among Rocky Mountain populations because preserving linkage between populations is a more legitimate long-term conservation strategy than are attempts to manage separate island populations.

Linkage zones are areas between currently separated populations that provide adequate habitat for low densities of individuals to exist and move between two or more larger areas of suitable habitat. Females should be able to live and reproduce in these zones and serve as “demographic stepping stones” between recovery areas (Noss 1996). “Linkage zones enhance the viability of populations that are separated by some distance by facilitating the exchange of individuals and maintaining demographic vigor and genetic diversity" (USFWS 1993, p. 24). Unfortunately, because much of the intervening areas are characterized by the presence of major highways, human developments, and agricultural lands, potential connectivity is unlikely (Servheen et al. 2001), especially between the GYE and other populations in the Northern Rocky Mountains (Bader 2000, Boon and Hunter 1996, Mattson and Reid 1991). Interestingly, gene flow into the GYE from the north was historically restricted (Miller and Waits 2003).

Gore et al. (2001) identified critical wildlife linkage habitat within the GYE. High priority areas needing immediate attention in Wyoming include Highway 89 from Alpine to Moran Junction and Highway 287 from Moran Junction to Dubois.

Habitat Trends

Destruction and fragmentation of grizzly bear habitat has contributed to their elimination from most of their former range and is the leading threat to continued persistence of remaining populations today. Primary causes of grizzly bear habitat loss and fragmentation in recent years are human activities such as road building, and residential, recreational, and commercial developments (Servheen et al. 2001). Roads are particularly deleterious because they promote degradation of adjacent habitat, permit and accelerate development in new areas, and heighten human access to grizzly bear habitat thereby increasing human-bear encounters and human-caused mortality. Doak (1995) demonstrated that habitat degradation associated with roads and developments can have highly nonlinear effects on population growth rates, with small amounts of degradation leading to large decreases in overall population growth. In fact, Doak (1995) found that areas near roads and developments serve as population sinks in the GYE and conversion of only 0.5% of the total habitat per year can lead to rapidly worsening pop dynamics. Roads can also function as structural or behavioral barriers to movement and avoidance of areas near roads and developments by grizzly bears results in substantial habitat loss (Kasworm and Manley 1989).

Ironically, studies have linked the rapid population growth in many western communities since the late 1980's to the demand for wildlife amenities. Unfortunately this development is not following the traditional pattern of concentrated growth in areas adjacent to urban centers and instead extends to very remote locations often bordering national forests and parks (Ingram and Lewandrowski 1999). For grizzly bears and other wildlife, the associated construction of homes, businesses, and infrastructure is diminishing, degrading, and fragmenting habitat.

The negative impacts of human developments and the degree of fragmentation are influenced by the spatial arrangement of the developments. In the Rocky Mountain west, developments usually occur in a linear fashion along valley floors, habitats commonly used by grizzly bears as foraging sites and travel corridors. When development reaches a certain concentration, bears can no longer cross the valley or use it as habitat. The four populations remaining in the southern Rocky Mountains are separated by valleys containing human developments of varying intensity. As development increases in these areas they become increasingly effective barriers to movement between recovery zones.

The Bitterroot Ecosystem in the Selway-Bitterroot Wilderness Area in Idaho and the North Cascades Ecosystem in Washington are unoccupied or under occupied by grizzly bears due to human induced population decline or extirpation, but they contain sufficient amounts of quality habitat to warrant grizzly bear recovery (USFWS 1993). Reintroduction into the San Juan Mountains in Colorado is also being considered.

Range Context

Despite its isolated nature, preservation of the grizzly bear population in Wyoming is important to the conservation of the species. Wyoming's grizzly bears constitute a significant portion of the number of bears remaining in the lower 48 States and represent the southernmost area of persistent occupation on the continent (Figure 1). Northwest Wyoming is one of only six or seven regions currently offering sufficient amounts of quality habitat capable of supporting a viable population of grizzly bears.

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts

The key reasons for decline of grizzly bears in North America are excessive human-caused mortality and habitat loss (Schwartz et al. 2003). Until about the 1950's excessive human-caused mortality was an intentional social response to fear of the animals and their purported danger to people and livestock. This response has become less prevalent in recent years and is no longer the primary reason for bear deaths. Today, excessive human-caused mortality from hunting, management removal, and defense of life and property by citizens constitutes as much as 90% of recorded mortalities. Human-related bear kills are usually in the vicinity of human facilities and access routes. In fact, Doak (1995) demonstrated that otherwise suitable habitats within 6 km of developments, 3 km of primary roads, or 1.5 km of secondary roads are population sinks for Yellowstone grizzly bears. These areas comprise one-third of the GYE and accounted for 70% of all known mortalities occurring in the GYE from 1983 to1990. The per capita mortality rate of grizzly bears in these areas is approximately five times the mortality rate in all other areas of the GYE. Because grizzly bear populations cannot sustain high mortality, managers of small, threatened populations seek to reduce or control human-related grizzly bear mortality.

Reducing and preventing human access to bear habitat will reduce the occurrence of human-bear encounters thereby greatly reducing mortality rates. However, increasing road densities threaten to promote and accelerate human-related mortality and habitat loss. For more information on roads and habitat loss see "Habitat Trends" and "Population Extent and Connectivity." See "Sensitivity to Disturbance" for implications of road avoidance by grizzly bears.

Invasive Species

Lake trout (*Salvelinus namaycush*) and white pine blister rust pose significant indirect threats to grizzly bears in the GYE (Reinhardt et al. 2001). Lake trout depredation resulting in reduction or elimination of native Yellowstone cutthroat trout in Yellowstone Lake can alter energy flow to consumers at higher trophic levels, including grizzly bears. Cutthroat trout are vulnerable to predation by a number of terrestrial and aerial species because they spawn in shallow water; lake trout on the other hand are unavailable to grizzly bears because they spawn in deep water. Decreased availability of cutthroat trout would have a tremendous impact on bears who rely on this important food source, roughly 10-30% of the population.

White pine blister rust infects and kills whitebark pine. The exotic fungus is present in the GYE but its rate of spread is not as great as has been observed in wetter areas. Grizzly bears throughout the GYE consume seeds of whitebark pine, exclusive of other foods when available, and their consumption has substantial effects on birth and death rates. Loss of this critical food source could reduce fecundity of grizzly bears and carrying capacity of the GYE.

Genetic Factors

Miller and Waits (2003, p. 4338) state "the viability of the Yellowstone grizzly bear population is unlikely to be compromised by genetic factors in the near future," and "genetic consequences of inbreeding and isolation are likely to transpire over longer periods of time (decades and centuries)." Gene flow via artificial transplantation or natural movements of one to two individuals per generation will be required within several generations to maintain genetic variability of the Yellowstone grizzly bear over long time spans.

Stochastic Factors and Climate Change

Stochastic environmental events can impact grizzly bears indirectly by impacting important food sources. Long life span, large body size, and large home ranges allow grizzly bears to survive most stochastic events (Mattson and Reid 1991). Low densities and reproductive output, however, may make grizzly bears vulnerable to large-scale transgenerational disturbances such as those resulting from climate change. Historically, persistence of grizzly bears in the GYE may have required natural augmentation from contiguous populations to survive such generalized disturbances. Because natural augmentation no longer occurs and because the GYE may be only marginally viable on its own, such disturbances may be a threat to continued persistence of the Yellowstone grizzly bear population. Researchers are particularly concerned about impacts of future climate warming on two very important foods, seeds of whitebark pine and aggregated army cutworm moths. These two species occur at high elevations (>2500 m and >3100 m respectively) and are therefore highly susceptible to climate warming. Worst-case scenarios predict total elimination of these food sources in the GYE, and no other foods of the same quality are likely to replace them.

Intrinsic Vulnerability

Habitat Specificity and Fidelity

Grizzly bears occupy a variety of habitats throughout their range and within the GYE; in the classic sense, they are habitat generalists. However, grizzly bears clearly require large tracts of undisturbed land (i.e., areas of low human impact and density), and the distribution of such land is currently the primary constraint on the distribution of grizzly bears. Given that areas of low human density are becoming increasingly rare in the Central Rocky Mountains, it could be argued that grizzly bears are specialists in the sense that they prefer an unusual and increasingly uncommon environment. Similar to gray wolves and wolverines (*Gulo gulo*), the current distribution and habitat use of grizzly bears is not an unrestricted reflection of the environments within which they can maximize survival and reproduction, but rather a reflection of where they can persist under limits currently imposed by people.

Territoriality and Area Requirements

Grizzly bear populations clearly require huge areas of suitable habitat. Territoriality is not common in the Yellowstone grizzly bear population and therefore does not contribute to intrinsic vulnerability. Area requirements on the other hand may contribute to intrinsic vulnerability of this species in areas where habitat is limited and of poor quality because “even in a population where range overlap [is] common, core areas small, and territoriality rare, thousands of square kilometers of undisturbed habitat [are] necessary to support a population of several hundred animals” (Craighead et al. 1995, p. 302).

Susceptibility to Disease and Parasites

A variety of diseases and parasites are known to infect grizzly bears, as is to be expected for a large omnivorous mammal with a high degree of scavenging. However, grizzly bears have extremely effective immune systems and no pathogens are known to be significant health threats at a population level.

Dispersal Capability

Grizzly bears can travel great distances through diverse landscapes, and thus are not made vulnerable by restricted dispersal abilities. For instance, Craighead et al. (1995) observed a male transverse Mt. Washburn, a 3122-meter peak, at about the 2743-meter level, and cross the Grand Canyon of the Yellowstone River five times, traveling 93 air km over rugged terrain in eight days. The distance this male traveled on ground is estimated to be three times the distance by air. It appears the primary barriers to dispersal of Yellowstone grizzly bears are roads and human developments, especially those at the boundaries of their currently occupied range in the GYE.

Reproductive Capacity

Grizzly bear populations have extremely low reproductive capacities, and cannot persist in the face of high mortalities. Late age of first reproduction, small litter size, and long interbirth interval contribute to the low reproductive potential of this species. See "Fecundity and Survivorship" for additional details.

Sensitivity to Disturbance

Documented human disturbances include aircraft flying overhead, hydrocarbon exploration and development, hydroelectric development, timber extraction, recreational activities, and roads and highways. These disturbances may result in displacement and/or disruption of normal behavior patterns such as copulation, movement, denning, foraging, physiological arousal without overt behavioral response. Direct loss of habitat via avoidance of constant disturbance has been documented by a variety of studies.

Grizzly bears are particularly vulnerable to disturbance while denned, especially early in the denning period when abandonment is more likely to occur. Interruption of hibernation and subsequent den abandonment are risky for adults and may be fatal to cubs (Linnell et al. 2000). Podruzny et al. (2002) investigated denning and potential conflict areas in the GYE in response to increasing winter recreation use of step, high elevation backcountry areas. More than half of the defined denning habitat in unrestricted areas was potentially used by snowmobiles. The effects of snowmobile disturbance on denned grizzly bears have not been quantified, but are likely to be substantially negative.

Disturbances during the active seasons can alter activity budgets and impact caloric intake and expenditure. Grizzly bears disturbed while foraging on army cutworm moths by mountain climbers in Glacier National Park (Montana) spent 53% less time foraging, 52% more time moving within the foraging area, and 23% more time behaving aggressively, compared to when they where not disturbed (MacCracken and O'Laughlin 1999). Disruption of moth feeding cost these bears approximately 12 kcal/ minute in addition to the energy expended in evasive and defensive behaviors. Clearly, disturbances of significant duration and frequency have the potential to jeopardize the health and well being of affected bears and populations.

Highly sensitive to disturbances associated with roads and developments, grizzly bears avoid areas within 3 km of developments and within 4 km of roads (Mattson et al. 1986). Displacement from quality habitats in these areas may prevent dispersal, force bears to use poorer quality sites, increase intraspecific competition by further forcing more bears into limited remote habitat, and may cause social disruption in areas away from developments and roads (Kasworm and Manley 1989, McLellen 1989). Road avoidance may result in higher mortality and lower fecundity of displaced individuals (Mattson et al. 1986). Additional impacts of roads on grizzly bears are discussed in "Habitat Trends," "Population Extent and Connectivity Trends," and "Anthropogenic Impacts." Sensitivity to disturbances such as those discussed here may contribute to intrinsic vulnerability in landscapes frequented or altered by humans.

Protected Areas

In the contiguous U.S. the grizzly bear is classified as Threatened under the Endangered Species Act, and thus receives commensurate federal protection. The PCA of the Yellowstone grizzly bear population encompasses 9,209 mi^2. Thirty-nine percent (3,632 mi^2) of this area includes USDI National Park Service land. Fifty-nine percent (5,383 mi^2) of the land lies on contiguous portions of the Shoshone, Bridger-Teton, Targhee, Gallatin, Beaverhead, and Custer National Forests; much of this is federally designated wilderness. Bureau of Land Management lands, and State and private lands in southeast Idaho, southwest Montana, and northwest Wyoming constitute the remaining 2.1% (195 mi^2) of the PCA.

Conservation Action

Existing or Future Conservation Plans

The Grizzly Bear Recovery Plan (USFWS 1993) defines a sequence of actions that will provide for the conservation and recovery of the grizzly bear in selected areas of the lower 48 States. Delisting of the species depends on implementing these actions; de-listing procedures are expected to start in spring 2005.

Specific objectives of the recovery plan are to:

- Identify grizzly bear population goals that represent species recovery in measurable and quantifiable terms for the six to seven ecosystems containing suitable habitat.
- Provide a robust population monitoring approach that will determine if recovery levels are met and maintained.
- Identify population and habitat limiting factors that account for current populations existing at levels requiring Threatened status.
- Identify management measures needed to remove population and habitat limiting factors so that populations will increase to and remain at recovery levels.
- Establish a recovered population in each of the ecosystems where habitat is available to sustain a grizzly bear population.

The plan addresses seven areas where grizzly bears were known or thought to occur in 1975. These seven grizzly bear ecosystems either presently have or have had the potential to provide adequate space and habitat to maintain the grizzly bear as a viable and self-sustaining species.

Implementation of the recovery plan is the responsibility of Federal and State Management agencies in areas where the species occurs. Currently grizzly bears are present in the GYE, NCDE, Cabinet/ Yaak Ecosystem, Selkirk Ecosystem, and North Cascades Ecosystem. This recovery plan mentions the need to develop a plan for the North Cascades and identifies an objective of re-establishing a population in the Bitterroot Ecosystem. Grizzly bears are to be reintroduced to the Bitterroot Ecosystem as an "experimental nonessential" population when funding becomes available.

Indicators of population status and goals to be monitored include sufficient reproduction to offset existing levels of human-caused mortality, adequate distribution of breeding animals throughout the area, and a limit on total human-caused mortality, which is related to the previous two parameters (USFWS 1993).

Methods used to establish population targets and monitor status of populations and habitats are discussed in "Inventory and Monitoring."

The population and distribution demographic goals of the Yellowstone grizzly bear population in the PCA as described in the Final Conservation Strategy developed by the Interagency Conservation Strategy Team (2003) are:

- Six year average of 15 unduplicated females with newborn cubs within the PCA and 10 mile buffer
- Six year average of 16 of 18 Grizzly Bear Management Units occupied by females with young with no two adjacent units unoccupied
- Human-caused mortality must be equal to or less than 4% of the population estimate; no more than 30% of the total human caused mortality can be females; mortality limits must not be exceeded during two consecutive years inside the PCA and 10 mile buffer
- A stable or increasing population trend.

The Interagency Grizzly Bear Study Team was initiated in 1973 to monitor the status of the Yellowstone grizzly bear population and conduct pertinent research.

Conservation Elements

Inventory and Monitoring

Following listing under the ESA, there has been a push to standardize grizzly bear population and habitat monitoring methods. Three parameters monitored and measured to assess the status of populations are:

- Sufficient reproduction to offset human-caused mortality estimated from number of unduplicated females with newborn cubs
- Adequate distribution of breeding females throughout the recovery area determined by distribution of females with young or family groups within defined Grizzly Bear Management Units in the PCA
- Population viability determined from number of unduplicated females with newborn cubs, and female and total human-caused mortality.

Method used for estimating populations is described in “Abundance.”

Habitat monitoring is done in a variety of ways, including a Cumulative Effects Analyses (CEA) implemented through the Cumulative Effects Model (CEM) (USFWS 1993) that examines the influences of human and natural activities on grizzly bear habitat. The CEM can be used every five years by land management agencies to assess habitat trends. Grizzly bear habitats must be monitored to insure they continue to offer a wide range of vegetation types providing an abundance of natural foods and resting and denning sites. However, the most critical features to monitor are probably roads and associated human developments that lead to human-bear encounters and subsequent human-caused bear mortalities.

Habitat Preservation and Restoration

Grizzly bears and grizzly bear habitat may be most efficiently protected by preventing or mitigating human activities that result in bear mortality. Given that the intensity of human activity is positively correlated with the density of roads (and in the winter, the density of plowed roads and trails), closure and obliteration of roads is probably the most effective way to protect grizzly bears and grizzly bear habitat. Areas in which road densities are reduced for the protection of grizzly bears should be monitored to determine bear responses, because such information can lead to more refined manipulations of road densities in other areas. Reducing road densities may be most important in areas separating current populations, in order to facilitate inter-population exchange of individuals.

Augmentation and Reintroduction

The grizzly bear recovery plan calls for augmentation of populations when necessary and reintroduction into areas containing sufficient amounts of quality habitat. The North Cascades Ecosystem in Washington and the Bitterroot Ecosystem in Idaho are each being considered for augmentation and/ or reintroduction (USFWS 1993). The San Juan Mountains of southwestern Colorado are also being evaluated for potential use by grizzly bears. The possible need for augmentation in the GYE in the future is discussed in "Genetic Factors."

Information Needs

Rangewide Needs

The conservation and management of grizzly bears would benefit greatly from improved methods for estimating population abundance and assessing trends. This involves, in part, better methods of detecting and estimating human-caused grizzly bear mortality. Estimates of carrying capacity under current and projected climate conditions are also needed. Managers would benefit from better information on how human presence and developments alter bear behavior, and especially information on how behavior in the presence of humans is modulated by vegetative and topographic cover (Servheen et al. 2001). Research into bear behavior, movements, and habitat use will greatly assist in identifying and improving linkage zones that can re-connect existing population centers in the contiguous U.S. In the immediate future, grizzly bear managers may benefit the most from quantitative models relating grizzly bear reproduction and survival to road density and other manageable manifestations of human presence.

Wyoming Needs

With an apparently expanding grizzly bear population in the GYE, improved techniques for estimating population size are crucial (Moody et al. 2002). Monitoring efforts must be extended to areas beyond the PCA and 10 mi buffer to accurately assess range expansion. Though much of the land in the PCA is protected as National Park or USDA Forest Service Wilderness, much of the area outside the PCA is managed for multiple use. Consequently, information on how land management practices influence reproduction, survival, home range size, human-caused mortality, food habits, travel patterns, daily activity patterns, seasonal use of habitat, and denning sites is required. Gore et al. (2001) identified high priority linkage habitats in Wyoming; detailed mapping and assessment of these areas is needed to be prepared for managing expanded populations in the future. Predictive range mapping throughout the GYE would help management of grizzly bears in general, and especially help prepare for potential effects of climate change on distribution and abundance.

Tables and Figures

Figure 1: Current (green) and historic (purple) range of grizzly bears (Ursus arctos) in North America. Map based on Hall (1981), Mattson and Merrill (2002), and Patterson et al. (2003).

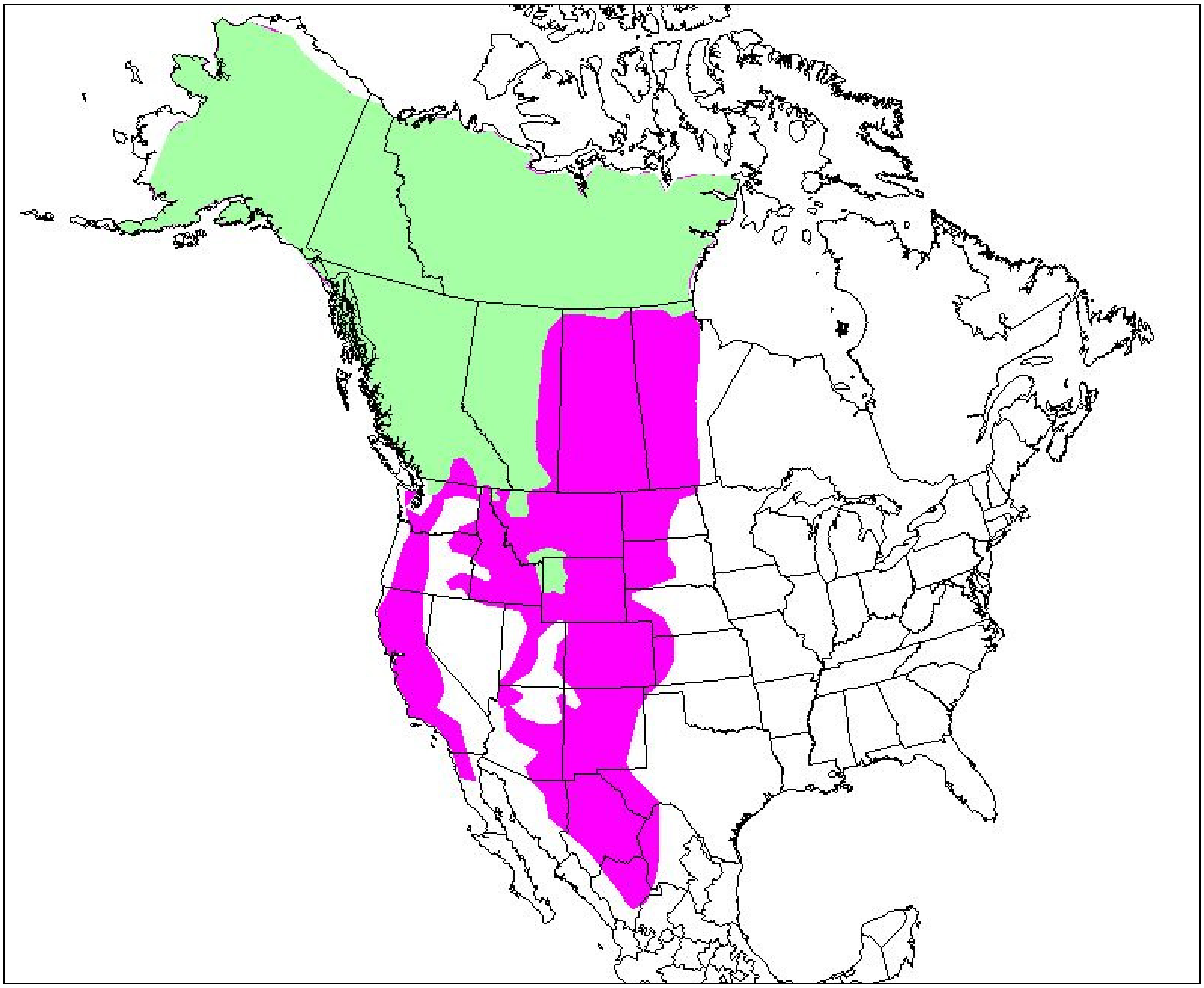
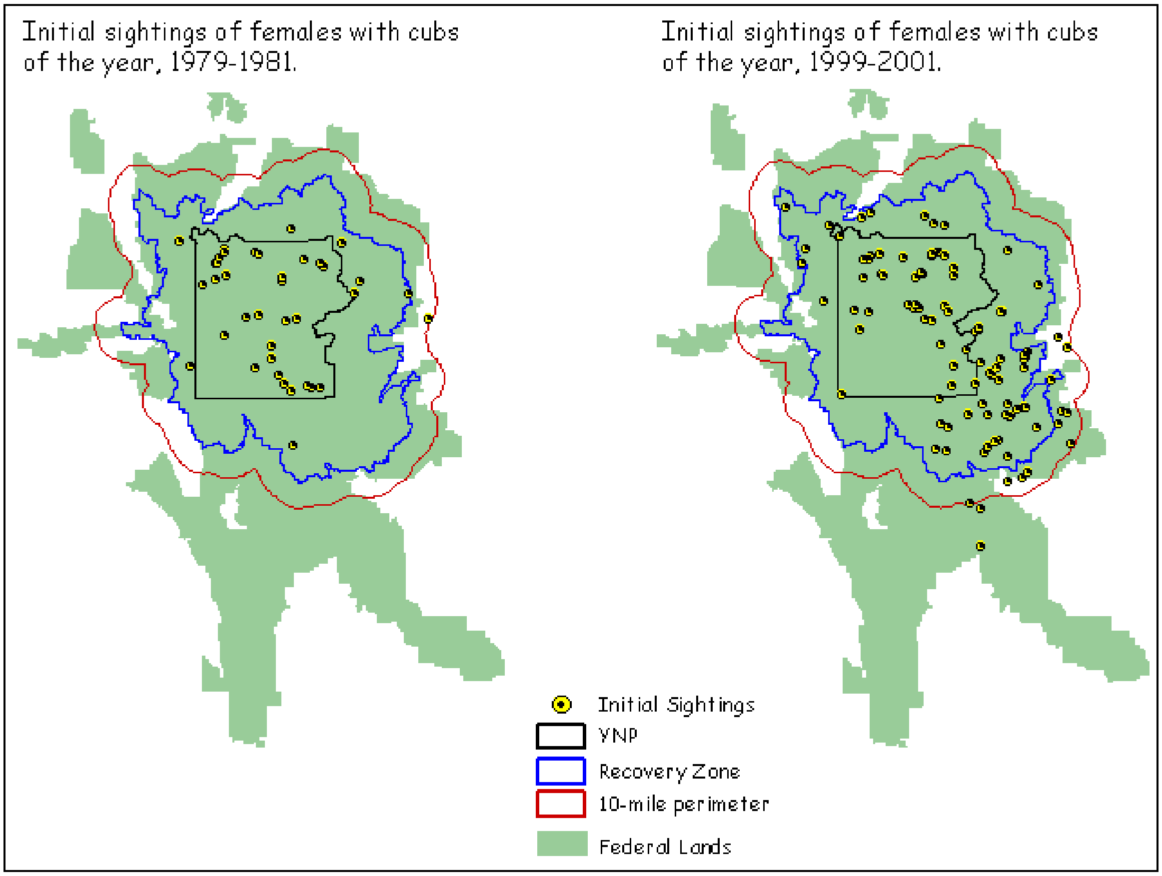


Figure 2: Distribution of female grizzly bears (Ursus arctos) with cubs in and around the Primary Conservation Area, 1979-1981 and 1999-2001. Source: Interagency Grizzly Bear Study Team homepage, http://www.nrmsc.usgs.gov/research/igst-home.htm. Permission for use granted by C. Schwartz.



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